

KATHARINA PERCH-NIELSEN

DER FEINBAU UND DIE  
KLASSIFIKATION DER COCCOLITHEN AUS  
DEM MAASTRICHTIEN VON DÄNEMARK

Det Kongelige Danske Videnskabernes Selskab  
Biologiske Skrifter **16, 1**



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## Synopsis

Aus dem Maastrichtien von Dänemark werden Coccolithen beschrieben und abgebildet, die im Lichtmikroskop und vor allem im Elektronenmikroskop untersucht worden sind. Die Coccolithen aus dem unteren Maastrichtien von Mon werden dabei besonders berücksichtigt.

Es wird hier vorgeschlagen, sich einer morphologischen Klassifikation für die Coccolithen des Mesozoikums zu bedienen. In dieser Arbeit wird den Regeln der botanischen Nomenklatur gefolgt.

Die Merkmale, die die systematischen Einheiten bestimmen sollen, werden wie folgt angenommen: Die Familien werden vor allem aufgrund der Ausbildung des Randes und der Grösse des Zentralfeldes unterschieden. So besteht der äusserste Randring der *Eiffellithaceae* aus sich dachziegelartig überlagernden Elementen. Die *Podorhabdaceae* besitzen ein grosses Zentralfeld und einen Randkranz, der aus nebeneinanderliegenden bis ineinandergreifenden Elementen besteht, sowie einen oder mehrere zusätzliche Randringe. Die *Ellipsagelosphaeraceae* haben ein kleines Zentralfeld und Randscheiben, die aus fächerförmig angeordneten oder nebeneinanderliegenden Elementen aufgebaut sind.

Die Gattungen werden unter anderem durch den Umriss der Coccolithen und die Bausteine des Zentralfeldes bestimmt, während die Arten vor allem durch die Anordnung der Bausteine des Zentralfeldes, die Form der Randelemente und die Ausbildung eines eventuell vorhandenen Fortsatzes voneinander unterschieden werden.

Es wird gezeigt, dass bei einigen Formen (*Cribrosphaerella ehrenbergi* und *Nephrolithus frequens*) ein linearer Zusammenhang zwischen dem grössten Durchmesser und der Anzahl Randelemente besteht der es erlaubt, diese Arten sehr weit zu fassen.

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## EINLEITUNG

In dieser Arbeit sollen die Coccolithen beschrieben und abgebildet werden, die am Aufbau der dänischen Schreibkreide so stark beteiligt sind. In einer späteren Arbeit wird deren Verbreitung und ihr stratigraphischer Wert näher untersucht werden.

Schon früher sind aus dänischen Sedimenten Coccolithen und verwandte Formen beschrieben worden. BRAMLETTE & SULLIVAN (1961) nennen Formen aus dem Tertiär, BRAMLETTE & MARTINI (1964) solche aus dem Maastrichtien und dem Danien, und in PERCH-NIELSEN (1967 a, b) finden sich auch im Elektronenmikroskop untersuchte Formen des Tertiärs. Aus den Kreideablagerungen der Nachbarländer wurden ebenfalls verschiedentlich Coccolithen beschrieben. ÅBERG (1966) berichtet über Formen aus dem Maastrichtien von Skåne (Südschweden) und REINHARDT (1964, 1965, 1966, 1967) hat sich in mehreren Arbeiten mit den Coccolithen vor allem des Maastrichtiens von Rügen beschäftigt. Auch aus Polen liegen Arbeiten über Coccolithen der untersuchten Periode vor: SUJKOWSKI (1931) und GORKA (1957, 1963), sowie DEFLANDRE (1959). BLACK (1959, 1964, 1965, 1967) hat mehrere Arbeiten mit Elektronenmikroskopaufnahmen von Coccolithen aus der Kreide Dänemarks und Englands publiziert. Über Coccolithen aus Holland und Frankreich hat zuletzt STOVER (1966) berichtet.

Eine Übersicht über die Geschichte der Erforschung der Coccolithen findet sich in der Arbeit über jurassische Formen bei NOEL (1965), wo auch Angaben über die Biologie der rezenten Formen gemacht werden.

Mein tiefster Dank für die der Arbeit erwiesene Förderung und deren Durchsicht gilt Frau Prof. Dr. T. BIRKELUND. Für die Überlassung von Probenmaterial sowie für manningssache Hilfe möchte ich Frau Prof. Dr. K. POZARYSKA, Fräulein Dr. GORKA, Herrn Priv. Doz. Dr. E. MARTINI und Herrn Dr. P. REINHARDT herzlich danken. Endlich danke ich dem Carlsbergfond für die finanzielle Unterstützung der Feldarbeiten und „Japetus Steenstrups legat“ für die Ermöglichung einer Studienreise nach Polen.

## PROBEENTNAHME UND PROBENAUFBEREITUNG

Die zur Untersuchung auf Nannoplankton im unteren Maastrichtien gesammelten Proben wurden gleichzeitig mit Proben von ca. 20 kg zur Untersuchung der Makro- und Mikrofossilien alle  $1\frac{1}{2}$  m an Profilen auf Møn am Klint entnommen. Die Proben

wurden im Laboratorium luftgetrocknet und dann in Plasticbehältern aufbewahrt. Da Verunreinigung einer Probe nur sehr schwer zu vermeiden ist, wenn am selben Tag viele verschiedene Proben gesammelt werden, wurde zur Untersuchung ein Stück Kreide aufgebrochen und von der frischen Bruchfläche mit einer Präpariernadel Material abgekratzt und in ein Zentrifugierglas fallen gelassen. Nach Zugabe von destilliertem Wasser wurde die Probe geschüttelt und wenn nötig mit Ultraschall behandelt und anschliessend zentrifugiert (EDWARDS 1963). Dabei wurde jedoch nur die feinste Fraktion weggeschüttet, so dass die Untersuchungen alles gröbere Material umfassten und hie und da auch kleine Foraminiferen auf den Präparaten erschienen. Damit war Gewähr geleistet, dass auch etwaige Coccospaeren nicht verloren gingen. Von dieser Aufschlammung wurde mit einem Trinkrörchen etwas aufgesaugt und ein Tropfen davon auf einem mit einer Formvarhaut belegten Kupfernetz sedimentieren gelassen. Einige Präparate wurden dann, in Methylisobutylketon eingebettet, im Lichtmikroskop untersucht. Anschliessend wurde in Vakuum Kohle schräg aufgedampft, der Kalk mit verdünnter Salzsäure aufgelöst, das Präparat mit destilliertem Wasser gespült und dann getrocknet und im Elektronenmikroskop betrachtet (PERCH-NIELSEN 1967 a). Andere Präparate wurden nur im Elektronenmikroskop untersucht.

## STRATIGRAPHIE

Die meisten der hier beschriebenen und abgebildeten Coccolithen stammen aus den an Møns Klint im unteren Maastrichtien aufgenommenen Profilen A und B. Profil A wurde am sogenannten „Hvidskud“ geschlagen, während Profil B am südlicher gelegenen „Hundefangsklint“ aufgenommen wurde. An beiden Aufschlüssen fallen die Lagen mit ca. 40° gegen Süden ein. Die Proben A 1–A 3 und B 1–B 38 liegen über dem „Hardground“ in einer Zone mit *Belemnella occidentalis*. A 4–A 28 wurden dem tieferen Teil des Profiles entnommen, in welchem *Belemnella lanceolata* auftritt. Ausserdem wurden Coccolithen verschiedener dänischer Lokalitäten im oberen Maastrichtien und Danien, darunter Stevns Klint und Kjølby Gård, untersucht.\* Zur Untersuchung stand mir ebenfalls Material von den Typuslokalitäten mehrerer Gattungen und Arten, die in der Kreide aufgestellt wurden, zur Verfügung.

## SYSTEMATIK

Vor der systematischen Beschreibung der untersuchten Formen seien die Probleme der Klassifikation der fossilen Coccolithen diskutiert. Zuerst sollen diese Probleme dargelegt werden und verschiedene Klassifikationen diskutiert werden. Nachher werde ich den im folgenden angenommenen Standpunkt als Vorschlag zu einer morphologischen Klassifikation darlegen und erläutern.

\* Das Danien wird hier als Unterstes des Tertiärs aufgefasst.

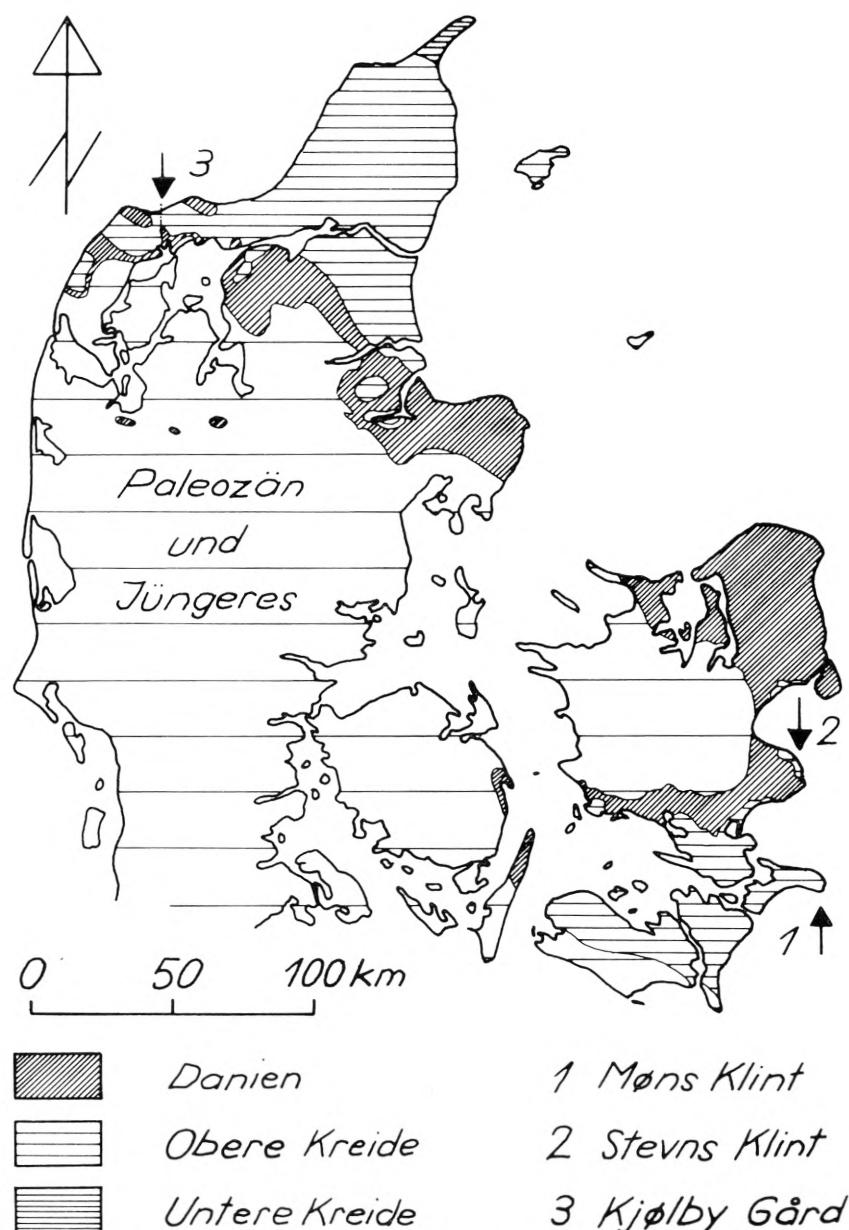


Fig. 1. Geologische Übersichtskarte von Dänemark, unter Weglassung des Quartärs.

## 1. Probleme der Klassifikation der fossilen Coccolithen

### 1.1. Nomenklatur.

Die Klassifikation der Coccolithen ist aus verschiedenen Gründen problematisch. Ein Grund liegt im Lebewesen selbst, das die Coccolithen trägt oder getragen hat: ist es Tier? ist es Pflanze? Die Frage wird von den Biologen verschieden beantwortet und es erscheint unwahrscheinlich, dass sie von den Paläontologen entschieden werden kann. Für die Klassifikation steht dementsprechend die botanische oder die zoologische Nomenklatur mit den entsprechenden Regeln zur Verfügung. Sowohl die botanische als auch die zoologische Nomenklatur sind denn auch, je nach dem Standpunkt des jeweiligen Verfassers, angewandt worden. Das hat zu nicht geringen Verwirrungen geführt, da die beiden Nomenklaturen unabhängig voneinander sind und z.B. für die Benennung von Teilen von Pflanzen oder Tieren verschiedene Regeln enthalten. Zudem werden einige Genera, aufgestellt im einen Reich, zu Homonymen, wenn sie in einer Arbeit gebraucht werden, deren Verfasser die Nomenklatur des anderen Reiches braucht. Also wird ein neuer Name eingeführt, der aber wiederum nur von einem Teil der Autoren gebraucht wird, da der alte Namen für die anderen ja gültig ist und Priorität besitzt. LOEBLICH & TAPPAN (1966:83 ff) haben auf einige Regeln speziell hingewiesen, sei es weil sie Probleme in beiden Nomenklaturen gleich oder verschieden behandeln, und haben diese mit Beispielen erläutert.

### 1.2. Coccolithen – Coccospaeren.

Ein weiterer Grund, der die Klassifikation der fossilen Coccolithen erschwert, ist der Umstand, dass diese in den meisten Sedimenten isoliert auftreten und dass intakte Coccospaeren nur relativ selten zu finden sind. Während der Biologe seine Klassifikation auf die Coccolithen und deren Anordnung auf der Coccospaere, das Auftreten von Dimorphismus der Coccolithen einer Coccospaere und die Eigenarten der Zelle baut, stehen dem Mikropaläontologen meist nur die isolierten Coccolithen zur Verfügung. Das bedeutet, dass Coccolithen verschiedener fossiler Arten möglicherweise ursprünglich dieselbe Zelle bekleidet haben können, ohne dass wir die Möglichkeit haben, dies festzustellen. Dem Mikropaläontologen ist es ebenfalls versagt zu entscheiden, ob zwei verschiedene Formen Coccolithen der mobilen und der immobilen Phase einer Art angehören, wie dies für einige rezente Formen getan werden kann (PARK & ADAMS 1960). Es ist deshalb nicht verwunderlich, dass sich die Paläontologen zuerst nur zögernd, in letzter Zeit aber recht entschieden für die Klassifikation der Coccolithen von der natürlichen Klassifikation entfernten und einer morphologischen zuwandten. Dies um so mehr, als mit dem Aufkommen des Elektronenmikroskopes die Feinstruktur der Coccolithen untersucht und als Bestimmungsmerkmal herangezogen werden konnte.

### 1.3. Lichtmikroskop – Elektronenmikroskop.

Nun ist auf eine weitere Schwierigkeit hinzuweisen, die es bei der Klassifikation der Coccolithen zu überwinden gilt: der Gebrauch zweier verschiedener Instrumente

zu deren Untersuchung. Bis in die 50-ziger Jahre wurden alle Arten im Lichtmikroskop gezeichnet und beschrieben. Seither publizieren einige Autoren nur Elektronenmikroskopbilder, andere veröffentlichen nur Zeichnungen oder Photographien von Beobachtungen im Lichtmikroskop und weitere arbeiten mit beiden Mikroskopen, ohne dabei sicher zu sein, dass eine im Lichtmikroskop erkannte Art mit der im Elektronenmikroskop beobachteten identisch ist. Untersuchungen am selben Coccolithen im Lichtmikroskop und im Elektronenmikroskop wurden erstmals an rezentem Material von HALLDAL et.al. 1954 durchgeführt und beschrieben. Die Methode wurde aber von den anderen Forschern meines Wissens nicht aufgegriffen, wohl weil die Prozedur zu umständlich schien. Die Zukunft wird weisen, ob die in dieser und früheren Arbeiten benützte Methode weitere Anwendung findet.

Das **Lichtmikroskop** erlaubt die Beobachtung der Architektur der Coccolithen, während die Feinstruktur darin kaum zu erkennen ist. Zwischen gekreuzten Polarisatoren können oft weitere Einzelheiten der Struktur beobachtet werden, was vor allem von KAMPTNER in verschiedenen Arbeiten beschrieben wurde. Die Grösse der einzelnen Bausteine der Randpartie und des Zentralfeldes der Coccolithen liegt aber oft unter oder an der Grenze des Auflösungsvermögens eines Lichtmikroskopes und die Elemente können deshalb nicht mehr unterschieden werden oder werden nicht mehr objektähnlich abgebildet. Daraus ergibt sich das Problem, dass im **Lichtmikroskop** beschriebene Gattungen und Arten im Elektronenmikroskop vollkommen neu definiert werden müssen, oft unter Missachtung der im **Lichtmikroskop** als diagnostisch angesehenen Merkmale.

Das **Elektronenmikroskop** ist im Stande, auch die Bausteine der Coccolithen abzubilden und gibt uns damit die Möglichkeit, die Klassifikation auf die Form und auf die Anordnung dieser Elemente zu basieren. Arten, die im Elektronenmikroskop unterschieden werden können, sind im **Lichtmikroskop** nicht immer zu unterscheiden. Sollen sie deshalb auch bei elektronenmikroskopischen Untersuchungen nicht unterschieden werden? Der stratigraphische Wert von im **Lichtmikroskop** gefundenen Formen erscheint plötzlich fraglich, wenn sich bei Elektronenmikroskopuntersuchungen herausstellt, dass die Form unterteilt werden kann. Das Beobachtungsinstrument und die Präparationstechnik spielen also ebenfalls eine grosse Rolle bei der Klassifizierung der Coccolithen. Hier sei auch darauf hingewiesen, dass Seitenansichten, die in **Lichtmikroskoppräparaten** mit flüssigem Einbettungsmittel leicht zu erhalten sind, im **Elektronenmikroskop** nur sehr selten gefunden werden und dann noch oft unbestimbar sind. Dies muss einen Einfluss auf die Wahl der Arten, Gattungen und Familien bestimmenden Merkmale haben, die einer morphologischen Klassifikation zugrunde liegen. Dass im **Elektronenmikroskop** bis jetzt meist nur die eine Seite des Coccolithen erkennbar ist, wird weiterhin zu Doppelbestimmungen führen, die nur im Laufe der Zeit durch vermehrtes Vergleichsmaterial ausgeschieden werden können. Es macht aber auch die Zuordnung einer Form, von der nur die eine Seite bekannt ist, problematisch, da einige Bestimmungsmerkmale nicht erkannt werden können. NOEL (1965:47) erklärt die Erscheinung der „Transparenz“ der Karbonrepliken, die uns oft Hinweise auf den Bau der anderen Seite des Coccolithen geben und auch an mehreren

Bildern dieser Arbeit auftritt (Taf. 22 Fig. 4). Ich habe Versuche angestellt, denselben Coccolithen von beiden Seiten ganz im Elektronenmikroskop abzubilden; bisher ist mir dies jedoch noch nicht zufriedenstellend gelungen.

## 2. Klassifikationen

Ohne dass hier näher auf die einzelnen älteren Klassifikationen eingegangen werden soll, seien sie erwähnt und die neueren Vorschläge von NOEL (1965) und REINHARDT (1966) anschliessend etwas ausführlicher dargelegt.

### 2.1. Historisches.

Die frühesten Klassifikationen der Coccolithen umfassten nur die rezenten Formen und wurden von LOHMANN (1902) und SCHILLER (1930) aufgestellt. Erst 1952 skizzierte DEFLANDRE eine Systematik für die fossilen Coccolithen. BRAARUD, DEFLANDRE, HALLDAL & KAMPTNER (1954) nehmen bereits Rücksicht auf die Erkenntnisse, die mit dem Elektronenmikroskop gewonnen worden waren. Da aber damals die meisten fossilen und rezenten Coccolithen, die im Elektronenmikroskop untersucht worden waren, nur als „Schatten“ abgebildet wurden und nicht als Replika, an der die einzelnen Bausteine erkennbar sind, müssen für die Beobachtungen mit der neueren Technik auch andere Merkmale zur Klassifizierung herangezogen werden. 1958 versuchte KAMPTNER, die fossilen Coccolithen dem natürlichen System beizuordnen, ohne dabei auf die noch spärlichen Beobachtungen im Elektronenmikroskop Rücksicht zu nehmen. Nach einer längeren „Stille“ sind kurz nacheinander und ohne gegenseitige Kenntnis zwei verschiedene Vorschläge zur Klassifikation vor allem der im Elektronenmikroskop untersuchten fossilen Coccolithen erschienen. NOEL (1965) untersuchte jurassische Formen und ordnete sie in zwei Parafamilien und zwei Familien, aus denen sie 20 Genera beschreibt und denen sie weitere zuordnet. REINHARDT stellte 1965 zwei neue Familien auf und erläutert 1966 a seine Ideen zur Klassifikation des fossilen Nannoplanktons anhand von Material aus dem Malm, der Kreide und dem Alttertiär, vor allem aber der Kreide. 1966 b und 1967 versuchte er die Vorschläge von NOEL mit seinen eigenen zu kombinieren. Im folgenden seien die Grundgedanken der beiden Autoren skizziert und anschliessend diskutiert und Stellung bezogen.

### 2.2. Neuere Klassifikationen.

REINHARDT 1964, 1965.

In einer Mitteilung hat REINHARDT (1964) einige im Lichtmikroskop bekannte Genera im Elektronenmikroskop beschrieben und emendiert und dazu eine Anzahl neue Gattungen aufgestellt. In einer weiteren Mitteilung im Januar 1965 stellte er zwei neue Familien auf. Die *Ahmuelerellaceae* wurden definiert als „schüssel-, napf- oder mützenförmige Kalkkörper mit oder ohne zentralen Fortsatz. Ein oder zwei Rand-

scheiben umsäumen eine Area centralis aus Granulae (diagnostisch). Dimorphismus wahrscheinlich". Die *Eiffellithaceae* sollten die Coccoolithen umfassen, die der folgenden Definition genügten: „Ein Kranz aus 1 bis 2 Randscheiben umsäumt ein Zentrafeld aus brücken-, kreuz- oder speichenförmig angeordneten Stäben. Auf diesen ruht z.T. zentral ein Fortsatz“. Es wurde in beiden Arbeiten nicht ausdrücklich angeführt, welche Merkmale als art-, gattung- oder familienbestimmend zu gelten haben. Die als diagnostisch angesehene granulat Ausbildung der Area centralis der *Ahmuelerellaceae* erweist sich als eine unglückliche Wahl, da der Generotypus von *Ahmuelerella*, *A. octoradiata* (GORKA 1957) REINHARDT 1966 b (= *A. limbitenius* REINHARDT 1964) einen ganz anderen Randaufbau zeigt als alle anderen Formen mit granulatem Zentrafeld und am Aufbau seines Zentrafeldes nicht nur Granulae sondern auch Latten beteiligt sind, die einen Kegelstumpf bilden.

#### NOEL 1965.

Im September 1965, also einige Monate nach REINHARDTS (1965) Publikation, erschien NOELS grosse Arbeit über die jurassischen Coccoolithen. Die Autorin gibt nach einer Einleitung und einem historischen Rückblick die Biologie der rezenten Coccoolithen, gibt Auskunft über das untersuchte Material und beschreibt ihre Präparations-techniken für das Licht- und das Elektronenmirkoskop ausführlich. Sie diskutiert anschliessend die Probleme der Klassifikation der Coccoolithen und beschreibt ihren Standpunkt, bevor sie an die systematische Beschreibung der beobachteten Formen und deren Klassifikation herangeht. Der systematische Teil schliesst mit einer Zusammenfassung der vorgeschlagenen Klassifikation ab. Es folgen Bemerkungen über die stratigraphische Verwendbarkeit der Coccoolithen, deren Sedimentation und Anteil an Sedimenten sowie eine Zusammenfassung der Schlussfolgerungen der einzelnen Abschnitte. Eine Bibliographie, bei welcher die Arbeiten, die Elektronenmikroskopuntersuchungen enthalten, speziell gekennzeichnet sind und ein sehr nützlicher Index bilden den Abschluss des Werkes. Auf den vielen Tafeln und in einer grossen Anzahl Zeichnungen im Text werden die Ausführungen vortrefflich illustriert.

NOEL schlägt eine rein morphologische Klassifikation vor und gibt den einzelnen Coccoolithen den Rang einer Art. Es wird dabei, um die unnötige Aufstellung von neuen Arten zu verhindern, auch auf die morphologische Variation innerhalb einer Art Rücksicht genommen. Die Klassifikation ist allein auf die Architektur und Struktur der Coccoolithen aufgebaut. Der Genus umfasst eine Anzahl Arten, die gemeinsame Merkmale aufweisen, durch die sie sich von anderen ähnlichen Gruppierungen unterscheiden. Hier und bei der Zuordnung zu höheren Einheiten ist es allein die morphologische Ähnlichkeit, die die Zuordnung bestimmt. Trotz dieser klaren Stellungnahme werden dann von NOEL Familien und Parafamilien, Genera und Paragenera unterschieden, je nachdem sie Arten mit bekannter Coccospaere oder nur morphologische Arten enthalten. Da es in der von NOEL angewandten botanischen Nomenklatur keine Parafamilien gibt, wurden diejenigen von NOEL denn auch von LOEBLICH & TAPPAN (1966) als invalid erklärt.

Ohne dies ausdrücklich zu bemerken, braucht NOEL in ihrer Arbeit den Aufbau der Randpartie des Coccolithen als ein Familien bestimmendes Merkmal.

<i>Zyglithaceae</i>	1 Reihe dachziegelartig übereinander lagernder Elemente bilden den Rand
<i>Discolithaceae</i>	1 Reihe schräg einfallender Elemente bildet eine Wand und 1 Lage horizontaler Elemente einen „Boden“
<i>Podorhabdaceae</i>	2 übereinander lagernde Reihen von Elementen bilden einen Rand, der eine grosse zentrale Area umschliesst
<i>Ellipsagelosphaeraceae</i>	2 übereinander lagernde Scheiben aus Randelementen; die Scheiben durchdringen sich oder sind durch einen „Tubus“ verbunden.

In diesen 4 Familien können fast alle mesozoischen und viele tertiäre Coccolithen untergebracht werden, wenn bei den *Discolithaceae* der „Boden“ reduziert werden darf zu einem Ring und bei den *Podorhabdaceae* anstatt der 2 Reihen 1,2 und mehr Reihen von Randelementen zuglassen werden.

Die Familie der *Ellipsagelosphaeraceae* wird weiter in drei Unterfamilien aufgeteilt, die sich durch die An- oder Abwesenheit eines „Tubus“ zwischen den Rand scheiben oder die Anwesenheit eines Fortsatzes (oder einer durch einen ausgebrochenen Stab verursachten Öffnung im Zentrum des Coccolithen) voneinander unterscheiden. Als Kriterium zur Abtrennung der Unterfamilien wird also die Art der Verbindung zwischen den beiden Scheiben benutzt.

Als Gattungen bestimmende Merkmale benutzt NOEL u.a. die Anordnung der Granulae und Lamellen im Zentralfeld (z.B. als Basis von Fortsätzen) und die äussere Form der Coccolithen, dies nach den Ideen von KAMPTNER. Sie bemerkt dazu S. 108, dass der relative Wert zu beachten sei, der den verschiedenen Gattungen zukomme, die sich oft nur durch Merkmale unterscheiden, die von anderen Autoren nur als artenbestimmend angesehen werden. Es gibt Arten, die in zwei verschiedenen Gattungen untergebracht sind und die sich voneinander durch eine grosse Anzahl Merkmale unterscheiden und solche, die nur durch ein einzelnes Merkmal voneinander abweichen.

Die Arten werden bei NOEL in den Gattungen *Discorhabdus*, *Parhabdolithus* und *Podorhabdus* vor allem durch die Unterschiede im Aufbau des Fortsatzes ausgeschieden. Innerhalb von *Zyglithus* sensu NOEL wird zur Artunterscheidung auch die Anzahl der Randelemente benutzt, die bei kleineren und grösseren Exemplaren von *Z. erectus* 20 nicht überschreite, während sie bei *Z. bussoni* um 40 herum schwankt, da der Grad der Überlagerung der schrägstehenden Randelemente bei den beiden Arten verschieden sei. Weiter sind es die Anordnung der verschiedenen Elemente im Zentralfeld und dessen Grösse, die zur Unterscheidung der Arten herangezogen wurden. Viele der von NOEL eingeführten Gattungen sind jedoch monotyp.

## REINHARDT 1966 a.

In der ersten 1966 von REINHARDT erschienenen Arbeit, deren Manuskript vor dem Erscheinen der Arbeit von NOEL (1965) abgeliefert worden war, setzt sich der Autor mit der Taxionomie und der Biostratigraphie des fossilen Nannoplanktons auseinander. Nach einer Einleitung erläutert er die Beziehungen zwischen der natürlichen Klassifikation und dem Feinbau der rezenten Coccoolithen. Der Feinbau der Coccoolithen aus dem Malm, der Kreide und dem Alttertiär und seine Typen bilden den Hauptteil der Abhandlung, dem eine Zusammenstellung der stratigraphischen Folge der behandelten und weiterer Coccoolithen folgt. Vor der abschliessenden Zusammenfassung werden die Beziehungen zwischen dem Feinbau der fossilen Coccoolithen und dem natürlichen System der Kalkflagellaten diskutiert. Eine grosse Anzahl Tafeln mit Elektronenmikroskopbildern und Lichtmikroskopaufnahmen zwischen gekreuzten Nicols samt einer Reihe von Textfiguren illustrieren die Beschreibungen vorzüglich.

In seiner Arbeit verwendet REINHARDT die botanische und die zoologische Nomenklatur nebeneinander und unternimmt in der Nomenklatur nur solche Schritte, die durch beide Regeln gestattet sind. Er ordnet Coccoolithen mit bekanntem Feinbau, welche Coccoolithen von Coccospaeren äquivalent seien, in die entsprechenden natürlichen Arten und Genera ein und erweitert sie somit. Er versucht die fossilen Coccoolithen mit Hilfe der Feinstrukturmerkmale soweit wie möglich natürlich zu klassifizieren und wählt als Merkmale für diese Systematik die Tracht der Mikrokristalle im Zentrafeld. REINHARDT unterscheidet 4 morphologische Typen der Ausbildung des Zentrafeldes.

Coronoider Typ 1–2 Randscheiben umsäumen ein Zentrafeld aus mehreren Granulaeringen

Styloider Typ Zentrafeld aus radialen Lamellen

Rhagoider Typ 1–2 Randscheiben umsäumen ein granulates Zentrafeld

Zeugoider Typ 1–2 Randscheiben werden von Speichen, einem Kreuz oder einer Brücke überspannt.

Die von REINHARDT früher aufgestellten Familien werden hier noch nicht direkt in Zusammenhang mit den morphologischen Typen gebracht, sondern ihre Gattungen und Arten darauf verteilt.

Als Gattungen bestimmende Merkmale scheint REINHARDT folgende anzusehen (herausgesucht aus den Bemerkungen über die Unterschiede eines behandelten Genus zu anderen Genera): das Vorhandensein einer zentralen Pore (*Tergestiella – Watznaueria*), eines Tubus zwischen den Randscheiben (*Cocco lithus*), flache oder wallförmige Randscheibe (*Rhabdospaera – Ahmuellerella*), 1 oder 2 Randscheiben (*Ahmuellerella – Cretarhabdus*), becherförmiger Basalteil (*Parhab dolithus*), elliptische Randscheiben – circuläre Kalotte (*Cribrosphaerella – Biscutum*), granulates Zentrafeld gegenüber einem granulaten Zentrafeld, das seinerseits von auf bestimmte

Weise angeordneten Tabulae bedeckt ist (*Cribrosphaerella* – *Arkhangelskiella*), ± flaches Zentrafeld gegenüber einem stark emporgewölbten, das z.T. einen zentralen Stab trägt (*Cribrosphaerella* – *Ahmuelrella*). Das Vorhandensein eines zentralen granulaten Septums unterscheidet nach REINHARDT *Biscutum* von *Tiarolithus* mit einer zentralen Durchbohrung und einer basalen Hervorragung. Monomorphismus trennt *Staurolithites* von *Deflandrius*, der die ähnlichen dimorphen Arten enthalten soll, während *Staurolithites* sich durch sein kreuzförmiges, flaches Jugum gegenüber den flachen oder aufgewölbten Querstegen von *Glaukolithus* abhebt. Obschon ich mit einigen von REINHARDTS Auffassungen der Gattungen nicht einverstanden bin, wurden obenstehend seine Ansichten über die diese Gattungen unterscheidenden Merkmale zusammengestellt, da diese ja in sich selbst unabhängig von bestimmten Gattungen Gültigkeit haben sollten.

An Arten bestimmenden Merkmalen nennt REINHARDT folgende: Anzahl der Randelemente in Scheiben und Ringen, Vorhandensein oder Fehlen einer Brücke, Weite der zentralen Pore, Größenverhältnisse der Randscheiben zueinander, verschiedene Elemente, die das Zentrafeld überspannen. Das Fehlen oder Vorhandensein von Stäben bei stabtragenden Arten wird als infraspezifisches Kennzeichen bewertet, ebenso die Orientierung sonst gleichförmiger Brückenelemente.

REINHARDT 1966 b, 1967.

Mit Interesse wurde die Reaktion auf die beiden Klassifikationsvorschläge erwartet. REINHARDT hat nun in zwei Mitteilungen begonnen, Synonymien, die durch die fast gleichzeitige Publikation der besprochenen Arbeiten und derjenigen von STOVER 1966 entstanden waren, aufzudecken. Dabei hat er 1966 b fossile Vertreter coronoider und styloider Coccoolithen der Familie *Coccolithaceae* POCHE 1913 zugeordnet, die er als synonym mit *Coccolithophoridae* LOHMANN 1902 und *Ellipsagelosphaeraceae* NOEL 1965 auffasst. An die Stelle der Unterfamilie *Ellipsagelosphaeroideae* NOEL 1965 wird *Tergestielloideae* (KAMPTNER 1958) emend. REINHARDT 1966 b gestellt und ihr *Watznaueria* REINHARDT 1964 (syn. *Ellipsagelosphaera* NOEL 1965) untergeordnet.

Bereits im März 1967 folgte eine weitere Arbeit, die sich mit den fossilen Coccoolithen mit rhagoideem Zentrafeld befasst und diese in die Familie der *Ahmuelllerellaceae* REINHARDT 1965 stellt. Der Autor unterteilt diese, Gesichtspunkten von NOEL 1965 folgend, nach der Ausbildung und der Anordnung ihrer Randblättchen in die Unterfamilie *Ahmuelllerelloideae* (syn. pro parte *Discolithaceae* NOEL 1965): rhagoide Coccoolithen mit einer Randscheibe und in die Unterfamilie *Podorhabdoideae* NOEL 1965 emend. REINHARDT 1967: rhagoide Coccoolithen mit zwei Randscheiben. Hernach werden die verschiedenen Genera der Familien durchgenommen und zwei neue Genera aufgestellt.

In dieser Arbeit treten weitere Gattungen bestimmende Merkmale auf: Formen mit granulatem durchbrochenen und undurchbrochenen Zentrafeld werden unterschieden (*Ahmuelrella* – *Rhagodiscus*) und das Vorhandensein eines Zentralfortsatzes trennt z.B. *Rhagodiscus* und *Rhabdolithina*. Dies hat zur Folge, dass dimorphe Cocco-

lithen wahrscheinlich einer Art in verschiedenen Gattungen untergebracht werden: *Rhagodiscus* ? *cryptochondrus* (STOVER 1966) REINHARDT 1967 und *Rhabdolithina anthophora* (DEFLANDRE 1959) REINHARDT 1967. Abgesehen davon, dass diese Genera hier zu den Formen mit einem Randring gezählt werden, während sie nach meiner Ansicht deren zwei besitzen, ist ihre Zuordnung zu den beiden neuen Genera unglücklich, da der Generotypus des einen nicht im Elektronenmikroskop bekannt ist und der des anderen unsicher ist. Wenn REINHARDT einerseits ein undurchbrochenes oder ein durchbrochenes granulates Zentrfeld als Gattungen bestimmendes Kennzeichen annimmt und andererseits *Cretarhabdus* BRAMLETTE & MARTINI 1964 als undurchbrochene Form beschreibt, kann er sie nicht als *Polypodorhabdus* NOEL 1965 synonym erklären, der zwischen den Stegen ansehnliche Öffnungen aufweist.

Die Arten bestimmenden Merkmale sind dieselben wie 1966 a.

### 2.3. Diskussion der neueren Klassifikationen.

Nachdem die Probleme einer Klassifikation speziell der fossilen Coccolithen beleuchtet worden sind und die beiden verschiedenen, neuesten Vorschläge zur Lösung dieser Probleme dargelegt wurden, seien diese nun hier auch diskutiert. Ich möchte dies tun, indem ich die Frage stelle und zu beantworten versuche, welchen Anforderungen eine Klassifikation der fossilen Coccolithen zu genügen habe. Ich werde dann die beiden Vorschläge dahin untersuchen, wie weit sie den an eine mir  $\pm$  befriedigend erscheinende Klassifikation gestellten Ansprüchen entsprechen. Diese Ideen sollen anschliessend, zusammen mit meinen eigenen, zu einem neuen Vorschlag formuliert werden.

Welchen Anforderungen muss die Klassifikation der fossilen Coccolithen genügen? Meine Antwort (die nicht erschöpfend sein kann) ist untenstehend in 5 Punkte zusammengefasst, die anschliessend besprochen werden.

1. Die Klassifikation muss, ob natürlich oder morphologisch, der botanischen oder der zoologischen Nomenklatur genügen. Bis man sich, zumindest von der paläontologischen Seite her, auf eine der beiden Nomenklaturen geeinigt hat, sollten wenn möglich nur solche Schritte unternommen werden, die in beiden Nomenklaturen erlaubt sind.
2. Die Basis der Klassifikation sollen Beobachtungen am Elektronenmikroskop bilden. Die systematische Einheiten bestimmenden Merkmale müssen dementsprechend so gewählt werden, dass sie aus dem Elektronenmikroskop ablesbar sind.
3. Die Klassifikation soll praktisch sein und sie soll weiter ausbaufähig gestaltet sein. Beim heutigen Stand der Kenntnisse darf noch kein allzu starres Gefüge aufgestellt werden. Wenn die Klassifikation so eingerichtet werden kann, dass sie auf Rundlochkarten aufnehmbar ist, bedeutet dies sicher keinen Nachteil!
4. Die Klassifikation sollte auf möglichst eindeutigen Unterscheidungskriterien für

die verschiedenen systematischen Stufen weilen. Das heisst, dass man sich auf Arten, Gattungen und Familien bestimmende Merkmale einigen sollte.

5. Die Klassifikation sollte allein auf Grund des Feinbaus der einzelnen Coccolithen erfolgen und unabhängig von derjenigen der rezenten Coccolithen aufgebaut werden. Ist. z.B. die Coccospaere einer Art bekannt und verschieden von derjenigen einer anderen Art in derselben Gattung, soll sie darin verbleiben, wenn die Arten sonst in den Gattungen bestimmenden Merkmalen übereinstimmen. Wenn man die Coccospaeraenausbildung als systematisches Kennzeichen für fossile Coccolithen braucht, werden dadurch Einheiten geschaffen, denen einzelne Coccolithen wiederum nicht gleichberechtigt zugeordnet werden können. Erst wenn unsere Kenntnisse des Feinbaus der rezenten und fossilen Coccolithen vergrössert worden sind, wird vielleicht entschieden werden können, welchen Platz die fossilen Coccolithen in der natürlichen Klassifikation einnehmen.

Zu 1.: Der erstgenannte Punkt ist eine absolute Notwendigkeit, wenn eine grosse Verwirrung umgangen werden soll. Trotzdem der Gedanke, eine unabhängige Nomenklatur einzuführen einiges für sich hat, soll ihm hier nicht weiter gefolgt werden. Sowohl NOEL als auch REINHARDT benützten die bestehenden Nomenklaturen. Die ungültigen Parafamilien in NOEL sind Ausdruck für ihr Zögern, die morphologische Klassifikation konsequent durchzuführen.

Zu 2.: Auch im zweiten Punkt sind die beiden Autoren einig. Es stellt sich hier aber das Problem, wie man sich gegenüber den im Lichtmikroskop aufgestellten Gattungen zu verhalten habe, deren Generotypus noch nicht im Elektronenmikroskop bekannt ist. NOEL hat für die Genera *Zygolithus* und *Discolithus* neue Generotypen gewählt, was nach den Nomenklaturregeln nicht erlaubt ist. REINHARDT hat in seiner neuesten Arbeit eine Gattung aufgestellt, deren Generotypus noch nicht elektronen-optisch bekannt ist. Dasselbe Problem stellt sich für die Übernahme im Lichtmikroskop aufgestellter Arten. Die korrekte Massnahme ist wohl die Aufstellung eines Hypotypus im Sinne von FRIZZEL (1933) (s. NOEL 1965:55). Es ist dabei wünschenswert, dass dieser wenn irgend möglich, aus dem ursprünglichen Material gewählt wird oder zumindest aus Material gleichen Alters. Ideal wäre eine Neubeschreibung der alten Arten und Gattungen im Licht- und Elektronenmikroskop aus dem Typusmaterial in der Reihenfolge ihres Erscheinens, angefangen bei den frühesten. Auf diese Weise könnte die Aufstellung weiterer Gattungen und Arten, von welchen viele sich sicher früher oder später als Synonyme von älteren Formen erweisen werden, vermieden werden (ich glaube, dass bereits jetzt die Zahl der aufgestellten fossilen Coccolithen-Arten und -Gattungen die Zahl der wirklich zu unterscheidenden Formen bei weitem übersteigt). Diese Lösung scheitert jedoch nicht nur an der Schwierigkeit, das Typusmaterial zu beschaffen und die daraus beschriebenen Formen mit Sicherheit nach den oft sehr schematischen Zeichnungen zu bestimmen, sondern auch daran, dass die meisten Forscher lieber Forschung auf einem neuen Gebiet betreiben als „Archiv-Arbeiten“ unternehmen.

Zu 3.: Keiner der Autoren ging bis jetzt soweit, die Bestimmungsmerkmale so zusammenzufassen, dass sie auf Randlochkarten gebracht werden können. STRADNER (1966) hat als Notlösung eine Aufstellung von stark vereinfachten Schattenbildern vorgeschlagen, die als Kodenummern oder Buchstaben in die Randlochkarten übertragen werden können und das Einordnen von noch unbestimmten Typen erleichtern und eine Übersicht auch bei sich ändernden Gattungszuordnungen erlauben. Selbst habe ich die anfallenden Elektronenmikroskopbilder von Coccolithen auf Randlochkarten gelocht, wobei neben anderen auch die verschiedenen systematischen Einheiten bestimmenden Merkmale zugrundegelegt wurden.

Zu 4.: Die beiden letzten Punkte verraten mich endgültig als Anhänger einer rein morphologischen Klassifikation. Was die Wahl der die systematischen Einheiten bestimmenden Merkmale betrifft, herrscht nicht Einigkeit. Was für den einen Autor Gattungen bestimend ist, ist für den anderen nur artbestimmend usw. auf allen Stufen. So lange keine einheitlichen Richtungslinien bestehen, können sie auch nicht befolgt werden, was in den beiden besprochenen und anderen Arbeiten, die Elektronenmikroskopuntersuchungen an Coccolithen enthalten, zum Ausdruck kommt.

Zu 5.: Dass in einer morphologischen Klassifikation erkannte Zusammenhänge der natürlichen Klassifikation nicht verleugnet werden sollen, ist selbstverständlich. Da aber mit den heutigen Kenntnissen eine vollständige natürliche Klassifikation nicht erreichbar ist, stellt sich die Frage, ob man lieber mit einer natürlichen Klassifikation für die auch als Coccospaeren bekannten Coccolithen arbeitet und mit einer morphologischen für die isolierten Coccolithen oder ob man auf die Anlehnung an die natürliche Klassifikation vorläufig ganz verzichtet und alle im Elektronenmikroskop beschriebenen und abgebildeten Coccolithen rein morphologisch klassiert. Ein morphologischer Genus kann deshalb also gut Coccolithen umfassen, deren Anordnung auf der Coccospaere sehr verschieden war. Das heißt im Grunde genommen nur, dass die Anordnung der Coccolithen auf der Coccospaere nicht als ein systematisch wichtiges Merkmal aufgefasst werden sollte, auf jeden Fall was die fossilen Coccolithen betrifft. REINHARDT, der die Coccolithen natürlich klassierte stellte sich dieses Problem nicht, während NOEL einen Mittelweg beschritt und die Coccolithen mit bekannten Coccospaeren in Familien klassierte und die anderen in Parafamilien zusammenfasste.

#### 2.4. Klassifikationsvorschlag

In dieser Arbeit wird im Prinzip den Nomenklaturregeln der Botanik gefolgt; es werden aber nur die Arten und Gattungen anerkannt, die nach den Regeln beider Reiche Gültigkeit besitzen. Nach der botanischen Nomenklatur stehen für Teile von fossilen Pflanzen Organgattungen und -arten und Formgattungen und -arten zur Verfügung. Organgattungen sind einer Familie zuweisbar, während die Formgattungen keiner Familie zuweisbar sind, jedoch einem höheren Taxon zuweisbar sein können. REINHARDT 1966 hat vorgeschlagen, Coccolithen mit bekanntem Feinbau als Organgenera und -species zu beschreiben und die nur im Lichtmikroskop unter-

suchten Formen als Formgenera und -species zu betrachten. Ich folge ihm teilweise in seinem Vorschlag, da er uns die Möglichkeit gibt, die Gattungen mit gemeinsamen Merkmalen in höheren Einheiten wie der Familie zusammenzufassen. Nur im Lichtmikroskop bekannte Formen werden in der Zusammenstellung nur erwähnt, wo sie den Generotypus einer Gattung bilden, dem Elektronenmikroskoparten beigegeben wurden. Ihre spezielle Klassifizierung scheint mir nicht notwendig, da es hoffentlich eine Frage kurzer Zeit sein dürfte, bis sie im Elektronenmikroskop bekannt werden.

#### *Die systematischen Merkmale und ihr Wert*

Die folgende Aufzählung der systematische Einheiten bestimmenden Merkmale sollte eine gewisse Einheitlichkeit in der Wahl dieser Merkmale zur Bestimmung der fossilen Coccolithen und deren Klassifikation bringen. Sie zeigt aber auch, dass es kaum möglich ist, die Definitionen so klar und eindeutig zu fassen, wie dies wünschbar wäre z.B. für die Verwendung von Randlochkarten. Das Auftreten von Zwischenformen zeigt deutlich, dass eine morphologische Klassifikation eine künstliche Sache ist, die der Natur nicht vollkommen gerecht werden kann.

Für die Zuordnung zu einer Familie und zu einer Unterfamilie wird in erster Linie die Ausbildung der Randpartie der Coccolithen herangezogen.

Familie <i>Eiffellithaceae</i>	äusserster Randring aus dachziegelförmig angeordneten Elementen
Unterfamilie <i>Zygolithoideae</i>	1 Randring
Unterfamilie <i>Eiffellithoideae</i>	1 Randring und ein „Boden“ oder 2 und mehr Randringe
Familie <i>Podorhabdaceae</i>	Randelemente des äussersten Ringes nebeneinander liegend oder ineinander greifend. Grosses, meist granulates Zentrafeld
Familie <i>Ellipsagelosphaeraceae</i>	äusserste Randscheibe aus sich überlagernden oder nebeneinander liegenden Randelementen. Kleines Zentrafeld
Unterfamilie <i>Ellipsagelosphaeroideae</i>	2 und mehr Randscheiben, 1 aus sich überlagernden Elementen
Unterfamilie <i>Discorhabdoideae</i>	2 und mehr Randscheiben aus nebeneinander liegenden Elementen
Familie <i>Microrhabdulaceae</i>	Stäbe, deren Basis unbekannt ist oder die keine haben
<i>Incertae sedis</i>	ortholithische Formen und Formen, die noch keiner Familie zugeordnet werden können
Die Genera bestimmenden Merkmale können wie folgt zusammengefasst werden:	
Umriss des Coccolithen:	rund, elliptisch, nierenförmig, vieleckig etc.

Bausteine des Zentralfeldes:	Granulae, Latten, Platten, Stege und deren Anzahl, Anzahl der Zentralfelddecken und das Flach- oder Aufgewölbtein des zentralen Elementes.
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Die Orientierung der Randelemente kann nur bedingt als Merkmal benutzt werden, da oft nicht zu bestimmen ist, ob von einer Form nicht eine spiegelbildliche Abbildung vorliegt. In einigen Fällen, so z.B. bei *Markalius BRAMLETTE & MARTINI* (1964) ist sie jedoch sicher bestimmbar und brauchbar. NOEL (1965) hat allerdings Formen ein und derselben Art gefunden, deren Randelemente entgegengesetzt orientiert waren. Dieses Merkmal ist deshalb unsicher und sollte nicht allein verwendet werden.

Das Vorhandensein oder Fehlen eines zentralen Tubus wurde von NOEL als Merkmal für die Abtrennung von Unterfamilien gebraucht. Meines Erachtens ist dies ein Merkmal, das sich bei elektronenoptischen Untersuchungen nicht dazu eignet, höhere Einheiten als Genera zu trennen. Die Verwachsungsstelle zweier Randscheiben im zentralen Teil kann nur selten beobachtet werden und es ist oft sehr schwierig zu entscheiden, wann von aneinanderliegenden Scheiben gesprochen werden soll und wann ein zentraler Tubus vorhanden ist, der die beiden Scheiben voneinander trennt, so dass sie nur durch eine „Röhre“ verbunden sind. Es ist daher fraglich, wie weit dieses aus dem Wortschatz der Lichtmikroskopie stammende Merkmal auch im Elektronenmikroskop anzuwenden ist. Hier wird nur dort von einem „Tubus“ gesprochen, wo der innerste Rand der Randscheiben von speziellen Elementen eingerahmt wird, die wahrscheinlich durchgehend sind, also von beiden Seiten als innerer Rand der Randscheiben des Coccoolithen erscheinen.

Das Vorhandensein oder Fehlen eines Fortsatzes ist ein weiteres zu diskutierendes Merkmal. Von den rezenten Coccoolithen wissen wir, dass Coccospaeren einiger Arten Coccoolithen mit und Coccoolithen ohne Fortsatz tragen. Ich sehe daher keinen Grund, fossile Coccoolithen, bei denen stablose und stabtragende Formen zusammen vorkommen, in verschiedene Arten oder gar Gattungen zu stecken. Eine Gattung kann deshalb stabtragende und stablose Arten umfassen.

Die Arten werden durch folgende Merkmale unterschieden:

Anordnung der Bausteine des Zentralfeldes, der Stege, Platten, Latten etc. Die Form der Randelemente wurde ebenfalls dazu verwendet und NOEL (1965) schlug die Ausbildung des Fortsatzes gewisser Formen vor, was hier übernommen wurde.

Den Größenangaben der im Elektronenmikroskop beschriebenen Coccoolithen ist mit Vorsicht zu begegnen. Der Vergrößerungsfaktor ist oft nicht so genau feststellbar, wie dies wünschbar wäre. Die Größe eines Coccoolithen allein ist deshalb ein unsicheres Unterscheidungsmerkmal. Dazu kommt, dass eigentlich nur die Größen der Coccoolithen ein und desselben Autors miteinander verglichen werden können. Es fällt z.B. auf, dass die Formen in NOEL (1965) alle sehr klein sind, wenn sie im Elektronenmikroskop gemessen wurden, dass aber die Angaben über die Formen derselben Art im Lichtmikroskop meist einen etwa doppelt so grossen Wert haben

(*Zygolithus erectus*, *Zygolithus bussoni*, *Parhabdolithus*; *Crepidolithus* misst im Elektronenmikroskop höchstens 4,4  $\mu$  und 10–14  $\mu$  im Lichtmikroskop). Dies kann auf falscher Ausrechnung des Abbildungsmassstabes oder auf Fehlbestimmungen beruhen. Es ist unwahrscheinlich, dass im Elektronenmikroskop immer nur die kleinen Formen einer Art gefunden wurden, da gleichzeitig auch andere, grössere Coccolithen und vollständige Coccospaeren gefunden wurden.

Den genannten Merkmalen können bei Bedarf neue hinzugesellt werden. Die Wahl der Merkmale und der ihnen beigemessene „Wert“ sind als ein Vorschlag aufzufassen, sich bei der Klassifizierung der fossilen Coccolithen eines einheitlichen Massstabes zu bedienen und sollen eine zu diskutierende Skizze zu einem solchen Massstab bilden.

Wie aus den systematischen Beschreibungen hervorgeht, ist dem Vorschlag hier nicht in allen Punkten konsequent gefolgt worden. So wurde der Genus *Tranolithus* STOVER 1966, dessen Generotypus nicht im Elektronenmikroskop bekannt ist, belassen, obwohl die aus ihm abgebildete Art in *Glaukolithus* REINHARDT 1964 untergebracht werden könnte. *Tranolithus* sollte nur verworfen werden, nachdem dessen Generotypus im Elektronenmikroskop bekannt geworden ist und es sich zeigt, dass er sich nicht in Gattungen bestimmenden Merkmalen von *Glaukolithus* oder anderen Gattungen unterscheidet. Es schien auch sonst nicht ratsam, schon jetzt alle diejenigen Gattungen zu verwerfen, die den Anforderungen nicht genügen, bevor der Klassifikationsvorschlag von anderen diskutiert werden konnte.

### 3. Systematische Beschreibungen

In den Synonymielisten wurden meist nur berücksichtigt: Die erste Nennung der Art und die anderen Namen, unter welchen die Art beschrieben wurde sowie die erste und weitere Beschreibungen der Art aufgrund elektronenoptischer Beobachtungen. Letztere sind hinter der Jahreszahl der Publikation mit einem\* gekennzeichnet.

#### 3.1. Familie *Eiffellithaceae* REINHARDT 1965 emend.

Coccolithen mit 1,2 oder mehr Randringen, deren äusserster durch einander dachziegelartig überlagernde Elemente gebildet wird.

Die Familie wird in zwei Unterfamilien geteilt:

*Zygolithoideae* NOEL 1965    Coccolithen mit nur 1 Randring  
emend.

*Eiffellithoideae* REINHARDT 1965 emend.    Coccolithen mit 1 Randring und einem „Boden“  
oder mit 2 und mehr Randringen.

#### Unterfamilie *Zygolithoideae* NOEL 1965 emend.

Coccolithen aus 1 Randring, der sich aus sich dachziegelartig überlagernden Elementen zusammensetzt und einem Zentrafeld, das durch Stege, Brücken oder andere Elemente überspannt wird.

Genus *Zygolithus* KAMPTNER ex MATTHES 1956Generotypus: *Zygolithus dubius* DEFLANDRE 1954.

NOEL (1965) hat für die Gattung *Zygolithus* einen anderen, illegitimen Generotypus (*Z. bussoni*) ausgewählt und darauf die Gattungsdiagnose nach den im Elektronenmikroskop beobachteten Befunden emendiert. Ihre Diagnose trifft zum grössten Teil auch auf den legitimen Generotypus *Z. dubius* zu.

*Diagnose*: Elliptische Coccolithen, die aus einem Randkranz bestehen, welcher aus einer Reihe einander ähnlichen Calcitlamellen aufgebaut ist. Die Lamellen stehen stark schräg zur radialen Ebene und überdecken einander dachziegelartig. Die Anzahl Lamellen variiert. Der zentrale Raum wird durch einen Steg parallel der kleineren Ellipsenachse überspannt, der längs oder X bis H-artig aufgespalten sein kann und meist den Randkranz deutlich überragt. Das X oder H steht diagonal oder leicht schräg zum Achsenkreuz.

*Bemerkungen*: Die Diagnose wird mit Hinsicht auf die Form des Steges sehr weit gehalten, da die vorkommenden Zwischenformen: einfacher Steg – X – H nicht in verschiedene Gattungen abzutrennen sind. Bei den jurassischen und kretazischen Formen ist der Steg aus mehreren, im Elektronenmikroskop erkennbaren, kleinen Elementen zusammengesetzt. Bei den jüngeren Formen sind diese nur selten zu erkennen, ebenso wie der Aufbau des Randes oft auch aus den Elektronenmikroskopbildern nicht ersichtlich ist. Das Auftreten eines Fortsatzes auf dem Steg in Form eines Knopfes, einer Rosette oder eines Stabes wird nicht als Gattungen bestimmendes Merkmal betrachtet.

BLACK (1967) hat dem Genus *Neococcolithes* SUJKOWSKI 1931 die Arten *Zygolithus dubius* DEFLANDRE und *Zygolithus protenus* BRAMLETTE & SULLIVAN 1961 zugeordnet. Nachdem der Generotypus von *Neococcolithes*, *N. lososnensis* nur aus einer sehr schematischen Zeichnung in der Originalabhandlung bekannt ist und *Zygolithus dubius* der Generotypus von *Zygolithus* ist, folge ich dieser Zuordnung nicht. Erst Elektronenmikroskopaufnahmen aus dem Typusmaterial werden zeigen, ob *Zygolithus* als jüngerer Name von *Neococcolithes* aufgefasst werden muss oder ob beide Gattungen Berechtigung haben.

Bis jetzt wurden folgende Arten von *Zygolithus* im Elektronenmikroskop abgebildet (Replika):

<i>Zygolithus dubius</i> DEFLANDRE 1954	H-förmiger Steg
<i>Z. erectus</i> DEFLANDRE 1954 in NOEL 1965	einfacher Steg mit Knopf
<i>Z. bussoni</i> NOEL 1956 in NOEL 1965	schwach X-förmiger Steg
<i>Z. diprogrammus</i> DEFLANDRE 1954 sensu NOEL 1965	längs aufgespaltener Steg
<i>Z. baldiae</i> STRADNER & ADAMIKER 1966	X-förmiger Steg, breitelliptisch
<i>Z. (?) delftensis</i> STRADNER & ADAMIKER 1966	längs- und Querstege
<i>Z. rhombicus</i> STRADNER & ADAMIKER 1966	rhombisch, Längs- und Querstege

<i>Z. pediculatus</i> PERCH-NIELSEN 1967	H-förmiger Steg mit Knoten an den Ansatzzstellen
<i>Z. minutus</i> PERCH-NIELSEN 1967	H-förmiger Steg, langelliptisch, klein
<i>Z. pyramidus</i> PERCH-NIELSEN 1967	X – H-förmiger Steg, kräftig.

*Zygolithus dubius* DEFLANDRE 1954

Taf. 1, Fig. 1–4.

- 1954 *Zygolithus dubius* DEFLANDRE: 149, Fig. 43, 44, 68.  
 1964 *Chiphragmalithus dubius* (DEFLANDRE 1954) SULLIVAN; Taf. 1:2.  
 1967\*<sup>1</sup> *Zygolithus dubius* DEFLANDRE 1954 in PERCH-NIELSEN; Taf. 1:3 a, b.  
 1967 *Neococcolithes dubius* (DEFLANDRE 1954) BLACK: 143.

*Bemerkungen:* Der Generotypus von *Zygolithus* soll hier erwähnt und abgebildet werden, obschon er nicht im sonst in dieser Arbeit untersuchten Material auftritt. NOEL (1965) hat die „Geschichte“ von *Zygolithus* zusammengestellt und auch LOEBLICH & TAPPAN (1966) haben die bewegte Vergangenheit von *Zygolithus* beleuchtet und diskutiert. Ich hoffe, mit den beigegebenen Abbildungen und der Beschreibung den praktischen Teil des Problems zu lösen, nachdem LOEBLICH & TAPPAN (1966) den „juristischen“ gelöst haben.

*Beschreibung:* Der Umriss der Coccolithen ist nicht streng elliptisch, sondern kann gegen rhombisch oder sechseckig tendieren. Der Rand besteht aus einer Reihe stark schräg stehender Lamellen, die einander dachziegelartig überlagern und sich stark überlappen. Das grosse Zentraffeld wird durch einen H-förmigen Steg überbrückt, der den Rand an Höhe überragt. Der Steg des H steht in einem kleinen Winkel zu der grösseren Ellipsenachse. An den mir zur Verfügung stehenden Exemplaren ist der Feinbau des Brückenelements nicht erkennbar, und auch der Feinbau des Randes lässt sich nur an wenigen Exemplaren beobachten.

*Vorkommen:* Røsnaes (Untereozän von Dänemark); weltweit verbreitet im Eozän, besonders im Untereozän.

*Zygolithus bussoni* NOEL 1956

Fig. 2; Taf. 1, Fig. 5, 6, 7, 8.

- 1956 *Zygolithus bussoni* NOEL: 321, Taf. 2:13, 14.  
 1957 *Zygolithus fibulus* (LECAL-SCHLAUDER 1951) GORKA: 242, Taf. 1:4.  
 1959 *Zygolithus repali* MANIVIT: 341, Taf. 1:2.  
 1964 *Zygodiscus sigmoides* BRAMLETTE & SULLIVAN 1961 in BRAMLETTE & MARTINI: 303, Taf. 4:4, 5 (?).  
 1965\* *Zygolithus bussoni* NOEL in NOEL: 59, Taf. 1:1, 2, Textfig. 1 a–c.

*Bemerkungen:* Die Exemplare von *Z. bussoni*, die im unteren Maastrichtien und Darien von Dänemark gefunden wurden, sind durchschnittlich gut doppelt so gross wie die von NOEL (1965) aus dem Jura elektronenoptisch abgebildeten Formen. Die

<sup>1</sup> \* = im Elektronenmikroskop untersucht.

Anzahl der Randelemente, ca. 40, ist jedoch dieselbe, ebenso der Aufbau des Steges, der den Zentralraum überbrückt und in zwei Teile teilt. Die von BRAMLETTE & MARTINI (1964) nur im Danien gefundenen und als *Zygodiscus sigmoides* bestimmten

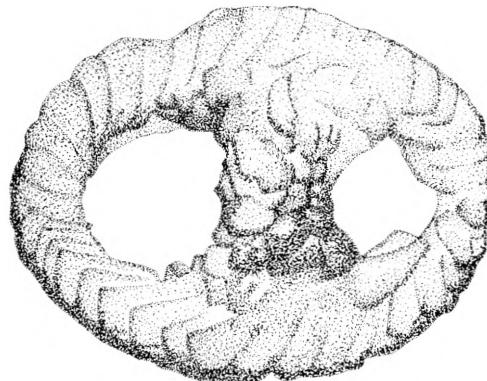


Fig. 2. *Zyglithus bussoni* NOEL. Oberseite, deren Steg eine Rosette trägt; aus dem unteren Maastrichtien von Mön, A 11. Vergrößerung ca. 7500×.

Formen erwiesen sich im Elektronenmikroskop z. T. ebenfalls als *Z. bussoni* und kommen, seltener als im Danien, auch im unteren Maastrichtien von Mön vor.

**Vorkommen:** Unteres Maastrichtien und Danien von Dänemark; weitverbreitet in Jura, Kreide und Alttertiär (s. a. BRAMLETTE & MARTINI (1964) und NOEL (1965)).

#### Genus *Ahmuelerella* REINHARDT 1964

Generotypus: *Ahmuelerella octoradiata* (GORKA 1957) REINHARDT 1967.

*Ahmuelerella* wird hierhergestellt auf Grund des Randkranzes aus dachziegelartig angeordneten Elementen, da ich zwischen Formen mit diesem Randaufbau und solchen mit sich nur knapp, eher fächerförmig überlagernden und nebeneinanderliegenden oder ineinander greifenden Randelementen unterscheide. An dieser Stelle sei auch auf die Schwierigkeit hingewiesen, REINHARDTS rhagoïden und zeugoiden Typ zu unterscheiden, wo es sich um Formen handelt, deren Zentralfeld von Brücken, Kreuzen oder anderen Elementen eingenommen wird, die aus Granulae und Stegen oder Latten aufgebaut sind. Unglücklicherweise wurde für den rhagoïden Typ als Typus *A. octoradiata* gewählt, deren Zentralfeld aus Stegen und Granulae aufgebaut ist und deren Rand dem der als zeugoïde Formen benannten Typen gleicht.

#### *Ahmuelerella octoradiata* (GORKA 1957) REINHARDT 1967

Fig. 3; Taf. 2, Fig. 1, 2, 12–15.

1957 *Discolithus octoradiatus* GORKA: 259, Taf. 4:10.

1964\* *Ahmuelerella limbilenuis* REINHARDT: 751, Taf. 2:6.

- 1966a *Ahmuellerella octoradiata* (GORKA 1957) REINHARDT: 24.  
 1966a\* *Ahmuellerella limbilenuis* REINHARDT 1964 in REINHARDT: 24, Taf. 14:1, 3, 4.  
 1967 *Ahmuellerella octoradiata* (GORKA 1957) REINHARDT 1967: 166, Abb. 1, 7:1, 2, 3.

*Bemerkungen:* Zum Vergleich wird hier auch ein Exemplar von *A. octoradiata* aus dem Material von GORKA (1957) abgebildet (Taf. 2:1). Es ist schlechter erhalten als die in der deutschen und der dänischen Kreide gefundenen Exemplare. Die Hohlräume zwischen den 8 Stützen des zentralen Kegelstumpfes sind in den polnischen

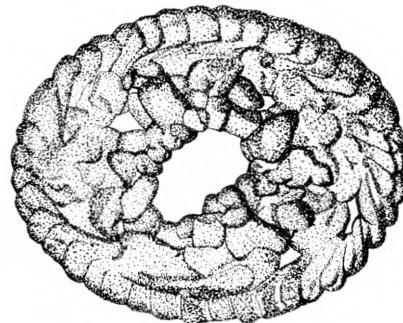


Fig. 3. *Ahmuellerella octoradiata* (GORKA) REINHARDT. Oberseite eines kleinen Exemplares, bei dem die 8 Stege nicht so ausgeprägt vorhanden sind wie bei grösseren Exemplaren. Unteres Maastrichtien von Mön, B 22. Vergrösserung ca. 7500 ×.

Exemplaren mit Calcit vollkommen ausgefüllt und die dachziegelartig angeordneten Randelemente zeigen Spuren von Anätzung.

Bei den im dänischen Material gefundenen Exemplaren (Fig. 3 und Taf. 2, Fig. 2) sind die 4 Paar granulaten Stege verschieden stark ausgebildet, je nach der Grösse des Exemplares. Sie treten jedoch auch im Lichtmikroskop stets deutlich hervor und sind besonders zwischen gekreuzten Nicols sehr gut erkennbar. Die Zwischenräume sind z.T. leer, z.T. mit Granulae ausgefüllt, die in der Mitte einen Kegelstumpf aufbauen. Stabtragende Exemplare konnten nicht beobachtet werden.

*Vorkommen:* Unteres Maastrichtien von Mön; weitverbreitet vor allem im Maastrichtien.

#### *Ahmuellerella?* sp.

Taf. 1, Fig. 9–11

Als *Ahmuellerella?* sp. wird hier eine Form vorgestellt, die mir nur in basaler? Sicht bekannt ist. Ihr Rand besteht aus sich dachziegelartig überlagernden Platten, wie dies für *Zygolithus*, *Loxolithus* und *Ahmuellerella* typisch ist. Das Zentrafeld wird durch verschiedene grosse Elemente eingenommen. Der Aufbau des Zentrafeldes verbietet eine Zuordnung zu *Zygolithus* oder *Loxolithus*, so dass nur *Ahmuellerella* übrigbleibt, um diese Form aufzunehmen.

*Vorkommen:* Unteres Maastrichtien von Mön, B 13.

Genus *Staurolithites* CARATINI 1963Generotypus: *Staurolithites laffithei* CARATINI 1963

Die Diagnose von *Staurolithites* umfasst nach CARATINI (1963) sowohl runde als auch elliptische Formen mit einem Ring und einem Kreuz im Zentralraum, das den Rand nicht überragt. REINHARDT (1965) stellt *Discolithus bochotnicae* GORKA 1957 als eine Form mit zwei Randringen zu *Staurolithites* und definiert 1966 den Genus: „Zygolithen aus einem circulären oder elliptischen Ring und einem zentralen Kreuz“. Inzwischen werden aber runde und elliptische Formen getrennt, und Formen mit einer und solche mit zwei Randscheiben (-ringen) werden ebenfalls in getrennten Gattungen untergebracht, letzteres bedingt sogar eine Zuordnung zu verschiedenen Unterfamilien. Die meisten Arten in *Staurolithites* müssen deshalb auf andere Gattungen verteilt werden, sobald ihr Feinbau bekannt wird. Da CARATINI (1963) in *S. laffithei* einen elliptischen Cocco lithen als Generotypus gewählt hat, kann der Genus weiterhin für elliptische Formen gebraucht werden und die runden müssen ausgeschlossen werden. In seiner Beschreibung des Generotypus nennt CARATINI nur einen Randring, was mich bewog, die Gattung vorläufig hier unterzubringen und ihr die Arten mit nur einem Randring zuzuordnen. Ob diese Zuordnung richtig ist, wird sich erst erweisen, wenn auch *S. laffithei* im Elektronenmikroskop abgebildet worden sein wird. Es besteht die Möglichkeit, dass *S. laffithei* mit *Deflandrius spinosus* oder *Glaukolithus bochotnicae* identisch ist. BRAMLETTE & MARTINI (1964) haben *Deflandrius* offenbar ohne Kenntnis der Arbeit von CARATINI (1963) aufgestellt. Es hat aber wenig Sinn, eine Umstellung schon vorzunehmen, solange *S. laffithei* noch nicht im Elektronenmikroskop bekannt ist und bis wir mit Sicherheit wissen, ob *Staurolithites* 1 oder 2 Randringe hat und ob diese aus aneinander grenzenden oder sich dachziegelartig überlagernden Elementen oder beidem bestehen, sei die Gattung hier untergebracht. Ich ordne ihr diejenigen Arten zu, die der folgenden Diagnose genügen.

**Diagnose:** Elliptische Cocco lithen, deren Randkranz aus einander ähnlichen Calcitlamellen besteht, die dachziegelartig übereinander liegen. Den Zentralraum durchmisst ein Kreuz, dessen Balken parallel den Ellipsenachsen oder bis 30° gegenüber diesen gedreht verlaufen. Die Balken bestehen aus mehreren Elementen und können an ihrem Kreuzungspunkt einen Fortsatz tragen. Das Kreuz liegt in derselben Ebene wie der Randkranz oder ist leicht gewölbt.

Damit unterscheidet sich *Staurolithites* von *Deflandrius* durch die Anzahl der Randringe, die bei *Deflandrius* 2 beträgt und durch die Stellung der Randelemente im Randring, der bei *Deflandrius* nicht aus dachziegelartig angeordneten Elementen besteht. Bei *Zygrhablithus* DEFLANDRE (1959) und bei *Zygolithus* ragt das zentrale Kreuz deutlich über den Rand des Cocco lithen heraus.

Falls sich erweisen sollte, dass die gegebene Diagnose *S. laffithei* nicht umfasst, kann sie für eine dann notwendig werdende neue Gattung gebraucht werden.

*Staurolithites cruciatus* (NOEL 1958) REINHARDT 1965

Taf. 2, Fig. 6

1958 *Discolithus cruciatus* NOEL: 162, Taf. 1:3.1965\* *Staurolithites cruciatus* (NOEL 1958) REINHARDT: 39, Taf. 3:5.

**Bemerkungen:** Das einzige Exemplar dieser Art, das ich im untersuchten Material fand, trägt ein Kreuz, dessen Balken nur in einem kleinen Winkel zu den Ellipsenachsen stehen und die sich auch nicht unter einem rechten Winkel treffen. Die Balken scheinen ursprünglich aus je zwei parallelen Stäben oder mehreren länglichen Elementen zusammengesetzt gewesen zu sein. In der Mitte stoßen sie zusammen, ohne eine Erhebung zu bilden oder einen Knopf oder Fortsatz zu tragen.

**Vorkommen:** Unteres Maastrichtien von Mon, Kreide von Algerien und Deutschland.

*Staurolithites mielnicensis* (GORKA 1957) n. comb.

Fig. 4; Taf. 2, Fig. 3-5

1957 *Discolithus mielnicensis* GORKA: 250, Taf. 2:14.1966a\* *Staurolithites bochotnicae* (GORKA) REINHARDT: 33, Taf. 19:4. Non Taf. 15:1 und Bild 22.

**Bemerkungen:** In GORKAS Material der Arbeit von 1957 konnte eine weitere Form gefunden werden, die *Staurolithites* zugeordnet werden kann. GORKA (1957) beschreibt von *S. mielnicensis* einen glatten Rand während sie für *Discolithus propinquus* einen Rand mit transversalen Streifen erwähnt. Dazu ist zu sagen, dass im Lichtmikroskop die Randelemente von *Staurolithites* schlechter zu sehen sind als diejenigen von z.B. *Deflandrius*, zu welchem *D. propinquus* vielleicht zu stellen ist. *S. mielnicensis* hat in GORKAS Beschreibung einen zentralen Knopf, der ihn von *Glaukolithus bochot-*

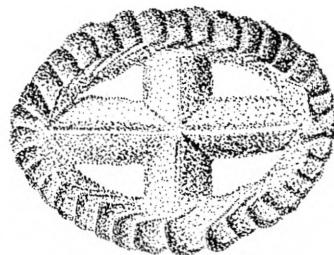


Fig. 4. *Staurolithites mielnicensis* (GORKA) n. comb. aus dem Maastrichtien von Gora Bulawska, Polen, von wo diese Form erstmals beschrieben wurde; Taf. 2, Fig. 4,5 finden sich Lichtmikroskopaufnahmen des gezeichneten Exemplares. Vergrösserung ca. 7500 ×.

*nicae* (GORKA 1957) n. comb. unterscheide. Da ich bei den Exemplaren mit zwei Randscheiben (*Glaukolithus bochotnicae*) keinen Knopf beobachten konnte, kann mit einiger Sicherheit angenommen werden, dass hinter der sehr schematischen Zeichnung und kurzen Beschreibung von *S. mielnicensis* durch GORKA die hier abgebildete Form steckt.

Der Rand des elliptischen Coccolithen besteht aus dachziegelartig übereinander liegenden Elementen. Das Zentrafeld wird von einem Kreuz durchspannt, das in der Mitte etwas emporgewölbt scheint und oft einen Knopf oder eine Rosette trägt. Die Balken des Kreuzes verlaufen parallel den Ellipsenachsen und bestehen aus paarweise angeordneten Elementen.

Vorkommen: Unteres Maastrichtien von Mon, Maastrichtien von Polen und Deutschland.

Unterfamilie *Eiffellithoideae* REINHARDT 1965 emend.

Coccolithen aus zwei Randringen, von denen der äussere aus dachziegelartig angeordneten Elementen gebildet ist und die einen „Boden“ oder einen oder mehrere weitere Randringe haben. Das Zentrafeld kann eine Rosette, Stege, Brücken oder andere Anordnungen aus Granulae und Latten tragen und kann einen zentralen Fortsatz tragen.

REINHARDT (1965) hat seine neue Familie *Eiffellithaceae* aufgestellt, ohne den Generotypus der namengebenden Gattung *Eiffellithus* im Elektronenmikroskop abzubilden. Da solche Aufnahmen jetzt vorliegen, möchte ich die Diagnose für die Unterfamilie wie obenstehend neu fassen. *Eiffellithoideae* enthält die meisten Gattungen, die NOEL (1965) ihrer Parafamilie *Discolithaceae* zugeordnet hat: *Discolithus* sensu NOEL (1965), *Crepidolithus* NOEL 1965, *Parhabdolithus* DEFLANDRE 1952 und *Diazomatolithus* NOEL 1965, wobei die Zuordnung der beiden letztgenannten Gattungen fraglich ist, da hier die Randelemente fast senkrecht stehen.

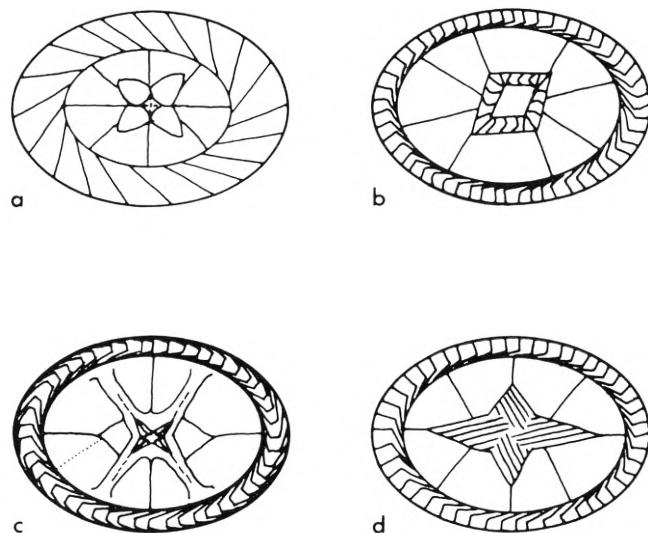


Fig. 5. Schematische Zeichnungen der Eiffellithusarten *E. gorkae* (a), *E. turriseiffeli* (b), *E. regularis* (c) und *E. eximus* (d).

Genus *Eiffellithus* REINHARDT 1965 emend.

Generotypus: *Eiffellithus turriseiffeli* (DEFLANDRE 1954) REINHARDT 1965

Emendierte Diagnose: Elliptische Coccolithen aus einem Randkranz, der sich aus dachziegelartig aufeinander liegenden Elementen aufbaut und einem „Boden“, der aus einer Anzahl Platten besteht, die den zentralen Raum ganz oder nur teilweise verschliessen. In beiden Fällen trägt die zentrale Partie ein Ornament, das einen zentralen Fortsatz tragen kann.

*Clinorhabdus* STOVER 1966 ist als Synonym von *Eiffellithus* REINHARDT 1965 zu betrachten, hat er doch denselben Generotypus.

### *Eiffellithus turriseiffeli* (DEFLANDRE 1954) REINHARDT 1965

Fig. 6; Taf. 3, Fig. 1-7

- 1954 *Zygolithus turriseiffeli* DEFLANDRE: 149 in DEFLANDRE & FERT, Taf. 13:15, 16, Abb. 65.
- 1959 *Zygrhablithus turriseiffeli* (DEFLANDRE 1954) DEFLANDRE: 135.
- 1963 *Rhabdolithus turriseiffeli* (DEFLANDRE 1954) STRADNER: 9.
- 1965 *Eiffellithus turriseiffeli* (DEFLANDRE 1954) REINHARDT: 32.
- 1966a *Eiffellithus turriseiffeli turriseiffeli* (DEFLANDRE 1954) REINHARDT in REINHARDT: 38, Taf. 23:1, 11, 12. Non Bild 18.
- 1966 *Clinorhabdus turriseiffeli* (DEFLANDRE 1954) STOVER: 138, Taf. 3:7-9.

Bemerkungen: Die schematische Zeichnung, die REINHARDT (1966 a:36, Abb. 18) von *E. turriseiffeli* gibt, stimmt nicht mit den Beobachtungen überein, die ich an Elektronenmikroskopbildern von auch im Lichtmikroskop bestimmten Exemplaren machen konnte (Taf. 3:1-7). Der Randkranz besteht aus ca. 50-60 schräggestellten Lamellen, die einander dachziegelartig überlagern. Der „Boden“, der einen Teil dieses Kranzes überlagert, besteht meist aus 8 mehr oder weniger horizontal liegenden Platten mit Trapezform, die radial orientiert sind. Gelegentlich scheinen jedoch die Platten ineinander überzugreifen oder es treten zusätzliche Trennungslinien auf. In der Mitte sitzt eine rhomboederförmige Struktur aus Granulae, die im Zentrum einen Durchbruch lassen.

Stabtragende Exemplare konnten im Elektronenmikroskop nicht gefunden werden, sind jedoch vom Lichtmikroskop her bekannt. Der Stab steht in einem Winkel von 60-90° zur Basalplatte. Einzelne abgebrochene Stäbe konnten gefunden werden. Sie seien hier nur erwähnt, da nicht ausgeschlossen werden kann, dass auch andere Arten von *Eiffellithus* oder anderer Gattungen Stäbe mit ähnlichem Feinbau tragen, wodurch isolierte Stäbe nicht immer bestimmten Arten ausserhalb der Familie der *Microrhabdulaceae* zugeordnet werden können.

Die Diagonalen des zentralen Rhomboeders sind auch Diagonalen der Ellipsen, was *E. turriseiffeli* von *E. eximius* unterscheidet, bei dem sie parallel den Ellipsenachsen verlaufen. Die Rückseite der Platten scheint durch grobe Granulae überdeckt zu sein; ob diese eine eigene „Decke“ bilden oder nur die in Einzelemente aufgelösten Platten darstellen ist nicht zu erkennen. Fig. 6 zeigt eine der recht häufigen

Kleinformen von *E. turriseiffeli*. Zwischenformen scheinen seltener zu sein als die kleinen und grossen Formen.

Vorkommen: Unteres und oberes Maastrichtien von Dänemark; weltweit verbreitet in der oberen Kreide.

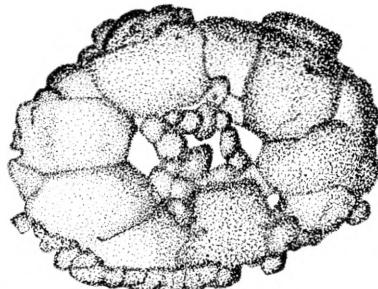


Fig. 6. *Eiffellithus turriseiffeli* (DEFLANDRE) REINHARDT. Kleines Exemplar. Unteres Maastrichtien von Mön, B 22. Vergrösserung ca. 7500 ×.

#### *Eiffellithus gorkae* REINHARDT 1965

Fig. 7; Taf. 3, Fig. 11–13

1965\* *Eiffellithus gorkae* REINHARDT: 36, Taf. 2:2, Abb. 6.

Bemerkungen: Die Verwandtschaft von *E. gorkae* und *E. turriseiffeli* ist sehr nahe. *E. gorkae* ist nur halb so gross wie die grösseren Formen von *E. turriseiffeli* und etwa gleich gross wie dessen Kleinformen. Die beiden Arten sind an den relativ grösseren, ausschweifenderen, schräggestellten Randelementen des Randkranzes bei *E. gorkae* und an dem einfacheren zentralen Aufbau der letzteren zu unterscheiden. Die Platten des „Bodens“ erreichen meist fast die Mitte des Coccoolithen. Es konnten keine stabtragenden Exemplare gefunden werden.

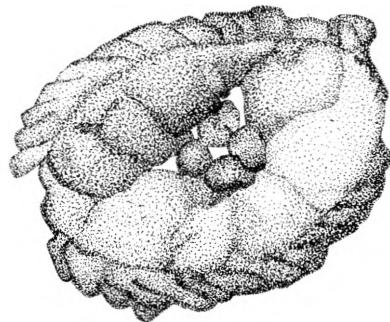


Fig. 7. *Eiffellithus gorkae* REINHARDT. Unteres Maastrichtien von Mön, A 10. Vergrösserung ca. 7500 ×.

Vorkommen: Unteres Maastrichtien von Mön, wohl weit verbreitet in der oberen Kreide, meist aber als *E. turriseiffeli* bestimmt. Seltener als *E. turriseiffeli*, der in der oberen Kreide weltweit verbreitet scheint und recht häufig ist.

*Eiffellithus eximus* (STOVER 1966) n. comb.

Taf. 3, Fig. 8–10

1966 *Clinorhabdus eximus* STOVER: 138, Taf. 2:15, 16, Taf. 8:15.

Bemerkungen: *E. eximus* wurde im Material von Mön nicht gefunden sondern nur in einer Probe aus dem Material von GORKA (1957). Er wird hier beschrieben und abgebildet, um dem Genus *Eiffellithus* eine weitere Art hinzuzufügen. Aus den Zeichnungen von GORKA (1957) ist nicht mit Sicherheit zu erkennen, ob die Art dort beschrieben wurde. In Frage käme z.B. *?Zygolithus polonicus* GORKA 1957, der, wie das hier abgebildete Exemplar, von Mecmierz stammt.

Diagnose: Eine Art von *Eiffellithus*, bei der die zentrale, rhomboederförmige Struktur in den Ellipsenachsen ausgerichtet ist und aus flachliegenden, kleinen Stäben besteht.

Beschreibung: Elliptischer Coccolith mit einem Randkranz aus stark schräg stehenden Lamellen, die einander dachziegelartig überlagern und einem „Boden“ aus in der Regel 8 trapezförmigen Platten, die das Zentrum des Coccolithen fast erreichen. Über der Mitte erhebt sich ein Kreuz, das ungefähr in den Ellipsenachsen ausgerichtet ist und aus übereinander gestapelten, flachliegenden Stäbchen gebildet ist. Höchster Punkt des Coccolithen ist die Mitte des Kreuzes. Stabtragende Exemplare konnten nicht beobachtet werden.

*E. eximus* ist im Lichtmikroskop (Beschreibung s. STOVER 1966:138) und im Elektronenmikroskop leicht zu erkennen und erscheint nach STOVER 1966 im Turon erstmals und ist im oberen Maastrichtien von Polen noch anwesend, wurde im unteren Maastrichtien von Mön aber nicht angetroffen.

*Eiffellithus regularis* (GORKA 1957) n. comb.

Taf. 32, Fig. 8, 9

1957 *Tremalithus regularis* GORKA: 246, Taf. 2:4.

Bemerkungen: GORKA (1957) hat aus dem Maastrichtien von Mecmierz (Polen) eine elliptische Form als sehr häufig beschrieben, die einen schmalen Rand besitzt und einen 4×breiteren, inneren Ring, der ein kleines Zentralfeld einrahmt. Der innere Ring soll mit 8 Strahlen verziert sein, der äußere glatt sein. Im Typusmaterial von Mecmierz wurde die Taf. 32, Fig. 8 wiedergegebene Form gefunden, die sehr wahrscheinlich von GORKA als *Tremalithus regularis* beschrieben und schematisch abgebildet worden ist.

Im Lichtmikroskop erscheint der aus dachziegelartig übereinander lagernden Plättchen bestehende äußere Rand glatt. Der „innere Ring“ besteht aus Platten, deren Abgrenzung variiert, die aber meist mindestens Grenzen in den Ellipsenachsen und unter den die zentrale Struktur tragenden Leisten haben. Das offene Zentralfeld ist sehr klein und besteht aus zwei vieleckigen Öffnungen in den Ellipsenbrennpunkten

und einer kleinen Öffnung in der Mitte der zentralen Struktur, die Taf. 32, Fig. 9 besonders gut beobachtet werden kann.

*E. regularis* steht *E. turriseiffeli* sehr nahe und unterscheidet sich von diesem nur durch den Aufbau der zentralen Struktur, die bei *E. turriseiffeli* rhomboedrisch ist, während sie bei *E. regularis* sternförmig ausgebildet ist. Möglicherweise ist *E. regularis* auf das obere Maastrichtien beschränkt – er wurde im unteren Maastrichtien von Mon nicht gefunden.

Vorkommen: Maastrichtien von Mecmierz, Polen und oberes Maastrichtien von Kjølby Gård.

Genus *Glaukolithus* REINHARDT 1964 emend.

Generotypus: *Glaukolithus diprogrammus* (DEFLANDRE 1954) REINHARDT 1964

Die erste Diagnose von *Glaukolithus* lautete wie folgt: „Elliptische Coccolithen bestehen aus zwei Limbi, Zentrfeld basal von einem Steg geteilt, zwei Poren“ (REINHARDT 1964:758) und wurde offenbar nur aufgrund lichtmikroskopischer Beobachtungen am Generotypus aufgestellt.

1966 lautete REINHARDTS Diagnose folgendermassen: „Querstege überspannen einen basalen elliptischen Ring. Marginal sitzt auf dem Ring ein distaler Wall“. Trotzdem der Generotypus zuerst aus dem Tertiär beschrieben worden ist und aus dem ursprünglichen Material nicht im Elektronenmikroskop bekannt geworden ist, möchte ich nun den Genus dahin ausweiten, dass er auch Formen enthalten soll, deren Randaufbau derselbe ist, deren Zentralraum jedoch von verschiedenen Anordnungen von verschiedenen Elementen eingenommen wird.

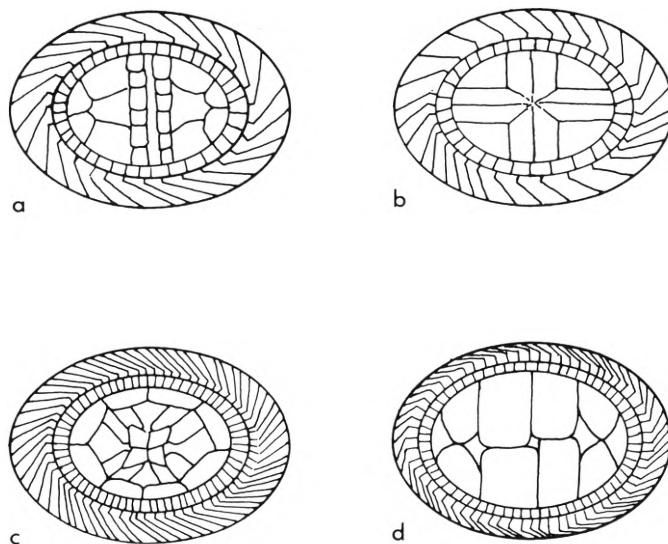


Fig. 8. Schematische Zeichnungen der Glaukolithusarten *G. diprogrammus* (a), *G. bohotnicae* (b), *G. fessus* (c) und von *Tranolithus orionatus* (d).

**Diagnose:** Elliptische Coccolithen, deren eine Randscheibe aus dachziegelartig übereinander gelagerten Lamellen besteht und deren andere Randscheibe zu einem schmalen Ring von Elementen reduziert ist, der der erstgenannten Randscheibe aufsitzt. Das Zentrafeld wird von Elementen überspannt, die aus mehreren verschiedenen Bausteinen bestehen können und eine Brücke, Brücken, ein Kreuz oder andere Anordnungen bilden können.

Damit ordnet sich *Glaukolithus* in die Unterfamilie *Eiffellithoideae* ein und umfasst die Arten *G. diprogrammus*, *G. bohotnicae* und *G. fessus*. Er unterscheidet sich von *Eiffellithus* durch dessen plattenförmigen „Boden“, von *Crepidolithus* ebenfalls durch dessen Boden, von *Tranolithus* nur durch die plattenförmige Ausbildung der zentralen Elemente und von *Reinhardlites* n. gen. durch dessen komplexen Aufbau des zentralen Raumes.

Im Falle dass der Generotypus von *Glaukolithus*, *G. diprogrammus* aus dem Typmaterial im Elektronenmikroskop sich als nicht zur gegebenen Diagnose passende Form herausstellen sollte, müsste für die genannten Arten ein neuer Genus aufgestellt werden oder *Tranolithus* ausgeweitet werden, um sie zu umfassen.

#### *Glaukolithus diprogrammus* (DEFLANDRE 1954) REINHARDT 1964

Taf. 4, Fig. 1–10

- 1954 *Zygolithus diprogrammus* DEFLANDRE: 148 in DEFLANDRE & FERT, Taf. 10:7, Abb. 57.  
 1964 *Glaukolithus diprogrammus* (DEFLANDRE 1954) REINHARDT: 758.  
 1966a\* *Glaukolithus cf. diprogrammus* (DEFLANDRE 1954) REINHARDT: 41, Taf. 15:6,? Taf. 23:25–28.  
 1966 *Zygolithus xenotus* STOVER: 149, Taf. 4:16–17, Taf. 9:2.  
 NON 1965\* *Zygolithus diprogrammus* DEFLANDRE 1954 in NOEL: 64, Taf. 1:5, 6.

**Bemerkungen:** NOEL (1965) hat für *Glaukolithus diprogrammus* einen Hypotyp, eine Elektronenmikroskopaufnahme der Art aus dem Oxfordien von Niort, Frankreich bestimmt. Nach ihren Beobachtungen besitzt die Art nur einen Randkranz und steht deshalb im Genus *Zygolithus* sensu NOEL (1965) und nicht in *Discolithus* sensu NOEL (1965), wo unsere Exemplare unterzubringen wären. BRAMLETTE & MARTINI (1964) erwähnen, dass sie im Typmaterial, Mio-Pliozän von Algerien, aufgearbeitete Kreideformen gefunden haben, unter anderen auch einige Exemplare von *G. diprogrammus*, wie er in den von ihnen untersuchten kretazischen Proben auftrat. Sie nehmen an, dass *G. diprogrammus*' Holotypus eine aufgearbeitete Kreideform ist. Dies führt mich dazu, NOELS Form aus dem Jura als nicht zu *G. diprogrammus* gehörend anzusehen. Die jurassischen Formen haben zudem ein weiter geöffnetes Zentrafeld und schmalere Brücken als die kretazischen.

Die hier abgebildeten Exemplare von *G. diprogrammus* zeigen den für die Unterfamilie der *Eiffellithoideae* typischen Aufbau des Randes: Die schräggestellten, dachziegelartig übereinanderlagernden Platten der einen Randscheibe und den zweiten Randring, der hier reduziert ist zu einem Ring aus kleinen Elementen, der dem ersten

aufsitzt. Das Zentralfeld wird durch zwei parallele Reihen von Elementen unterteilt, die beidseitig der kleinen Ellipsenachse angeordnet sind. Sie können, wie die Abbildungen Taf. 4:1–10 zeigen, schmäler oder breiter sein und mehr oder weniger weit voneinander liegen. Weiter wird das Zentralfeld mit einer Anzahl Tabulae ausgefüllt, sodass nur sehr wenig offener Raum übrigbleibt, der die Form zweier dreiecksförmiger Öffnungen annimmt. Diese liegen etwas außerhalb der Brennpunkte der Ellipse, die schwach breit- bis schwach langelliptische Form haben kann. Bei einigen Exemplaren erscheint auch eine offene Stelle zwischen den beiden Elementreihen. Je zwei Tabulae liegen in den spitzen Enden der Ellipse und treffen sich im Ellipsenende.

Im Lichtmikroskop ist die Zweiteilung des zentralen Steges bei den kleinsten Exemplaren kaum mehr sichtbar, und die Tabulae erfüllen den freien Raum im Zentralfeld fast ganz.

**Vorkommen:** Unterer Maastrichtien von Mön; weltweit verbreitet in der Kreide; aufgearbeitet im Miozän, fraglich im Jura.

Es wäre merkwürdig, wenn STOVER (1966) *G. diplogrammus* in seiner Kreidearbeit über Coccolithen nicht angetroffen hätte – genannt wird er dort nicht. Ich glaube deshalb, dass sein *Zygolithus xenotus* *G. diplogrammus* entspricht. STOVER spricht jedoch von einem zeitweilig auftretenden Fortsatz auf *Z. xenotus*. An *G. diplogrammus* konnten bisher keine Fortsätze festgestellt werden. Die Zuweisung ist deshalb unsicher.

*Glaukolithus bohotnicae* (GORKA 1957) n. comb.

Taf. 4, Fig. 11–14

- 1957 *Discolithus bohotnicae* GORKA: 273, Taf. 2:15.  
 1965\* *Staurolithites bohotnicae* (GORKA 1957) REINHARDT: 39, Taf. 3:3.  
 1966a\* *Staurolithites bohotnicae* (GORKA 1957) REINHARDT 1965 in REINHARDT: 33, Taf. 15:1,  
     NON Taf. 19:4.  
 1966 *Zygolithus biramiculatus* STOVER: 147, Taf. 3:16, Taf. 8:23.

**Bemerkungen:** REINHARDT (1965) wählte für *G. bohotnicae* einen Hilfstypus, dessen Randaufbau aus zwei Randringen ihn nach der Trennung der Gattungen in solche mit einem und solche mit zwei Randringen in die Gattung *Glaukolithus* stellt, nachdem diese erweitert worden ist. Die Diagnose von REINHARDT 1966 lautet jedoch auf nur eine Randscheibe und ein solches Exemplar wird auch abgebildet. Der gewählte Hilfstypus hat jedoch, wie die hier abgebildeten Exemplare, einen Kranz aus sich überlagernden, schräggestellten Lamellen und darauf aufsitzend einen kleineren Ring aus Granulae. Der zentrale Raum wird durch ein Kreuz eingenommen, dessen Arme je aus einem Paar parallelen Stäben aufgebaut sind, die sich beidseitig den Ellipsenachsen anschmiegen. Bei gut erhaltenen Exemplaren treffen sich die Arme des Kreuzes in der Mitte, bei anderen lassen sie im Zentrum eine Lücke offen. Vom Zentralfeld bleibt in jedem Quadranten nur ein kleines, dreieckiges Loch offen, das durch sekundäre Kalkanlagerung geschlossen sein kann.

Im Lichtmikroskop erscheint *G. bochotnicae* als zarte Form. Bis jetzt konnte ich *G. bochotnicae* aus dem Typusmaterial erst im Lichtmikroskop finden.

**Vorkommen:** Unteres Maastrichtien von Mön; weltweit verbreitet in der oberen Kreide.

*Glaukolithus fessus* (STOVER 1966) n. comb.

Taf. 4, Fig. 20-23

- 1965\* *Eiffellithus turriseiffeli inturratus* REINHARDT: 36, Taf. 2:3, Abb. 5.  
 1966a\* *Eiffellithus turriseiffeli inturratus* REINHARDT 1965 in REINHARDT: 38, Taf. 8:2, Taf. 11:3 a, b; Bild 19.  
 1966 *Discolithus fessus* STOVER: 142, Taf. 2:17-21, Taf. 8:16.

**Bemerkungen:** STOVER (1966:142) hat eine sehr gute Beschreibung von *G. fessus* im Lichtmikroskop gegeben und auch seine Abbildungen sind ausgezeichnet. REINHARDT hat sowohl 1965:36 als auch 1966:38 *G. fessus* als Unterart von *Eiffellithus turriseiffeli* angeschaut, ohne aber Elektronenmikroskopaufnahmen von *E. turriseiffeli* abzubilden oder zu beschreiben. Seine Zeichnung (Bild 18, 1966 a) von *E. turriseiffeli* stimmt nicht mit den Beobachtungen überein, die ich an im Lichtmikroskop bestimmten und im Elektronenmikroskop untersuchten Exemplaren von *E. turriseiffeli* machen konnte. Dementsprechend erwies sich die Verwandtschaft auch als nicht so nahe, wie sie REINHARDT annahm. Da nun STOVER 1966 eine neue Art für diese Form aufgestellt hat, übernehme ich diese und stelle sie zu *Glaukolithus*, wo sie nach ihrem Randaufbau und durch die Anordnungen im Zentrafeld hingehört.

*G. fessus* zeigt auf der einen Seite den für *Glaukolithus* typischen Aufbau der Randpartie: Die schräggestellten, sich überlappenden Platten und den schmalen Ring aus Granulae, der als zweiter Randring dem ersten anhaftet. Auf der anderen Seite schliessen an den Wall 8 Platten an, die den offenen Teil des Zentrafeldes reduzieren, jedoch nicht so lange gegen das Zentrum vordringen wie bei *Eiffellithus*. Sie tragen die zentrale Struktur, die aus 4 paarweise angeordneten Säulchen besteht, die in einem diagonal stehenden Kreuz angeordnet sind. Die Säulchen stossen in der Mitte zusammen und tragen, nur selten erhalten, 4 oder mehr Granulae. Bei kleinen Formen ist oft fast das ganze Zentrafeld durch die längs des Randes und im Zentrum angeordneten Tabulae und Säulchen ausgefüllt, während bei den grösseren Formen mehr freier Raum bleibt. Meist stossen die Säulchen in der Mitte nicht mehr zusammen, sondern sind abgebrochen. Stabtragende Exemplare konnten nicht beobachtet werden.

Im Lichtmikroskop ist *G. fessus* auch eher eine zarte Form, ist jedoch gut zu erkennen (s. Beschreibung in STOVER 1966).

**Vorkommen:** Unteres Maastrichtien von Mön; nach STOVER im Albien und im Cenomanien von Frankreich und Holland, nach REINHARDT (1966 a) auch im unteren Maastrichtien von Rügen, Norddeutschland.

REINHARDT (1966 a) hat *G. fessus* als Vertreter des Feinbautypus für die zeugoiden Formen gewählt und abgebildet. Offenbar hat er keine Exemplare dieser Art gefunden,

deren Säulchen sich im Zentrum treffen und von Granulae überlagert werden. Granulae sind diagnostisch für seinen rhagoiden Typ und sollten im zeugoiden Typ nicht vorkommen.

Genus *Tranolithus* STOVER 1966

Generotypus: *Tranolithus manifestus* STOVER 1966

Der Generotypus von *Tranolithus*, *T. manifestus* STOVER 1966 ist im Elektronenmikroskop noch unbekannt und ich verzichte deshalb darauf, eine Gattungsdiagnose von *Tranolithus* zu geben. Nachdem jedoch REINHARDT (1966 b) seinen *Discolithus orionatus* 1966 a bereits zu *Tranolithus* gestellt hat, übernehme ich diese Zuordnung. *T. orionatus*, der *T. phacelosus* STOVER 1966 entspricht, kann in die Unterfamilie der *Eiffellithoideae* gestellt werden. Er muss, falls es sich zeigen sollte, dass der Generotypus von *Tranolithus* nicht hierher gehört, daraus entfernt werden und kann *Glaukolithus* zugeordnet werden.

*Tranolithus orionatus* (REINHARDT 1966 a) REINHARDT 1966 b

Fig. 9; Taf. 4, Fig. 15–19

- 1966a *Discolithus orionatus* REINHARDT: 42, Taf. 23:22, 31–33.
- 1966 *Tranolithus phacelosus* STOVER: 146, Taf. 4:23–25, Taf. 9:7.
- 1966b *Tranolithus orionatus* (REINHARDT 1966) REINHARDT: 522.

Beschreibung: Die eine Randscheibe von *T. orionatus* besteht aus dachziegelartig übereinanderliegenden, breiten Latten. Der andere Ring besteht aus kleineren Elementen, sitzt dem erstgenannten Wall am inneren Rand ringförmig auf

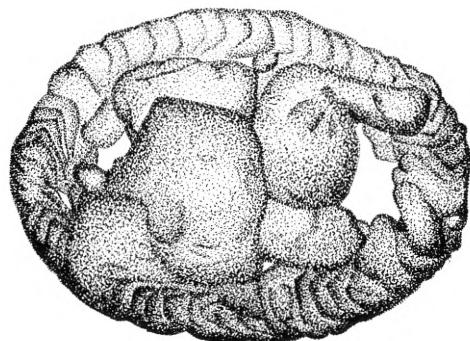


Fig. 9. *Tranolithus orionatus* (REINHARDT) REINHARDT. Unteres Maastrichtien von Mön, A 10. Vergrößerung ca. 7500 ×.

und ist oft nur teilweise erhalten. Die auffälligsten, auch im Lichtmikroskop gut zu erkennenden Elemente des Zentralfeldes bilden 4 grosse Tafeln, die einander in der Mitte etwas überlappen können und die den elliptischen Coccolithen quer teilen. Die Längsenden der Ellipse sind bei einigen (beschädigten?) Exemplaren teilweise offen,

d.h. die hier am inneren Rand der grösseren Randscheibe ansetzenden Tafeln erfüllen sie nicht ganz.

**Vorkommen:** Unteres Maastrichtien von Mön; REINHARDT (1966 a) beschreibt die Form aus dem Albien und dem Cenomanien, STOVER (1966) aus dem oberen Cenomanien und dem Santonien.

Genus *Crepidolithus* NOEL 1965

Generotypus: *Crepidolithus crassus* (DEFLANDRE 1954) NOEL 1965

NOEL (1965:90) hat der jurassischen Gattung *Crepidolithus* NOEL eine Anzahl tertiäre Formen aus *Discolithus* s.l. zugeordnet, ohne sie im Elektronenmikroskop

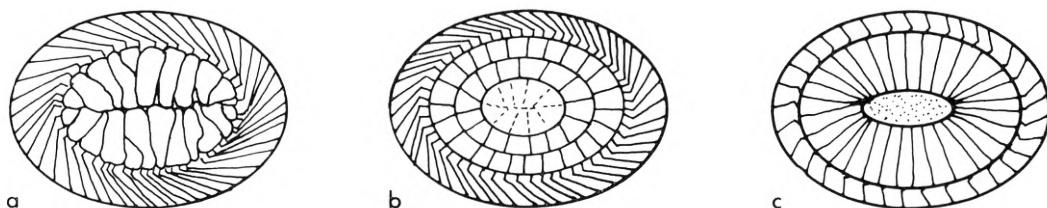


Fig. 10. Schematische Zeichnungen der *Crepidolithus*-arten *C. neocrassus* (a), *C. cohenii* (b) und *C. crassus* (c).

abzubilden oder zu beschreiben. Weiter hat die Autorin den ebenfalls tertiären *Discolithus ocellatus* BRAMLETTE & SULLIVAN 1961, der von HAY & TOWE (1962) im Elektronenmikroskop abgebildet wurde, zu *Crepidolithus* gestellt. Ich möchte hier der Gattung zwei neue Arten, *C. neocrassus* und *C. cohenii* aus dem unteren und oberen Maastrichtien von Dänemark zuweisen.

*Crepidolithus neocrassus* n. sp.

Fig. 11, Taf. 2, Fig. 9

Holotypus: Taf. 2, Fig. 9 (K. P.-N. 61/20).

Masse des Holotypus: Länge 6,5  $\mu$  Breite 4  $\mu$ .

Locus typicus: Kjølby Gård.

Stratum typicum: Oberes Maastrichtien.

**Diagnose:** Elliptische Coccolithen mit einem Randwall aus sich dachziegelartig überlagernden Platten, die schräg einfallen und einen Kegelstumpf mit elliptischer Grundfläche bilden. Das obere Ende des Kegelstumpfes wird von einem „Boden“ gebildet, der aus  $\pm$  radial angeordneten Elementen besteht.

**Beschreibung:** Die den Randwall aufbauenden Platten sind ungleichförmig und oben schmäler als unten. Sie stehen stark schräg und bilden einen Kegelstumpf mit elliptischem bis langelliptischem Umriss. Der „Boden“ wird aus Elementen gebildet, die sich längs einer Mittellinie treffen, die ungleichförmig sind und z.T. radial orientiert. Die Grösse von *C. neocrassus* variiert stark.

Bemerkungen: *C. neocrassus* wurde von *C. crassus* abgetrennt aufgrund von NOELS Abbildungen von letzterem. Dort zeigen die Randelemente nur geringste Abweichung von der senkrechten Lage, die Lamellen scheinen gleichförmiger zu sein, ebenso die Elemente die den „Boden“ aufbauen. Von *C. cohenii* n. sp. unterscheidet sich *C. neocrassus* durch die Anordnung der Elemente, die den „Boden“ aufbauen.

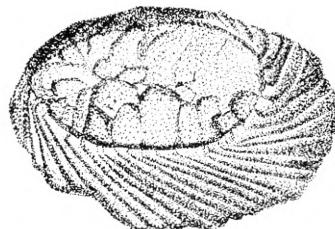


Fig. 11. *Crepidolithus neocrassus* n. sp. aus dem unteren Maastrichtien von Møn, B 3. Vergrösserung ca. 7500 ×.

Vorkommen: Unteres Maastrichtien von Møn, oberes Maastrichtien von Kjølby Gård; kleine Exemplare können im Lichtmikroskop, wo sie als undifferenzierte, elliptische Calztikörper auftreten, gut übersehen worden sein. Ähnliche Formen treten auch im Danien der Typregion auf.

#### *Crepidolithus cohenii* n. sp.

Fig. 12; Taf. 2, Fig. 7, 10

Holotypus: Taf. 2, Fig. 7 (K. P.-N. 58/8).

Masse des Holotypus: Länge: 7 μ Breite: 5 μ.

Locus typicus: Møn, A 11.

Stratum typicum: Unteres Maastrichtien.

Diagnose: Elliptische Coccolithen aus einem Randwall aus schräg einfallenden, sich dachziegelartig überlagernden Platten und einem „Boden“, der aus in Ringen angeordneten Granulae besteht und das obere Ende des durch den Randwall gebildeten Kegelstumpfes überdeckt.

Beschreibung: Der Randwall besteht aus schräg einfallenden, fast gleichförmigen Platten, die einen Kegelstumpf bilden, dessen Umriss elliptisch ist. Der „Bo-



Fig. 12. *Crepidolithus cohenii* n. sp. aus dem unteren Maastrichtien von Mon, B 3. Vergrösserung ca. 7500 ×.

den“ besteht aus einem oder mehreren Ringen aus ungefähr gleichgrossen Granulae und bedeckt das obere Ende des Kegelstumpfes. Die Anordnung der Granulae in Ringen ist an den grösseren Exemplaren besser zu erkennen als an den kleineren. Die Anzahl der Randelemente ist bei den grossen Exemplaren von *C. cohenii* grösser als bei den kleinen.

Im Lichtmikroskop erkennt man nur eine elliptische Form, manchmal auch die schrägstehenden Randelemente.

Bemerkungen: *C. cohenii* unterscheidet sich im Lichtmikroskop nicht erkennbar von *C. neocrassus*. Im Elektronenmikroskop sind vor allem die grösseren Exemplare leicht zu unterscheiden an der verschiedenen Ausbildung des „Bodens“. Ansichten der anderen Seite der Coccoolithen sind nicht artlich zu bestimmen und werden als *Crepidolithus* sp. abgebildet (Taf. 2, Fig. 8).

Vorkommen: Unteres Maastrichtien von Mön; auch diese Art ist sicher in anderen Ablagerungen vorhanden, wird aber im Lichtmikroskop übersehen oder als unbestimmt angesehen.

#### Genus *Reinhardtites* n. gen.

Generotypus: *Reinhardtites anthophorus* (DEFLANDRE 1959) n. comb.

Diagnose: Schrägstehende, dachziegelartig übereinander liegende Elemente bauen den distalen, elliptischen Randwall auf, dem ein reduzierter, basaler Randring aus Granulae anhaftet. Das distale Zentrafeld ist mit Tabulae überdeckt, das basale weist komplexe Strukturen auf. Die Coccoolithen können Stäbe tragen. Dimorphismus.

Bemerkungen: Der hier eingenommene Standpunkt, dass elliptische Coccoolithen mit einem und mit zwei Randringen zu trennen seien veranlasst mich, *R. anthophorus* aus *Rhabdolithina* REINHARDT 1967 herauszunehmen, da der Autor der Gattung diese mit nur einer Randscheibe definiert. Da *Cretarhabdus* BRAMLETTE & MARTINI 1964, dessen zwei Randscheiben anders aufgebaut sind, zu der Familie der *Podorhabdaceae* NOEL 1965 gehört, kann *R. anthophorus* auch nicht hier untergebracht werden. *Rhabdolithus* endlich, in dem die Art aufgestellt wurde, hat einen tertiären Generotypus, der noch nicht im Elektronenmikroskop bekannt ist und nach den neueren Auffassungen *R. anthophorus* kaum umfassen dürfte.

Der Aufbau der Randpartie von *R. anthophorus* erinnert stark an denjenigen von *Glaukolithus*; die Ausbildung des Zentrafeldes ist von diesem jedoch so verschieden, dass die Aufstellung einer eigenen Gattung gerechtfertigt schien.

#### *Reinhardtites anthophorus* (DEFLANDRE 1959) n. comb.

Fig. 13, 14; Taf. 5, Fig. 1-8

1959 *Rhabdolithus anthophorus* DEFLANDRE: 137, Taf. 1:21, 22.

1964 *Cretarhabdus? anthophorus* (DEFLANDRE 1959) BRAMLETTE & MARTINI: 299, Taf. 3:1-4.

1966a *Discolithus polonicus* GORKA 1957 in REINHARDT: 45, 53, 54.

1966 *Discolithus cryptochondrus* STOVER: 142, Taf. 2:8–9, Taf. 8:13.

1967a\* *Rhagodiscus? cryptochondrus* (STOVER 1966) REINHARDT: 167, Abb. 3, Abb. 7:6, 9.

1967a *Rhabdolithina anthophora* (DEFLANDRE 1959) REINHARDT: 167.

Bemerkungen: Die Identität dieser hier beschriebenen Formen mit dem Holotypus der Art von DEFLANDRE (1959) konnte in Material von der Typuslokalität

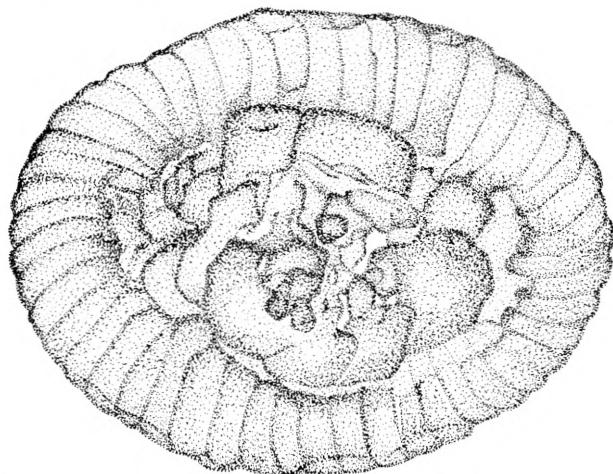


Fig. 13. *Reinhardtites anthophorus* (DEFLANDRE) n. comb. Distale Seite eines Coccolithen aus dem unteren Maastrichtien von Mon. Vergrösserung ca. 7500×.

(Grodno, ehemals Polen) sowohl im Lichtmikroskop als auch im Elektronenmikroskop festgestellt werden.

Beschreibung: Die den distalen Randwall aufbauenden Elemente sind eher keilförmig als plattenförmig und nicht so dicht gepackt wie z.B. bei *Eiffellithus*

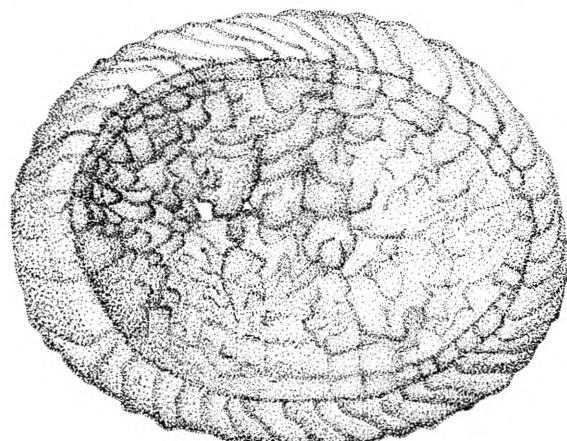


Fig. 14. *Reinhardtites anthophorus* (DEFLANDRE) n. comb. Basale Seite eines Coccolithen, bei welchem die beiden Durchbrüche nur angedeutet sind. Unterer Maastrichtien von Mon. Vergrösserung ca. 7500×.

*turriſeiffeli* oder *Crepidolithus cohenii*. Die basale Randscheibe besteht nur aus einer Leiste aus kleinen Plättchen, die dem kegelstumpfförmigen Randwall aus dachziegelartig übereinander lagernden Elementen am oberen Ende anhaften. Die distale Seite des Coccolithen ist mit Platten belegt, die verschiedene Form und verschiedene Grösse haben und nicht streng symmetrisch um die Ellipsenachsen zu einer pyramidenartigen Erhebung aufgetürmt sind. Etwas innerhalb der Brennpunkte der Ellipse sind oft zwei Öffnungen ausgespart, die in Form und Grösse stark variieren. Über der Brücke zwischen diesen beiden „Poren“ kann sich ein Stab oder Knopf erheben. Die basale Seite des Coccolithen fällt vom Randwall zu den beiden Öffnungen ab, wie ein Hang, der durch rinnendes Wasser in Gräben und Rücken zerfurcht wurde. Das Feld zwischen den Öffnungen wird durch keilförmige, grössere Elemente eingenommen, die oft herausgebrochen sind. Im Material von Møn konnten im Elektronenmikroskop keine Exemplare mit ganzem Stab gefunden werden.

Vorkommen: Unteres Maastrichtien von Møn; weltweit verbreitet im Senonien.

*Reinhardtites mirabilis* n. sp.

Fig. 15; Taf. 7, Fig. 1

Holotypus: Taf. 7, Fig. 1 (K. P.-N. 62/6).

Masse des Holotypus: Länge: 9  $\mu$  Breite: 6,5  $\mu$ .

Locus typicus: Kjølby Gård.

Stratum typicum: Oberes Maastrichtien.

Diagnose: Elliptische Coccolithen aus einem Randkranz aus sich dachziegelartig überlagernden Elementen und einem zweiten Randring, der dem anderen als

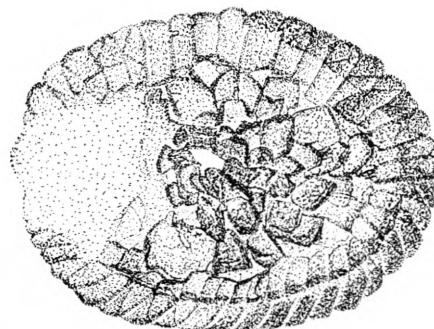


Fig. 15. *Reinhardtites mirabilis* n. sp. Distale Ansicht einer kleinen Form, bei welcher die schwalbenschwanzartige Anordnung der Tabulae, die den zentralen Kegel aufbauen, aber auch schon zu erkennen ist. Oberes Maastrichtien von Kjølby Gård. Vergrößerung ca. 7500  $\times$ .

schmaler Ring aus Plättchen basal aufsitzt. Das Zentrafeld trägt einen Kegel aus Tabulae, die schwalbenschwanzähnlich in 8 Reihen angeordnet sind.

Beschreibung: Der Aufbau des Randes ist derselbe wie bei *R. anthophora*. Das distale Zentrafeld besteht aus einem Kegel, der aus 8 Reihen verschiedengrosser

und verschieden orientierter Tabulae besteht. Jede Reihe besteht aus von unten (aussen) nach oben (innen) an Grösse abnehmenden, übereinanderliegenden Tabulae, die paarweise zu einem schwabenschwanzförmigen Gebilde zusammengefügt sind. *R. mirabilis* ist mir nur aus dem Elektronenmikroskop bekannt, wo seine Grösse recht stark variiert.

Vorkommen: Oberes Maastrichtien von Kjolby Gård.

*Genus Kamptnerius* DEFLANDRE 1959

Generotypus: *Kamptnerius magnificus* DEFLANDRE 1959

*Kamptnerius* wurde von REINHARDT (1966 a) zu den styloiden Formen gestellt, wurde aber in seiner weiteren Arbeit (1966 b) über coronoide und styloide Cocco-lithen nicht mehr erwähnt, wohl weil er nicht in die dort erwähnte Familie (*Coccolithaceae* POCHE 1913) hineinpasst. Mit seinem am äusseren Rand angelagerten „Schweif“ passt er auch schlecht in die bestehenden neudefinierten höheren Einheiten.

*Kamptnerius* wurde hier vorläufig in die Unterfamilie der *Eiffellithoidea* gestellt, weil in *Kamptnerius? minimus* REINHARDT 1964 und *Kamptnerius? tabulatus* n. sp. Zwischenformen vorkommen, die an Arten der Gattungen dieser Unterfamilie erinnern. Der Aufbau der Randpartie weist jedoch auch auf eine Verwandtschaft mit *Arkhangelskiella* hin.

*Kamptnerius magnificus* DEFLANDRE 1959

Fig. 16; Taf. 6, Fig. 1-3, 5

1959 *Kamptnerius magnificus* DEFLANDRE: 135, Taf. 1:14.

1966a\* *Kamptnerius magnificus* DEFLANDRE 1959 in REINHARDT: 22, Taf. 17:1, 2, Taf. 18:1, 2 a, b.

Bemerkungen: Das Zentrafeld von *K. magnificus* ist elliptisch und aus Keilen gebildet, die sich längs der längeren Ellipsenachse treffen. Die Keile sind ungleichförmig und einige sind längs der Mittellinie am breitesten. Nach aussen an das Zentrafeld anschliessend folgt auf der einen Seite ein Randring aus einer grossen Anzahl (- 70 -) sich leicht überlagernder Elemente, die in der Mitte eingeschnürt sind, so dass ein Graben entsteht, in welchem dieser Randring durchbrochen erscheint (Taf. 6:3). Im Graben, diesen ausfüllend und überragend, lagert eine Reihe dachziegelartig angeordneter Lättchen, die in Fig. 3, Taf. 6 zum Teil fehlen und die unterliegende Struktur erkennen lassen. Unter der Randscheibe setzt der Schweif an, dessen Strahlen entgegen dem Uhrzeigersinn von der radialen Richtung abgedreht sind. Der Schweif ist, auf die Ellipse des Randes und des Zentrafeldes bezogen, asymmetrisch. Der Umriss des ganzen Cocco-lithen ist aber oft ebenfalls elliptisch, wobei diese Ellipsenachsen in einem Winkel von ca. 20° zu denen des Zentrafeldes und des Randes stehen. Auf der anderen Seite ist der Schweif nur durch einen Knick

von der zentralen Ellipse abgesetzt und deren Keile scheinen sich zum Teil im Schweif fortzusetzen.

Bei den hier im Elektronenmikroskop abgebildeten Formen umsäumt der Schweif sichtbar gut 3/4 des Umrisses des Randes. Seine grösste Breite entspricht ca.

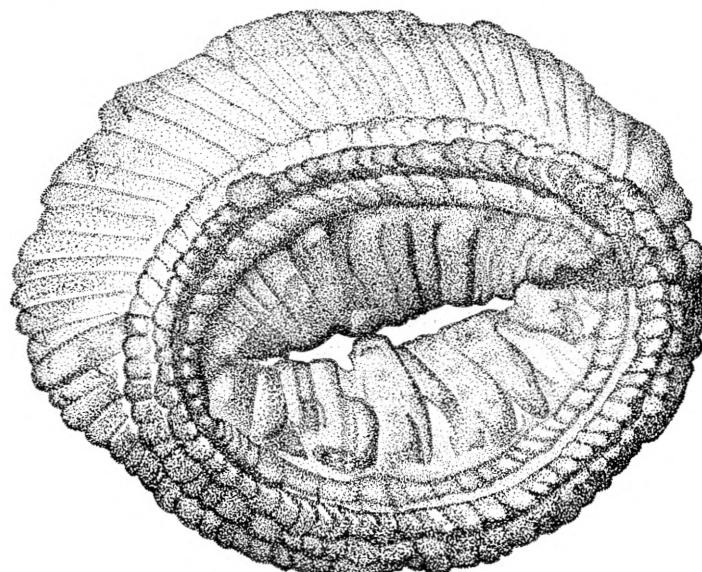


Fig. 16. *Kamptnerius magnificus* DEFLANDRE. Längs der Mittellinie sind Teile der Elemente des Zentralfeldes herausgebrochen. Unteres Maastrichtien von Mön. Vergrösserung ca. 7500×.

dem halben kleineren Durchmesser des Zentralfeldes. Bei anderen Formen ist der Schweif fast grösser oder grösser als der Rest des Coccolithen.

**Vorkommen:** Unteres Maastrichtien von Mön; weltweit verbreitet in der oberen Kreide.

#### *Kamptnerius? tabulatus* n. sp.

Taf. 6, Fig. 4

**Holotypus:** Taf. 6, Fig. 4 (K. P.-N. 54/27).

**Masse des Holotypus:** Länge: ca. 7  $\mu$  Breite: ca. 7  $\mu$ , mit dem „Schweif“.

**Locus typicus:** Mön, B 22.

**Stratum typicum:** Unteres Maastrichtien.

**Diagnose:** Ein breitelliptischer Coccolith mit einem steilstehenden Schweif und einem „Boden“ aus Platten, in deren Mitte Granulae rosettenförmig angeordnet sind. Ein Randring aus Granulae scheidet den „Boden“ vom asymmetrischen Schweif.

**Beschreibung:** Der asymmetrische Schweif bildet einen schrägen Kegelstumpf, bestehend aus einer Anzahl steilstehender Keile. Den höchsten Rand des Kegelstumpfes bilden eine Reihe Elemente, an deren Innerseite die Platten ansetzen, die den Boden

bilden und das Zentrafeld grösstenteils ausfüllen. Die Platten fallen gegen das Zentrum hin ab und tragen dort eine rosettenförmige Anordnung von Granulae. Die andere Seite des Coccolithen ist mir nicht bekannt, und auch sein Aussehen im Lichtmikroskop kenne ich nicht.

Bemerkungen: *Kamptnerius?* *tabulatus* unterscheidet sich von *K. magnificus* durch die Platten im Zentrafeld bei ersterem und der Aufstellung des Schweifes, der bei *K. magnificus* weit flacher ist. Von *K.?* *minimus* REINHARDT 1964 unterscheidet sich die neue Art ebenfalls durch den Aufbau des Zentrafeldes, das bei *K.?* *minimus* aus ± radial stehenden Lamellen besteht.

Das Zentrafeld von *K. tabulatus* erinnert stark an das Zentrafeld von *Eiffellithus*, während der schweifförmige Rand an *Kamptnerius* erinnert. Als Zwischenform zu *Kamptnerius* kann *K.?* *minimus* angesehen werden, der denselben kurzen, steilen Schweif hat wie *K.?* *tabulatus*, dessen Zentrafeld aber noch mehr demjenigen von *K. magnificus* gleicht. Als Zwischenform zu *Eiffellithus* kann *E. gorkae* angesehen werden, bei dem die schräggestellten Randelemente relativ breiter und weniger zahlreich sind als bei den anderen Arten von *Eiffellithus* und dessen Zentrafeld dem von *K. tabulatus* sehr ähnlich ist.

Vorkommen: Unteres Maastrichtien von Mon.

### 3.2. Familie *Podorhabdaceae* NOEL 1965.

Coccolithen mit 1, 2, oder mehr Randringen, deren Elemente nebeneinander liegen oder ineinander greifen und die ein relativ grosses Zentrafeld haben, das meist granulat ist.

Bemerkungen: LOEBLICH & TAPPAN (1966) haben diese Familie als invalid taxiert, da sie auf einem invaliden Genus basiert sei, der seinerseits invalid sei, weil der Generotypus nicht abgebildet sei. Da die Arbeit von NOEL (1965) aber Abbildungen des Generotypus von *Podorhabdus*, *P. grassei* enthält, übernehme ich den Namen und erweitere die Familie, so dass sie auch Formen mit 1 Randring und Formen mit mehr als 2 Randringen enthalte. Auch Formen nicht elliptischen Umrisses sollten darin aufgenommen werden können.

REINHARDT (1967) hat seine Familie *Ahmuelerellaceae* 1965 an die Stelle von *Podorhabdaceae* NOEL 1965 gestellt mit dem Hinweis, dass diese Priorität besitze. Da die Gattung *Ahmuelerella*, auf der die Familie gegründet wurde, nach dem hier eingenommenen Standpunkt zu den *Eiffellithaceae* gehört (Ausbildung des Randes), bleibe ich bei der von NOEL (1965) vorgeschlagenen Familie. Eine Unterteilung der Familie in zwei Unterfamilien mit 1 beziehungsweise mit 2 und mehr Randringen wird noch nicht vorgenommen, da die Formen mit nur einem Randring dieses Konstruktions-typs im Elektronenmikroskop nur von der einen Seite her gesehen nachgewiesen werden konnten.

Die von REINHARDT (1967) mit einer Randscheibe beschriebenen Formen von *Rhagodiscus* REINHARDT 1967 und *Rhabdolithina* REINHARDT 1967 sind noch nicht genügend illustriert, *Parhabdolithus* DEFLANDRE 1952 in NOEL (1965) und *Crepidolithus*

NOEL 1965 scheinen eher zu den *Eiffellithaceae* zu gehören. Die *Podorhabdaceae* umfassen neben den von NOEL (1965) daraus beschriebenen Arten und Gattungen hauptsächlich die von REINHARDT als rhagoid beschriebenen Formen mit Ausnahme der Formen mit einem sehr kleinen Zentrafeld und der Formen mit einem aus dachziegelartig gelagerten Elementen bestehenden Rand.

Genus *Rhagodiscus* REINHARDT 1967 a

Generotypus: *Rhagodiscus asper* (STRADNER 1963) REINHARDT 1967 a

Der Generotypus von *Rhagodiscus* ist noch nicht im Elektronenmikroskop bekannt geworden und die weitere von REINHARDT (1967 a) diesem Genus zugeordnete Art, *R. cryptochondrus* (STOVER 1966), wurde nur mit einem? zu ihm gestellt und wird hier aus ihm entfernt und als Typus einer neuen Gattung, *Reinhardtites*, gewählt. Trotzdem ordne ich *Rhagodiscus* 3 neue Arten zu, die mir ihrerseits nur von der einen Seite und z.T. nur im Elektronenmikroskop bekannt sind. Auf einer von ihnen einen neuen Genus zu gründen schien mir nicht sinnreich.

REINHARDTS (1967 a:166) Diagnose lautet: „Elliptische Discolithen mit einem undurchbrochenen granulaten Zentrafeld und einer wallförmigen Randscheibe“. Dazu ist zu bemerken, dass der Ausdruck „undurchbrochenes Zentrafeld“ offenbar eine zentrale Öffnung nicht ausschliesst, nachdem REINHARDT der Gattung eine Form zuordnete, von der er eine solche Öffnung beschreibt. Eine an und für sich undurchbrochene Anordnung von Granulae kann durch Wegfallen einiger Granulae zu einem durchbrochenen Zentrafeld führen, während Kalkanlagerung ursprünglich vorhandene Durchbrüche ausfüllen kann. Der Ausdruck muss wohl als Gegensatz zu den „geordneten“ Durchbrüchen zwischen den Stegen bei z.B. *Ahmuelerella octoradiata* oder *Polypodorhabdus crenulatus* verstanden werden.

*Rhagodiscus plebeius* n. sp.

Taf. 7, Fig. 2-6

Holotypus: Taf. 7, Fig. 2 (K. P.-N. 43/10).

Masse des Holotypus: Länge: 6,5  $\mu$  Breite: 4,5-5  $\mu$ .

Locus typicus: Mon, A 10.

Stratum typicum: Unteres Maastrichtien.

Diagnose: Elliptischer Coccolith mit einem Randwall aus radial orientierten, steilstehenden Platten und einem kegelstumpfförmigen, granulaten Zentrafeld.

Beschreibung: Der Rand des Holotypus wird durch ca. 40 radial orientierte, ungleichdicke Platten gebildet und lässt ein Zentrafeld offen, das ca. 65% der Länge des Coccolithen umfasst. Dieses Zentrafeld ist von plättchenförmigen Granulae bedeckt, die einen flachen Kegelstumpf aufbauen und recht unregelmässig verteilt sind. Der obere Rand des Kegelstumpfes um die zentrale Öffnung wird ebenfalls durch unregelmässig angeordnete und verschiedene grosse, ungleichförmige Granulae gebildet. Die

andere Seite des Coccolithen ist mir nicht bekannt. Kleinere Formen haben weniger Randelemente und weniger zentrale Granulae.

Vorkommen: Unteres Maastrichtien von Mon.

*Rhagodiscus granulatus* n. sp.

Fig. 17; Taf. 7, Fig. 8-11

Holotypus: Taf. 7, Fig. 8 (K. P.-N. 43/6).

Masse des Holotypus: Länge: 6  $\mu$  Breite: 4,5  $\mu$ .

Locus typicus: Mon, A 10

Stratum typicum: Unteres Maastrichtien.

Diagnose: Elliptischer Coccolith mit einem Randwall aus steilstehenden, annähernd radial orientierten Platten und einem Zentralfeld aus ungeordneten, grossenteils gleichgrossen Granulae.

Beschreibung: Die Platten des Randwalles des Holotypus scheinen aus horizontal liegenden dünneren Elementen aufgebaut zu sein. Ihre Orientierung ist schwer zu erkennen, da der Coccolith meist leicht schräg auf dem unterliegenden Formvarfilm ruht. Der Randwall hat die Form eines niedrigen Kegelstumpfes mit elliptischer Basis. Das Zentralfeld nimmt an der engsten Stelle 60–70 % der Längsstreckung der Ellipse ein. Die Granulae im Zentralfeld sind fast alle gleich gross, scheinen aber nicht in einem bestimmten Muster angeordnet zu sein, sondern sind in jedem Exemplar wieder anders verteilt. Diese Art erinnert etwas an *Nephrolithus* GORKA 1957, ohne aber dessen nierenförmigen Umriss und in Ringen angeordnete Granulae aufzuweisen. Die elliptische Form kann etwas in breitelliptisch übergehen



Fig. 17. *Rhagodiscus granulatus* n. sp. Ansicht von der Seite eines Coccolithen aus dem unteren Maastrichtien von Mon. Vergrösserung ca. 7500  $\times$ .

oder asymmetrisch erscheinen. Die andere Seite des Coccolithen ist mir nicht bekannt. Hier und da sind zwischen den Granulae im Zentralfeld offene Lücken vorhanden.

Vorkommen: Unteres Maastrichtien von Mon.

*Rhagodiscus bispiralis* n. sp.

Taf. 7, Fig. 7

Holotypus: Taf. 7, Fig. 7 (K. P.-N. 40/23).

Masse des Holotypus: Länge 7,5  $\mu$  Breite: 5,5  $\mu$ .

Locus typicus: Mon, A 10

Stratum typicum: Unteres Maastrichtien.

**Diagnose:** Elliptischer Randwall aus nicht radial orientierten, etwas schräg stehenden Platten und einem Zentrafeld aus in Spiralen geordneten Granulae und einer zentralen, rundlichen Öffnung.

**Beschreibung:** Der Rand des Holotypus wird durch ca. 50 etwas schräg stehende Platten gebildet, die nicht radial orientiert sind. Sie umgeben ein Zentrafeld, das fast 70 % der Länge des Coccolithen umfasst und in der Mitte von einer rundlichen Öffnung durchbrochen wird. Diese Öffnung ist von fast 1 Windung in einer Spirale angeordneter Granulae umgeben, die gleichförmig und ungefähr gleich gross sind. Die nächstäußere Granulaereihe verläuft ebenfalls spiralförmig aus dem zentralen Granulaering. Die beiden spiralförmigen Granulaereihen bauen zusammen das ganze Zentrafeld auf. Die andere Seite der Coccolithen dieser Art ist mir nicht bekannt, ebensowenig wie deren Ansicht im Lichtmikroskop.

**Vorkommen:** Unteres Maastrichtien von Mön.

Genus *Podorhabdus* NOEL 1965

Generotypus: *Podorhabdus grassei* NOEL 1965

Elliptische Coccolithen, in deren Zentrafeld Granulae 4 Stege aufbauen, die meist einen Fortsatz tragen.

*Podorhabdus dietzmanni* (REINHARDT 1965) REINHARDT 1967 a

Taf. 8, Fig. 6

1965\* *Ahmuelllerella dietzmanni* REINHARDT: 30, Taf. 1:1.

1965\* *Rhabdosphaera* – Art, in BLACK, Fig. 10.

1967a\* *Podorhabdus dietzmanni* (REINHARDT 1965) REINHARDT: 169, Abb. 4.

**Bemerkungen:** Die beiden bisher von REINHARDT abgebildeten Exemplare sind Oberseiten von *P. dietzmanni*, den ich nur in 2 Exemplaren und nur von der Unterseite her gesehen fand. Die Abbildung Taf. 8, Fig. 6 zeigt den Aufbau der unteren Randscheibe aus ca. 40–50 eng aneinander liegenden Elementen. Es sind nur zwei der vier grossen Poren im Zentrafeld sichtbar, wobei die regelmässige Anordnung der Granulae um die eine, vollständig sichtbare Pore, auffällt.

**Vorkommen:** Unteres Maastrichtien von Mon; Kreide von Deutschland und England.

Genus *Dodekapodorhabdus* n. gen.

Generotypus: *Dodekapodorhabdus noelii* n. sp.

**Diagnose:** Elliptischer Coccolith mit relativ schmaler Randpartie, bestehend aus Randringen aus Plättchen. Das grosse Zentrafeld wird von einem granulaten Kegelstumpf aufgebaut, der auf 12 ebenfalls granulaten Stützen steht und der in einen Fortsatz ausmünden kann, der aus Lattenreihen aufgebaut ist, die spiralförmig einen Hohlraum in der Mitte des Stabes umgeben.

Bemerkungen: Ich folge bei der Aufstellung dieser Gattung den Gesichtspunkten von NOEL (1965), nach welchen *D. noelii* nicht in *Octopodorhabdus* oder *Hexapodorhabdus* eingeordnet werden kann, denen er im Aufbau, abgesehen von der Anzahl der granulaten Pfeiler, die den zentralen Kegelstumpf aufbauen, sehr nahe steht. Weiter stände *Polyopodorhabdus* NOEL 1965 zur Verfügung. Dieser zeigt aber eine ganz andere Anordnung der Pfeiler, die hier aus Stegen und Granulae bestehen, die sich längs einer Mittellinie treffen, während *D. noelii* nur Granulae aufweist, die die Stützen und den Kegelstumpf bilden.

*Dodekapodorhabdus noelii* n. sp.

Taf. 8, Fig. 1–5; Taf. 9, Fig. 1–7

Holotypus: Taf. 8, Fig. 1 (K. P.-N. 47/7).

Masse des Holotypus: Höhe des Stabes: ca. 34  $\mu$ .

Locus typicus: Mön, A 11.

Stratum typicum: Unteres Maastrichtien.

Diagnose: Elliptischer Coccolith mit schmalen Randscheiben, die einen granulaten Kegelstumpf umsäumen, an dessen Basis 12 rundliche Durchbrüche in einem elliptischen Ring angeordnet sind. Der Kegelstumpf mündet in einen Stab aus Lattenreihen, die spiralförmig um den zentralen Hohlraum laufen.

Beschreibung: Die elliptischen Randscheiben sind aus je ca. 70–90 leicht schräg stehenden Elementen zusammengesetzt. Am Holotypus ist erkennlich, dass der Rand komplexer aufgebaut ist, als die Aufnahmen der distalen Seite der Coccolithen ahnen lassen. Bei diesen kann ein basaler und ein distaler Ring unterschieden werden, der vom basalen allseitig überragt wird. Beim Holotypus aber liegt die Basisscheibe schräg und ist von unten sichtbar, wodurch an einer Stelle, wo ein Stück des Ringes ausgebrochen ist, das Profil des Randes erkennbar wird. Hier zeigt sich nun, dass eine weitere Scheibe basal anschliesst, die auch etwa die Grösse der distalen Scheibe erreicht. Die beiden kleineren Scheiben klemmen die grössere ein. Der Rand ist am tiefsten an der Ansatzstelle der Granulae, die das Zentrafeld aufbauen. Die 12 Durchbrüche erscheinen rundlich und sind gleichmässig entlang dem inneren Rand des Randes verteilt. Der mächtige Stab hat einen fast dreieckigen Querschnitt, was an Basalplatten sichtbar ist, von denen der Stab etwas höher oben abgebrochen ist als an den abgebildeten Exemplaren. Der Stab selbst ist an der Basis noch granulat; die Granulae werden gegen oben abgelöst durch keilförmige Latten, deren ausgedünnte Seite gegen innen weist und die reihenweise spiralförmig den zentralen Hohlraum umfahren. Der Stab ist gerade über der Anwachungsstelle dünner als weiter oben, wo er etwas ausbeult um dann gegen die Spitze hin wieder auszudünnen. Die Ausbildung des Stabendes konnte nicht beobachtet werden, da die Spitze an allen gefundenen Stäben abgebrochen scheint.

Im Lichtmikroskop ist diese grosse Art sehr leicht an den 12 Öffnungen zu erkennen, die das Zentrafeld durchbrechen und den komplex aufgebauten Rand vom

kegelförmigen Teil des Zentralfeldes trennen. Sie sind besonders in hoher Einstellung gut zu erkennen. Auch die einzelnen, abgebrochenen Stäbe sind dank ihrer Grösse und charakteristischen Form im Lichtmikroskop leicht zu erkennen.

Vorkommen: Unteres Maastrichtien von Mon.

Bemerkungen: *D. noelii* erinnert an verschiedene früher beschriebene Arten. Ihr zweifellos nahe stehen dürfte *Dodekapodorhabdus regularis* (CARATINI 1963) n. comb., der kleiner ist als *D. noelii* und nach der Beschreibung ca. 30 Randeinschnitte hat. CARATINI erwähnt keinen Fortsatz und bildet auch keine losen Stäbe ab. *D. regularis* ist noch nicht im Elektronenmikroskop bekannt. STOVER (1966) hat in *Dodekapodorhabdus fenestratus* (STOVER 1966) n. comb. eine Art aufgestellt, die *D. noelii* äusserst ähnlich sieht. Während die Abbildungen der neuen Art sehr gleichen, entfernt sich deren Beschreibung deutlich davon. So beschreibt STOVER einen inneren Ring von Öffnungen zusätzlich zu dem gleich an den Rand anliegenden. Der innere zählt 6–8, der äussere 8–12 Durchbrüche. Abgesehen davon, dass ich keine Formen mit in zwei Ringen angeordneten Öffnungen fand, variierte auch die Anzahl der Durchbrüche im vorhandenen, bei STOVER dem äusseren Ring, nicht, sondern ist konstant 12, auch bei kleineren Exemplaren. STOVER erwähnt jedoch, dass der innere Ring von Öffnungen fehlen könne und dass ein Fortsatz hie und da vorhanden sei. Da weder CARATINIS noch STOVERS Form im Elektronenmikroskop bekannt sind und mir davon kein Material zur Verfügung stand, wurde als Generotypus der neuen Gattung auch eine neue Art aufgestellt.

#### Genus *Polypodorhabdus* NOEL 1965

Generotypus: *Polypodorhabdus escaigi* NOEL 1965

REINHARDT (1967:169) hat *Polypodorhabdus* als jüngeres Synonym von *Cretarhabdus* BRAMLETTE & MARTINI 1964 aufgefasst. Er begründet dies damit, dass *Polypodorhabdus* sich nicht in Gattungen bestimmenden Merkmalen von *Cretarhabdus* unterscheidet. Gleich darauf schliesst er praktisch *Polypodorhabdus* wieder aus *Cretarhabdus* aus, indem er als Unterscheidungsmerkmal von *Cretarhabdus* und *Pedorhabdus* anführt, dass *Cretarhabdus* ein geschlossenes Zentralfeld zeige und weder Poren noch Stege besitze. Da das Zentralfeld des Generotypus von *Polypodorhabdus* nicht geschlossen ist und die zentrale Struktur von stegförmigen Elementen getragen wird, besteht meiner Ansicht nach *Polypodorhabdus* zu recht. Zudem ist der Generotypus von *Cretarhabdus*, *C. conicus* BRAMLETTE & MARTINI 1964 noch nicht aus dem Originalmaterial im Elektronenmikroskop beschrieben worden.

#### *Polypodorhabdus crenulatus* (BRAMLETTE & MARTINI 1964) n. comb.

Fig. 18; Taf. 11, Fig. 2–5

1964 *Cretarhabdus crenulatus* BRAMLETTE & MARTINI: 300, Taf. 2:21–24.

Bemerkungen: Der Holotypus von *P. crenulatus* stammt von Bellocq in Frankreich, von wo mir Vergleichsmaterial zur Verfügung stand. Die Exemplare, die

ich aus dieser Probe im Elektronenmikroskop fand, waren sehr schlecht erhalten und zeigten weder den Aufbau des Randes oder des Zentralfeldes in seinen Einzelheiten. Es ist deshalb schwierig zu entscheiden, welche der verschiedenen ähnlichen Formen als *P. crenulatus* angesehen werden soll. Mir schienen es die hier abgebildeten Formen zu sein, die in ihrem Zentralfeld keine Anzeichen eines über den Ellipsenachsen ver-

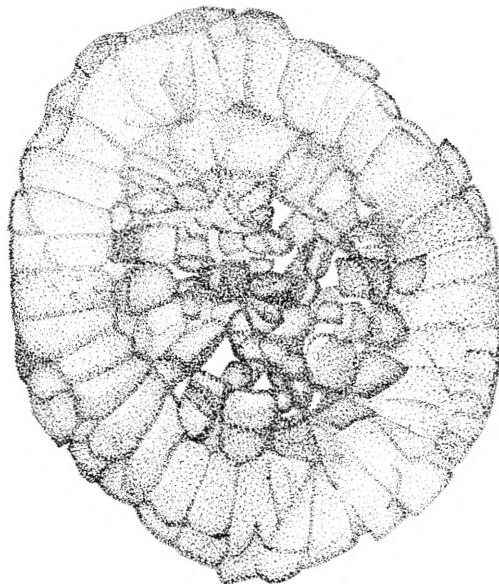


Fig. 18. *Polypodorhabdus crenulatus* (BRAMLETTE & MARTINI) n. comb. aus dem unteren Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

laufenden Aufbaus zeigen. Der Rand besteht aus mehreren Ringen aus nebeneinanderliegenden Platten. Mindestens zwei der Ringe haben verschiedene Grösse. An die Randpartie schliessen leicht schräg stehende Platten an, zwischen welchen Durchbrüche offen sein können, da nur etwa halb so viele Platten die zentrale Struktur tragen, wie Platten in einem Randring sind. Von den Platten aus ragen Latten gegen das Zentrum und tragen eine zentrale Rosette aus Granulae. Das Zentralfeld ist nur leicht aufgewölbt. Bei kleinen Exemplaren kann die zentrale Rosette die Latten fast ganz überdecken (Taf. 11, Fig. 2).

Im Lichtmikroskop ist *P. crenulatus* kaum von *Polypodorhabdus actinosus* (STOVER 1966) n. comb. und *Stradneria limbicrassa* REINHARDT 1964 zu unterscheiden. Im Elektronenmikroskop unterscheidet er sich von *P. actinosus* durch dessen andere zentrale Struktur und von *Stradneria limbicrassa* durch deren aus Latten aufgebaute kreuzförmige Zentralstruktur. Wieweit die Unterscheidung der verschiedenen Arten gerechtfertigt werden kann, muss von zukünftigen Untersuchungen über die Variation innerhalb der Arten entschieden werden. Es liegt mir vorläufig noch nicht genug

Material vor, um entscheiden zu können, wie sich das Zentrafeld ändert mit der Grösse des Coccolithen und mit dem Auftreten eines Fortsatzes.

**Vorkommen:** Unteres Maastrichtien von Mön und oberes Maastrichtien von Kjølby Gård; weltweit verbreitet im Maastrichtien.

*Polypodorhabdus actinosus* (STOVER 1966) n. comb.

Fig. 19; Taf. 10, Fig. 1–6

1966a\* *Cretarhabdus crenulatus* BRAMLETTE & MARTINI, Form A in REINHARDT: 26, Taf. 13:3.  
1966 *Coccolithus actinosus* STOVER: 138, Taf. 1:15–16, Taf. 8:7.

**Bemerkungen:** Leider steht mir von STOVERS Originalmaterial nichts zur Verfügung, sodass eine sichere Bestimmung der hier abgebildeten Exemplare als

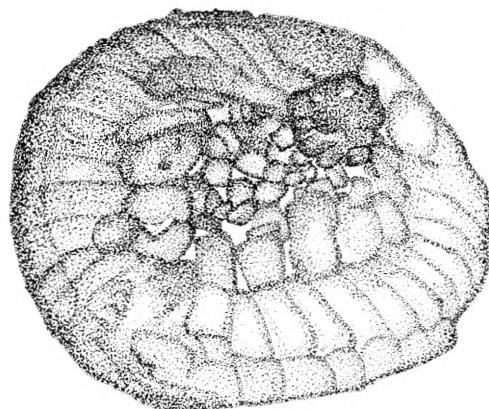


Fig. 19. *Polypodorhabdus actinosus* (STOVER) n. comb. aus dem unteren Maastrichtien von Mön. Ansatz zu einem Fortsatz. Vergrösserung ca. 7500 ×.

*P. actinosus* nicht möglich ist, da dieser noch nicht im Elektronenmikroskop bekannt ist. REINHARDT (1967 a) hat ihn zu *C. crenulatus* gestellt. Die Randscheiben sind ähnlich ausgebildet wie bei *P. crenulatus*. Inwendig an den inneren Rand der Randscheiben anschliessend, stehen bei den kleineren Formen 10–12 kurze Latten gegen ein etwas erhöhtes Zentrum auf. An diese Latten zentral anschliessende kleinere Elemente treffen längs der längeren Ellipsenachse zusammen. Im Zentrum kann ein Fortsatz seine Basis haben. Zwischen den Latten der kleineren Exemplare sind meist dreieckige Durchbrüche ausgespart. Die lattenförmigen Stützen und der andere Aufbau des Randes unterscheiden *P. actinosus* u.a. von *Dodekapodorhabdus noelii* n. sp.

**Vorkommen:** Unteres und oberes Maastrichtien von Dänemark; weltweit verbreitet in der Kreide.

Genus *Cretarhabdus* BRAMLETTE & MARTINI 1964Generotypus: *Cretarhabdus conicus* BRAMLETTE & MARTINI 1964

Bemerkungen: Der Generotypus ist aus dem Typmaterial nicht elektronenoptisch bekannt, wurde jedoch auch in Material gefunden, in dem er von BRAMLETTE & MARTINI gemeldet wurde.

Die emendierte Diagnose von REINHARDT (1966 a:25) ist unbrauchbar, weil sie auf Elektronenmikroskopaufnahmen von *Stradneria limbicrassa* REINHARDT 1964 baut, die REINHARDT als mit *C. conicus* synonym betrachtet. Nach meiner Ansicht sind dies jedoch zwei verschiedene Arten, und auch die Gattungen, in denen sie aufgestellt wurden, brauchen noch nicht wieder zusammengelegt zu werden, bevor grössere Einigkeit über die Gattungen bestimmende Merkmale herrscht. Die neue Diagnose lautet deshalb wie folgt.

Diagnose: Elliptische Coccolithen mit Randscheiben aus nebeneinander liegenden, ineinander greifenden Platten. Das kegelförmige Zentrafeld wird durch dichtgelagerte Granulae eingenommen, die über den Ellipsenachsen Verstärkungsleisten bilden, die als Basis eines Fortsatzes dienen können.

*Cretarhabdus conicus* BRAMLETTE & MARTINI 1964

Taf. 12, Fig. 1-4

1964 *Cretarhabdus conicus* BRAMLETTE & MARTINI: 299, Taf. 3:5-8.NON 1967a\* *Stradneria limbicrassa* REINHARDT 1964 in REINHARDT: 169.NON 1967a\* *Cretarhabdus crenulatus* BRAMLETTE & MARTINI 1964 in REINHARDT: 170.

Bemerkungen: Der lichtmikroskopischen Beschreibung von BRAMLETTE & MARTINI ist hier die Beschreibung im Elektronenmikroskop zuzufügen. Die Randscheiben bestehen aus Tafeln, die nebeneinander liegen und etwas ineinander greifen. In der distalen Sicht (Taf. 12, Fig. 2) scheint *C. conicus* eine kleinere distale und eine grössere basale Randscheibe zu besitzen. In der basalen Ansicht (Taf. 12, Fig. 1) scheint die distale Randscheibe die basale zu überragen. Daraus ist zu schliessen, dass drei Ringe vorhanden sind, ähnlich wie bei *Dodekapodorhabdus*. Die Granulae, die das Zentrafeld besetzen sind dicht gepackt und ca.  $0,5 \mu$  gross. Über den Ellipsenachsen bilden sie in basaler Sicht Gräben am Inneren des kegelförmigen Zentrafeldes, die auf der distalen Seite als Leisten hervortreten. Hier werden sie zusätzlich durch längliche Granulae oder Latten akzentuiert, die bis auf die äusserste Randscheibe hinunterziehen. Im Zentrum kann aus dem kreuzförmigen Aufbau ein Fortsatz wachsen.

Bei *C. conicus* tritt die kreuzförmige Struktur auch im Lichtmikroskop sehr deutlich vor dem gleichförmigen Untergrund hervor. Dies unterscheidet ihn im Lichtmikroskop von *Stradneria limbicrassa*, wo die kreuzförmige Struktur im zentralen Kegel fast verschwindet und wo der Hintergrund uneinheitlich erscheint. Im Elektronenmikroskop zeigt sich das durch die verschiedene Zusammensetzung der zentralen

Kegel bei den beiden Arten: *C. conicus* mit fast gleichförmigen, gleichgrossen Granulae und *Stradneria limbicrassa* mit verschiedengrossen, verschiedenförmigen Granulae.

Vorkommen: Unteres Maastrichtien von Mön; weltweit verbreitet in der Kreide.

*Stradneria* REINHARDT 1964

Generotypus: *Stradneria limbicrassa* REINHARDT 1964

Bemerkungen: REINHARDT (1966 a:25) hat seine *Stradneria* als Synonym von *Cretarhabdus* aufgefasst, da er auch die beiden Generotypen als synonym anschaute. Ich schliesse mich seiner Ansicht nicht an (s. unter *Cretarhabdus conicus*, S. 51) und behalte deshalb diesen Genus bei.

*Stradneria limbicrassa* REINHARDT 1964

Taf. 10, Fig. 7

1964\* *Stradneria limbicrassa* REINHARDT: 752, Taf. 1:3, Abb. 3.

1966a\* *Cretarhabdus crenulatus* BRAMLETTE & MARTINI 1964 in REINHARDT: 25, Taf. 7:1, 2, Taf. 14:2 (?)

1967a *Cretarhabdus conicus* BRAMLETTE & MARTINI 1964 in REINHARDT: 169.

Bemerkungen: REINHARDT (1964, 1966) hat diese Form ausführlich beschrieben und auch im Elektronenmikroskop abgebildet. Auf die Unterschiede zu den anderen nahe verwandten Formen wurde bei diesen hingewiesen.

Genus *Cribrosphaerella* DEFLANDRE 1952 emend. REINHARDT 1964

Generotypus: *Cribrosphaerella ehrenbergi* (ARCHANGELSKY 1912) DEFLANDRE 1952

Bemerkungen: REINHARDT (1967 a) hat die Arten von *Cribrosphaerella* anhand der Anzahl Randblättchen und der gleichen oder verschiedenen Grösse der Randscheiben unterteilt. Dabei können *C. ehrenbergi* und *C. matthewsi* (meiner Meinung nach ein Synonym von *C. laughtoni*, d.h. deren andere Seite) nur durch die verschiedene Anzahl Randelemente unterschieden werden: ca. 28–30 Randelemente für *C. ehrenbergi* und etwa 20–22 Randelemente bei *C. matthewsi*.

Ich habe nun an meinen Elektronenmikroskopaufnahmen der beiden Arten aus den Proben von Mön die totale Länge gemessen und mit der jeweiligen Anzahl Randelementen des gemessenen Exemplares verglichen. Das Resultat dieser Messungen ist in Fig. 20 dargestellt. Die erhaltenen Punkte gruppieren sich um eine Gerade, ohne dass dabei zwei oder mehrere Stellen besonders dicht besetzt werden. Eine Gruppierung der Exemplare in zwei oder mehr Arten ist nicht nötig und auch nicht möglich. Wo sollte die Grenze gezogen werden?

ARCHANGELSKY (1912) gibt für *C. ehrenbergi* auf seinen Skizzen 20 und 32 Kerben

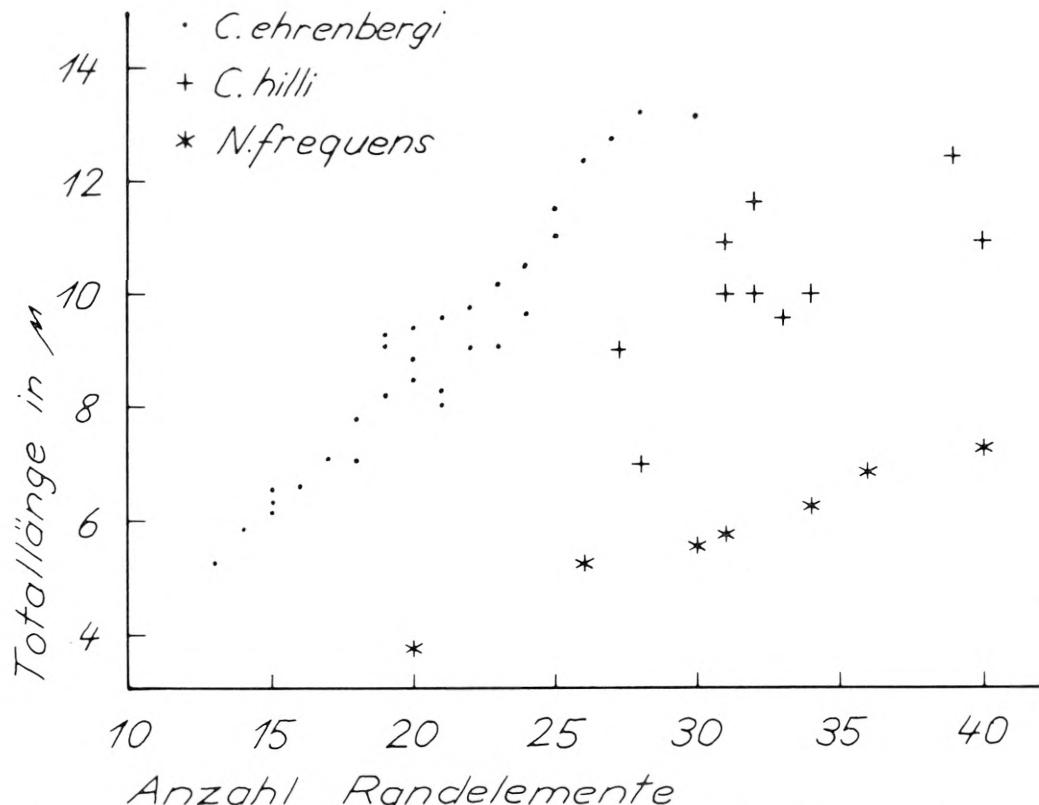


Fig. 20. Graphische Darstellung des Verhältnisses der totalen Länge der Coccolithen in  $\mu$  und ihrer Anzahl Randelemente für *Cribrosphaerella ehrenbergi*, *Cribrosphaerella hilli* und *Nephrolithus frequens* aus dem Maastrichtien Dänemarks.

an, GORKA (1957) wählt dafür 26 und beschreibt *Discolithus ingens* mit 30, *Discolithus numerosus* mit 28 und *Discolithus rudis* mit 18–19. Da BLACKS (1964) Gattung *Favocentrum*, mit *F. laughtoni* als Generotypus, als jüngeres Synonym von *Cribrosphaerella* aufgefasst werden muss (REINHARDT 1966 a:27) und sein *F. matthewsi* die andere Seite von *F. laughtoni* ist, können ruhig alle Formen unter dem ältesten Namen, d.h. *C. ehrenbergi* zusammengefasst werden.

Ähnliche Schwierigkeiten stellen sich bei den verschieden grossen und mit verschiedener Anzahl Randplättchen versehenen Coccolithen der *Coccolithus pelagicus*-Gruppe im Tertiär, deren Unterteilung ebenfalls anhand der Zahl der Randplättchen erfolgt und die zuletzt von HAY et al. (1966) zusammengestellt wurde. Auch hier umfassen die Exemplare des Typmaterials Coccolithen verschiedener Grösse (3–25  $\mu$ ), die alle die neueren Arten umfassen dürften. Die Formen der Gattung *Deflandrius* dagegen zeigen ein anderes Verhalten, indem die Grösse variiert, die Anzahl der Randelemente mit 16 jedoch konstant bleibt.

*Cribrosphaerella ehrenbergi* (ARCHANGELSKY 1912) DEFLANDRE 1952

Fig. 21; Taf. 17, Fig. 1–8

- 1912 *Cribrosphaera ehrenbergi* ARCHANGELSKY: 412, Taf. 6:19, 20.
- 1952 *Cribrosphaerella ehrenbergi* (ARCHANGELSKY 1912) DEFLANDRE in GRASSE: 466.
- 1957 *Discolithus ehrenbergi* (ARCHANGELSKY 1912) GORKA: 260, Taf. 3:12.
- 1957 *Discolithus numerosus* GORKA: 257, Taf. 4:5.
- 1957 *Discolithus ingens* GORKA: 256, Taf. 3:13.
- 1957 *Discolithus rufus* GORKA: 257, Taf. 4:6.
- 1962\* *Coccolithus archangelskii* SHUMENKO: 472, Fig. 1.
- 1964 *Discolithina?* cf. *Discolithus numerosus* (GORKA 1957) BRAMLETTE & MARTINI: 301, Taf. 1:23, 24.
- 1964\* *Favocentrum matthewsi* BLACK: 314, Taf. 53, 5, 6.
- 1964\* *Favocentrum laughtoni* BLACK: 313, Taf. 53:1, 2.
- 1964\* *Cribrosphaerella romanica* REINHARDT: 756, Taf. 2:1, Abb. 7.
- 1966a\* *Cribrosphaerella matthewsi* (BLACK 1964) REINHARDT: 28, Taf. 5:1, 2, Taf. 12:5, Bild 7.
- 1966 *Discolithus venatus* STOVER: 144, Taf. 3:12–13, Taf. 8:21.

**Diagnose:** Elliptische Coccolithen, deren Rand aus Ringen besteht, deren Elemente nebeneinander liegen und etwas ineinander greifen. Das Zentrafeld ist leicht gewölbt oder flach und durch Granulae besetzt, die geordnet erscheinen und zwischen denen Lücken auftreten können. Große Exemplare haben mehr Randelemente als kleine.

**Beschreibung:** Die Größe der Exemplare von *C. ehrenbergi* variiert beträchtlich und mit ihr die Anzahl der Randelemente und die Größe des Zentrafeldes sowie die Anzahl der dieses ausfüllenden Granulae. Wenn wir, wie REINHARDT (1966 a:28) vorschlägt, bei der von ARCHANGELSKY vorgeschlagenen Orientierung des Coccolithen bleiben, wonach der schmälere Limbus der distale genannt wird, ergibt sich folgende Beschreibung.

Auf der basalen Seite des Coccolithen bildet der basale Randring den Umriss des Coccolithen und gibt den Ellipsenenden oft korbbogenförmiges Aussehen. Die einzelnen Randelemente sind annähernd trapezförmig, mit der kürzeren Kante nach innen gerichtet. Anschließend an diesen Rand treten an der basalen Scheibe eine Reihe Elemente auf, deren Größe zwischen der der Randelemente der basalen Scheibe und der der Granulae des Zentrafeldes liegt. Sie können als durchstossende Teile der Randelemente einer distalen Randscheibe angesehen werden. Das Zentrafeld ist oft flach gewölbt.

Die distale Seite zeigt auf den ersten Blick ein kleineres Zentrafeld als die basale Seite, da man hier nur den Teil als Zentrafeld auffasst, der innerhalb der distalen Randscheibe liegt, während diese z.T. ja in das Zentrafeld der Basalseite eingeht. Diesem Umstande ist es wohl zuzuschreiben, dass die beiden Seiten von *C. ehrenbergi* als zwei verschiedene Arten beschrieben wurden (*C. matthewsi* BLACK 1964 und *C. laughtoni* BLACK 1964). Auch die distale Randscheibe besteht aus flachliegenden Elementen, die ineinander greifen. Zwischen der distalen und der basalen Scheibe erscheint eine Zwischenscheibe, die in der Größe zwischen den beiden anderen liegt

und deshalb nur von der distalen Seite her gesehen werden kann. Ihre Elemente sind gegenüber denen der anderen beiden Ringe verschoben. Die Granulae des Zentraffeldes sind, ebenso wie die Randelemente, bei den kleinen und den grossen Exemplaren der Art fast gleich gross.

Es sei hier noch einmal betont, dass ich bei *Cribrosphaerella* die Anzahl der Randelemente (deren Zahl im Lichtmikroskop ohnehin oft kaum zu bestimmen ist)

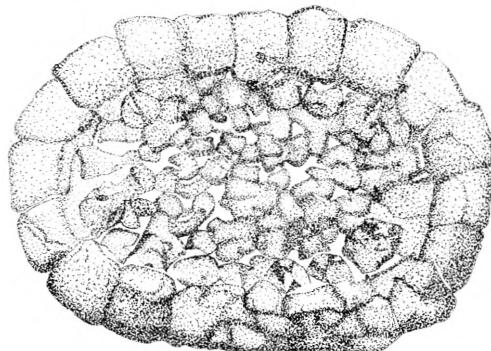


Fig. 21. *Cribrosphaerella ehrenbergi* (ARCHANGELSKY) DEF LANDRE aus dem unteren Maastrichtien von Mön.  
Vergrösserung ca. 7500 ×.

nicht als ein arbestimmendes Merkmal ansehe, da sie kontinuierlich mit dem Zunehmen der Grösse ebenfalls zunimmt.

Vorkommen: Unteres und oberes Maastrichtien von Dänemark; weltweit verbreitet in der Kreide.

*Cribrosphaerella hilli* (BLACK 1964) REINHARDT 1967 a

Fig. 22; Taf. 12, Fig. 5, 6

1964\* *Favocentrum hilli* BLACK: 314, Taf. 53:3, 4.

1964\* *Cribrosphaera pchaleki* REINHARDT: 757, Abb. 8.

1967a *Cribrosphaerella hilli* (BLACK 1964) REINHARDT: 172.

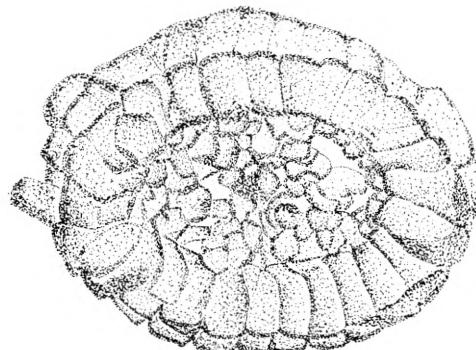


Fig. 22. *Cribrosphaerella hilli* (BLACK) REINHARDT aus dem unteren Maastrichtien von Mön.  
Vergrösserung ca. 7500 ×.

Bemerkungen: Im untersuchten Material konnten Exemplare dieser Art mit 28 bis 39 Randelementen festgestellt werden. Ihre Grösse wurde gemessen und ebenfalls in die graphische Darstellung Fig. 20, neben *C. ehrenbergi* eingetragen.

Es konnte nicht beobachtet werden, ob auch *C. hilli* eine Zwischenrandscheibe besitzt. Eine schräge Ansicht lässt dies bezweifeln, erscheinen doch nur zwei annähernd gleichgrosse Randringe. Diese bestehen, im Gegensatz zu denen von *C. ehrenbergi*, aus nebeneinander liegenden, etwas ineinander greifenden Platten, deren Länge deren Breite um Einiges übertrifft. Im Zentrafeld sind die Granulae nicht in Gruppen angeordnet wie bei *C. ehrenbergi*.

Vorkommen: Unteres Maastrichtien von Mön; weltweit verbreitet in der oberen Kreide.

Genus *Nephrolithus* GORKA 1957 emend. ÅBERG 1966

Generotypus: *Nephrolithus frequens* GORKA 1957

Bemerkungen: ÅBERG (1966) hat aus schwedischem Material zu den 4 bereits von GORKA (1957) aufgestellten Arten eine neue Art von *Nephrolithus* beschrieben. 3 von GORKAS Arten haben nach ihrer Autorin nur einen glatten Randring und nur die seltene Form, *N. barbara* zeigt zwei Randringe mit Randkerben. Wie auch ÅBERG feststellte, sind im Typmaterial nur nierenförmige Coccolithen mit zwei Randscheiben aus Einzelementen zu finden. Die von GORKA im Lichtmikroskop beschriebene Barrenstruktur im Zentralraum erweist sich im Elektronenmikroskop als durch Granulaeringe mit einer zentralen Öffnung hervorgerufen.

Es konnten im Typmaterial nicht verschiedene Arten festgestellt werden, wenn angenommen wird, dass mit der Vergrösserung des Coccolithen auch die Anzahl der Randelemente und die Anzahl der durchbohrten Ringe im Zentrafeld steigt. Ich fasse daher alle Arten von GORKA (1957) und die Art von ÅBERG (1966) unter dem Namen des Generotypus der Gattung zusammen. Die graphische Darstellung Fig. 20 zeigt das Verhältnis der Anzahl Randelemente und der totalen Länge einiger Coccolithen von *Nephrolithus frequens* GORKA 1957 emend. Im Vergleich zu *Cribrosphaerella ehrenbergi* hat *Nephrolithus frequens* kleinere Randelemente und es fallen daher mehr Randplättchen per  $\mu$  der Länge. Daran sind auch die kleineren *Nephrolithus* – formen, die kaum mehr nierenförmig sind (Taf. 18, Fig. 8), leicht von *Cribrosphaerella ehrenbergi* zu unterscheiden.

Zur systematischen Stellung von *Nephrolithus* nahm ÅBERG (1966) nicht Stellung, wies aber auf die mögliche Verwandtschaft mit *Favocentrum* BLACK (*Cribrosphaerella*) hin. *Nephrolithus* ordnet sich mit seinem grossen, granulaten Zentrafeld und den zwei Randscheiben ohne weiteres in die Familie der *Podorhabdaceae* ein.

*Nephrolithus frequens* GORKA 1957 emend.

Fig. 23; Taf. 7, Fig. 12–14, Taf. 18, Fig. 1–9

1957 *Nephrolithus frequens* GORKA: 263, Taf. 5:7.

1957 *Nephrolithus barbara* GORKA: 264, Taf. 5:9.

- 1957 *Nephrolithus furcatus* GORKA: 263, Taf. 5:8.  
 1957 *Nephrolithus trientis* GORKA: 263, Taf. 5:10.  
 1966\* *Nephrolithus gorkae* ÅBERG: 65, Taf. 1, Taf. 2:1–6, Taf. 3:1–6, Fig. 1.

Bemerkungen: Als Diagnose gilt die von ÅBERG (1965:65) für *N. gorkae* gegebene. Die Zusammenfassung der obgenannten Arten erfolgt aus derselben Überlegung wie die Zusammenfassung der Arten in *Cibrosphaerella*, nämlich dass es zu künstlich ist, die Arten aufgrund ihrer Anzahl Randelemente oder Anzahl Granulaerringe im Zentralfeld zu unterscheiden, wenn diese sich kontinuierlich mit der Grösse

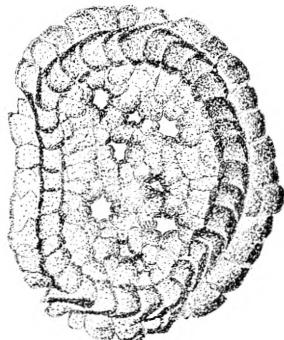


Fig. 23. *Nephrolithus frequens* GORKA aus dem oberen Maastrichtien von Kjølby Gård.  
 Vergrösserung ca. 7500 ×.

des Coccolithen verändern. Die Barren, deren Anzahl und Anordnung bei GORKA (1957) die Arten unterscheidet, sind Ausdruck der Anzahl Granulaeringe.

Vorkommen: Oberes Maastrichtien von Kjølby Gård; *Nephrolithus* scheint eine der Formen zu sein, die erst im oberen Maastrichtien auftreten und hier auch wieder aussterben. Aufgearbeitet findet er sich auch im dänischen Paleozän.

#### Genus *Arkhangelskiella* VEKSINA 1959 emend. REINHARDT 1964

Generotypus: *Arkhangelskiella cymbiformis* VEKSINA 1959 emend. REINHARDT 1964

REINHARDT (1967a:174) unterscheidet die Arten innerhalb der Gattung *Arkhangelskiella* nach der Ausbildung der Randscheiben. Ich folge ihm insofern, als ich dieselben Arten beschreibe, möchte hierzu aber bemerken, dass der Typ des Randaufbaues bei den verschiedenen Arten annähernd der gleiche ist, dass auch der Typ des Zentralfeldes derselbe ist und dass sich in diesem Rahmen die Arten durch Änderungen in Einzelheiten beider Kennzeichen unterscheiden.

#### *Arkhangelskiella cymbiformis* VEKSINA 1959 emend. REINHARDT 1964

Fig. 24, 25; Taf. 19, Fig. 1–2; Taf. 20, Fig. 3–8

- 1959 *Arkhangelskiella cymbiformis* VEKSINA: 66, Taf. 1:1, Taf. 2:3 a–c.  
 1964\* *Arkhangelskiella cymbiformis* VEKSINA in REINHARDT: 752, Taf. 1:1, 2.  
 1966 *Discolithus octocentralis* STOVER: 143, Taf. 3:1–2, Taf. 8:18.

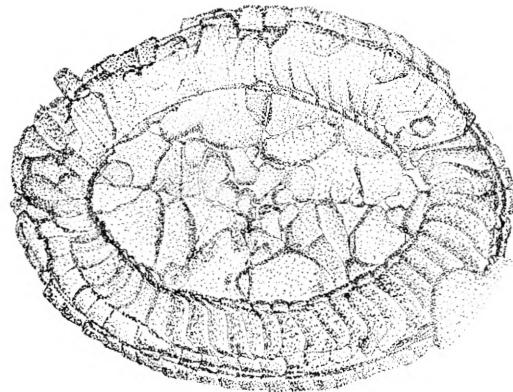


Fig. 24. *Arkhangelskiella cymbiformis* VEKSINA. Basale Ansicht aus dem unteren Maastrichtien von Mon. Vergrösserung ca. 7500×.

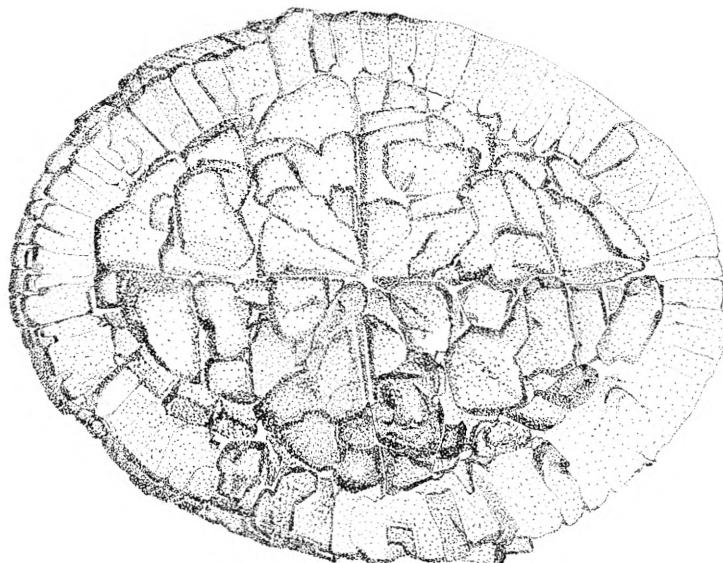


Fig. 25. *Arkhangelskiella cymbiformis* VEKSINA. Distale Ansicht eines grossen Exemplares aus dem unteren Maastrichtien von Mon. Vergrösserung ca. 7500×.

Bemerkungen: *A. cymbiformis* ist in den untersuchten Proben recht häufig anzutreffen und erscheint in verschiedener Grösse und Ausbildung. Die Randscheiben bestehen aus nebeneinander liegenden Elementen. Bei den kleineren Exemplaren scheinen die Randscheiben mehr oder weniger gleich gross zu sein. Bei grösseren Exemplaren sind bis 3 Randscheiben sichtbar, deren äusserste ein ausgefranstes Aussehen haben. Die kleineren Formen haben weniger Randelemente als die Grösseren. Das basale Zentraffeld ist von Granulae bedeckt, die in einem für *Arkhangelskiella* typischen Muster angeordnet sind. Die distale Seite wird von Tabulae bedeckt, die

eine flache Kuppel bilden. Bei *A. cymbiformis* bildet das Achsenkreuz der Ellipsen Symmetriearchsen für das Muster, in welchem die Granulae und Tabulae im Zentralfeld angeordnet sind. Bei *A. obliqua* STRADNER 1963 ist nur die längere Ellipsenachse auch Symmetriearchse.

Vorkommen: Maastrichtien von Dänemark; weltweit verbreitet im Campanien und Maastrichtien.

*Arkhangelskiella obliqua* STRADNER 1963

Taf. 19, Fig. 3–6; Taf. 20, Fig. 1, 2

1963 *Arkhangelskiella obliqua* STRADNER: 10, Taf. 1:2.  
NON 1967a *Arkhangelskiella obliqua* STRADNER in REINHARDT: 174.

Bemerkungen: STRADNER (1963) hat in *A. obliqua* eine Form beschrieben und abgebildet (Zeichnung) mit einem schrägen Kreuz, bei welchem die längeren Kreuz-

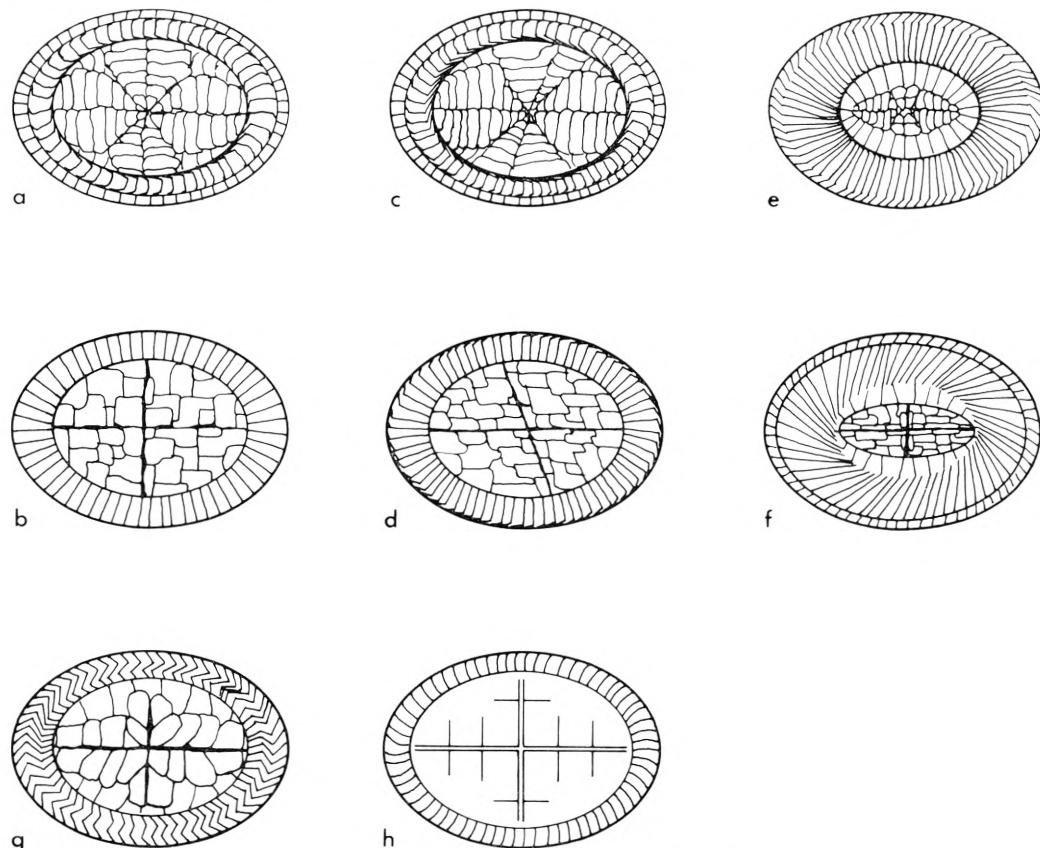


Fig. 26. Schematische Zeichnungen der Arkhangelskiellaarten *A. cymbiformis* (a basal, b distal), *A. obliqua* (c basal, d distal), *A. parca* (e basal, f distal), *A. erratica* (g basal) und *A. ornamenta* (h, nach REINHARDT 1967 a).

balken in Richtung der längeren Ellipsenachse verlaufen. REINHARDT (1965) hat eine Art von *Arkhangelskiella* beschrieben und *A. inclinata* genannt, die 1963 schon von CARATINI als *Discolithus ornamentos* beschrieben worden war und die sich von *A. cymbiformis* durch die Auslöschungsfigur in der Randpartie unterscheidet. 1967 a hat dann REINHARDT seine *A. inclinata* zu *A. obliqua* gestellt. Aus seiner Zeichnung dieser Art geht hervor, dass er sie als Form mit sich rechtwinklig schneidenden Kreuzbalken ansieht, also nicht so wie sie von STRADNER (1963) definiert wurde. Da ich in meinem Material im Elektronenmikroskop und im Lichtmikroskop nur Formen mit schrägem Kreuz und einer Auslöschungsfigur wie *A. cymbiformis* fand vermute ich, dass hier doch zwei Arten vorliegen. Obschon die Randelemente bei *A. obliqua* schräg liegen, löscht die Randpartie nicht so aus wie bei *A. inclinata* REINHARDT oder *Discolithus ornamentos* CARATINI.

**Beschreibung:** Mehrere Randscheiben bilden einen elliptischen Umriss, der oft ausgefranst erscheint. Mindestens je die innerste und die äusserste Randscheibe bestehen aus schräg liegenden Elementen, während die grösste aus nebeneinander liegenden zu bestehen scheint. Das Zentrafeld der distalen Seite wird von Tabulae bedeckt, die eine flache Kuppel bilden. Die Trennungslinien der Quadranten stehen schräg zueinander, sowohl auf der distalen, wie auf der basalen Seite des Cocolithen. Das basale Zentrafeld wird von Granulae eingenommen, die ähnlich angeordnet sind wie bei *A. cymbiformis*. Die Abgrenzung der beiden Formen ist nicht leicht, da auch Formen vorkommen, bei welchen der Winkel zwischen den Trennungslinien der Quadranten nur sehr wenig von  $90^\circ$  abweicht und die Randelemente weniger schräg stehen. Die Variation dieser Merkmale ist noch zu wenig bekannt um eine Zusammenlegung der beiden Arten zu rechtfertigen.

**Vorkommen:** Unteres Maastrichtien von Mön; weltweit verbreitet in der Kreide.

#### *Arkhangelskiella ornamento* (CARATINI 1963) n. comb.

- 1963 *Discolithus ornamento* CARATINI: 18, Taf. 1:7–9.
- 1963 *Discolithus decoratus* CARATINI: Taf. 1:7–9 (Legende zur Tafel).
- 1965 *Arkhangelskiella inclinata* REINHARDT: 31, Taf. 2:5,
- 1965\* *Ahmuelerella oblata* REINHARDT: 31, Taf. 1:2.
- 1966 *Discolithus segmentatus* STOVER: 143, Taf. 3:3, Taf. 8:19.
- 1967a\* *Arkhangelskiella obliqua* STRADNER 1963 in REINHARDT: 174, Abb. 9, 10, 12 d, e.

**Bemerkungen:** *A. ornamento* wurde im untersuchten Material nicht gefunden und auch BRAMLETTE & MARTINI (1964) scheint sie nicht begegnet zu sein. Sie wird hier nur erwähnt, um ein vollständigeres Bild der Gattung *Arkhangelskiella* zu geben.

CARATINI (1963) beschrieb die Form unter dem Namen *Discolithus ornamento* und wies auf die Tafel mit den Figuren hin, deren Legende dann aber auf *Discolithus*

*decoratus* lautet. Es kann aber kein Zweifel bestehen, dass dieselbe Art gemeint ist und *D. decoratus* wird auch nirgends sonst in dieser Arbeit beschrieben.

REINHARDT (1967 a) stellt seine 1965 aufgestellte Art zu *A. obliqua*, womit ich aus den bei der Besprechung dieser Art genannten Gründen nicht einverstanden bin.

Vorkommen: Weltweit verbreitet in der oberen Kreide, offenbar aber fehlend im Maastrichtien.

*Arkhangelskiella parca* STRADNER 1963

Fig. 27; Taf. 21, Fig. 1-4

1963 *Arkhangelskiella parca* STRADNER: 10, Taf. 1:3.

1966 *Arkhangelskiella cymbiformis* VEKSINA 1959 in STOVER: 137, Taf. 1:17, Taf. 8:8. NON Taf. 1:18.

Bemerkungen: Diese Art wurde bisher erst im Lichtmikroskop untersucht und lichtmikroskopisch zuletzt eingehend von REINHARDT (1967 a) beschrieben. Sie zeichnet sich vor allem durch ein relativ kleines distales Zentrafeld aus.

Beschreibung: Die Elektronenmikroskopaufnahmen zeigen die unterschiedliche Grösse des Zentrafeldes von der basalen und der distalen Seite her gesehen. Auf der distalen Seite ist das Zentrafeld bedeutend kleiner als auf der basalen, weil die Randelemente weiter hinein ragen und so den äussersten Teil des Zentrafeldes verdecken. Die Anordnung der Granulae und Tabulae ist ähnlich wie bei den anderen Arten von *Arkhangelskiella*. Die Randpartie wird aus bis 3 Randscheiben gebildet, die

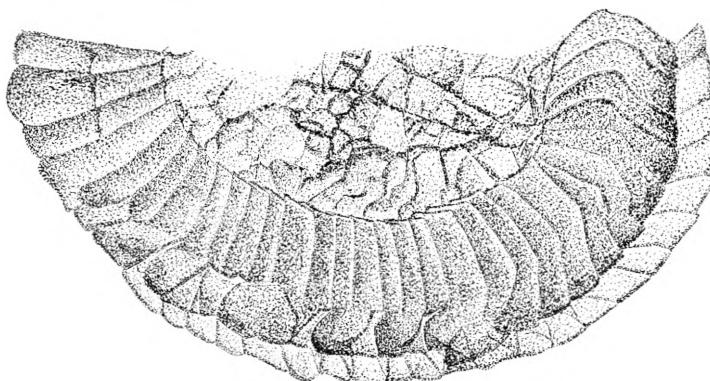


Fig. 27. *Arkhangelskiella parca* STRADNER. Basale Ansicht eines Exemplares aus dem unteren Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

einen elliptischen Umriss haben und deren basale aus nebeneinanderliegenden, leicht schrägstehenden Platten besteht. Die distale Randscheibe ist aus merkwürdigen, ungleichförmigen Elementen zusammengesetzt (Taf. 21, Fig. 1).

Vorkommen: Unteres Maastrichtien von Mön; weltweit verbreitet in der oberen Kreide.

*Arkhangelskiella erratica* STOVER 1966

Taf. 21:5–7

1966 *Arkhangelskiella erratica* STOVER: 137, Taf. 2:10, Taf. 8:14.

**Bemerkungen:** *A. erratica* weicht stärker vom Generotypus von *Arkhangelskiella* ab als die anderen Arten der Gattung.

**Beschreibung:** Die Anordnung der Tabulae und Granulae im Zentralfeld erinnert an diejenige von *A. cymbiformis*, beschränkt sich jedoch mehr auf die Umgebung der Ellipsenachsen und lässt in allen 4 Quadranten Ecken frei, die vom Rand her mit Randelementen aufgefüllt werden können. Die Anordnung der Elemente im Zentralfeld ist symmetrisch in bezug auf die Ellipsenachsen. Die Randelemente der elliptischen Randscheiben greifen mit geschwungener Sutur ineinander über. Die beiden Randscheiben sind annähernd gleich gross. Das distale Zentralfeld bildet einen flachen Buckel.

Im Lichtmikroskop wurden die Elemente des Zentralfeldes von STOVER (1966) als Perforationen gedeutet. *A. erratica* ist kleiner als *A. parca* und *A. inclinata* und etwa gleich gross wie die kleineren Formen von *A. cymbiformis* und *A. obliqua*.

**Vorkommen:** Unteres Maastrichtien von Mön (selten); Albien von Frankreich.

Genus *Deflandrius* BRAMLETTE & MARTINI 1964Generotypus: *Deflandrius cretaceus* (ARCHANGELSKY 1912) BRAMLETTE & MARTINI 1964

**Bemerkungen:** Der von BRAMLETTE & MARTINI (1964) für *Deflandrius* bestimmte Generotypus *D. intercisis* ist als Generotypus sicher *D. cretaceus* (ARCHANGELSKY 1912) BRAMLETTE & MARTINI 1964 vorzuziehen. Da nach dem hier eingenommenen Standpunkt Coccoolithen mit und ohne Fortsatz mit gleicher Basis in einer Art vereinigt werden, ist *D. intercisis* aber als jüngeres Synonym anzusehen und *D. cretaceus* an dessen Stelle zu setzen.

*Deflandrius* umfasst elliptische bis breitelliptische Coccoolithen mit 2 Randscheiben aus nebeneinander liegenden, ineinandergreifenden Platten und einem zentralen Kreuz aus Latten und Granulae, das einen Fortsatz tragen kann.

REINHARDT (1966 a) hat vorgeschlagen, die stablosen Formen von *Deflandrius cretaceus* *D. cretaceus cretaceus* zu benennen und für die stabtragenden Exemplare *D. cretaceus intercisis* zu gebrauchen. Ich folge diesem Vorschlag nicht, sondern fasse diese Formen mit einem diagonal orientierten Kreuz unter *D. cretaceus* zusammen. Coccoolithen, deren Randausbildung derjenigen von *D. cretaceus* gleicht, deren zentrales Kreuz jedoch in den Ellipsenachsen liegt, werden *D. spinosus* BRAMLETTE & MARTINI 1964 zugeordnet, dessen Fortsatz sich ebenfalls von demjenigen von *D. cretaceus* unterscheidet. Gleichzeitig werden zwei neue Arten aufgestellt, deren zentrales Kreuz in den Ellipsenachsen liegt, die jedoch in ihrer Randausbildung (*D. stoveri*) oder in der Ausbildung ihres zentralen Kreuzes (*D. rhombicus*) von *D. spinosus* abweichen. Fig. 28 gibt eine Übersicht über die hier beschriebenen Arten von *Deflandrius*.

BLACK (1967) hat einen *Deflandrius cantabrigensis* aus dem unteren Cenomanien von England beschrieben, dessen Fortsatz in der Mitte Knoten hat, von dem er aber die Basalscheibe nicht abbildet.

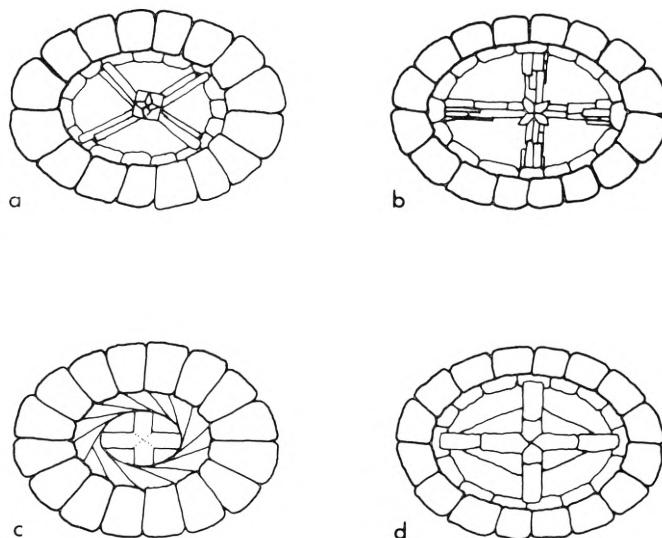


Fig. 28. Schematische Zeichnungen der *Deflandrius*-arten *D. cretaceus* (a), *D. spinosus* (b), *D. stoveri* (c), und *D. rhombicus* (d).

#### *Deflandrius cretaceus* (ARCHANGELSKY 1912) BRAMLETTE & MARTINI 1964

Fig. 29, 30, 31; Taf. 13, Fig. 1–6; Taf. 14, Fig. 1, 2; Taf. 15; Taf. 16, Fig. 1–5

- 1912 *Coccolithophora cretacea* ARCHANGELSKY: 410, Taf. 6:12, 13?
- 1954 *Rhabdolithus intercisis* DEFLANDRE: 159, Taf. 13:12, 13.
- 1957 *Discolithus cretaceus* (ARCHANGELSKY 1912) GORKA: 251, Taf. 2:11.
- 1959\* *Discolithus cretaceus* (ARCHANGELSKY 1912) GORKA in BLACK: 326, Taf. 11:1, 2.
- 1959 *Zygrhablithus intercisis* (DEFLANDRE 1954) DEFLANDRE: 136, Taf. 1:5–20.
- 1964 *Deflandrius cretaceus* (ARCHANGELSKY 1912) BRAMLETTE & MARTINI: 301, Taf. 2:11–12.
- 1964 *Deflandrius intercisis* (DEFLANDRE 1954) BRAMLETTE & MARTINI: 301, Taf. 2:13–16.
- 1965\* *Eiffellithus cretaceus intercisis* (DEFLANDRE 1954) REINHARDT: 36.
- 1965\* *Eiffellithus cretaceus cretaceus* (ARCHANGELSKY 1912) REINHARDT: 35.
- 1966a\* *Deflandrius cretaceus cretaceus* (ARCHANGELSKY 1912) REINHARDT: 35, Taf. 15:4.
- 1966a\* *Deflandrius cretaceus intercisis* (DEFLANDRE 1954) REINHARDT: 35, Taf. 19:3, Taf. 22:2, Bild 20 a.
- 1966? *Deflandrius columnatus* STOVER: 141, Taf. 6:6–10, Taf. 9:16.

Bemerkungen: *D. cretaceus* wurde erstmalig von BLACK (1959) als Elektronenmikroskopbild veröffentlicht. Seither hat auch REINHARDT verschiedentlich Elektronenmikroskopaufnahmen von *D. cretaceus* publiziert, wobei einige seiner Abbildungen wahrscheinlich *D. spinosus* darstellen (s. Synonymie). Es sind verschiedene Gründe, die mich dazu veranlassen, *D. intercisis* mit *D. cretaceus* zu vereinen. Da ist die

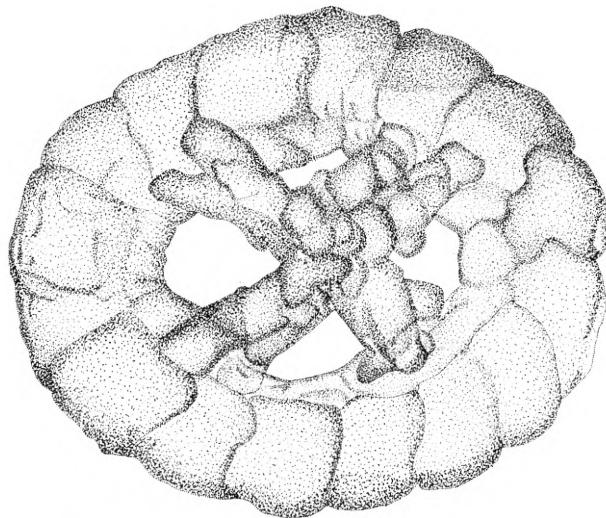


Fig. 29. *Deflandrius cretaceus* (ARCHANGELSKY) BRAMLETTE & MARTINI. Exemplar mit zentralem Kreuz aber ohne Fortsatz aus dem unteren Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

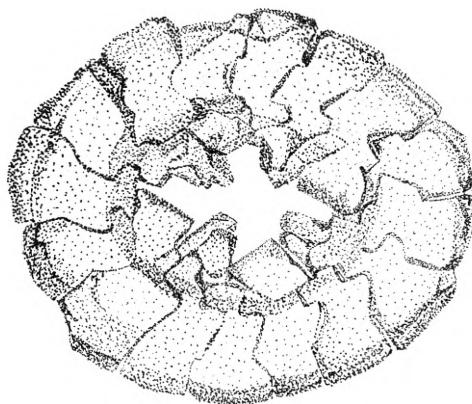


Fig. 30. *Deflandrius cretaceus* (ARCHANGELSKY) BRAMLETTE & MARTINI. Exemplar ohne zentrales Kreuz. Dieser Erhaltungszustand ist in einigen Proben sehr häufig. Unterer Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

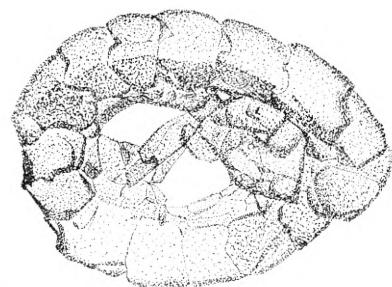


Fig. 31. *Deflandrius cretaceus* (ARCHANGELSKY) BRAMLETTE & MARTINI. Ansicht von schräg unten eines Exemplares aus dem unteren Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

eingenommene Stellung, dass sonst gleiche Formen nicht artlich getrennt werden sollen, wenn sie stablos oder – tragend auftreten. Der Umstand, dass oft auch Formen mit einem auf halber Höhe abgebrochenen Stab auftreten (Taf. 13:1–3), spricht ebenfalls für eine Vereinigung, denn bei welcher Höhe sollte die Grenze gesetzt werden? Bei *D. cretaceus* treten stabtragende und stablose Formen zeitlich und örtlich zusammen auf. Bei vielen Coccolithen dieser Art ist das ganze zentrale Kreuz herausgebrochen. Die Höhe des Fortsatzes variiert stark und es kann oft nicht entschieden

werden, ob die Coccolithen nie einen Fortsatz getragen haben oder ob dieser nur ab- oder ausgebrochen ist. Durch die Zusammenlegung von *D. intercisis* mit *D. cretaceus* umgeht man somit auch die Benennung eines Erhaltungszustandes mit einem Artnamen.

Die Grösse der Coccolithen variiert stark. Von 50 gemessenen Elektronenmikroskopbildern von *D. cretaceus* massen 14 ca. 4–5,5  $\mu$ , 16 ca. 5,5–7  $\mu$  und 10 ca. 7–8,5  $\mu$ . 2 Exemplare massen ca. 8,5–10  $\mu$ , 2 weitere 11,5–14  $\mu$  und die letzten 6 Formen erreichten gar 15,5–17  $\mu$ . Wohl sind die Riesenformen im untersuchten Material seltener als die kleineren; die Auswahl der gezählten Exemplare ist jedoch nicht representativ und weittragende Schlüsse deshalb nicht sinnreich. Die Anzahl der Randelemente in den Randscheiben ist auch bei den grössten Formen immer 16, und ein Fortsatz kann vorhanden sein oder fehlen.

Vorkommen: Weltweit verbreitet vor allem in der oberen Kreide, wo *D. cretaceus* eine der häufigsten Formen ist.

#### *Deflandrius spinosus* BRAMLETTE & MARTINI 1964

Taf. 11, Fig. 1; Taf. 14, Fig. 3–8; Taf. 16, Fig. 8–10

1964 *Deflandrius spinosus* BRAMLETTE & MARTINI: 301, Taf. 2:17–20.

1965\* *Eiffellithus cretaceus cretaceus* (ARCHANGELSKY 1912) REINHARDT, Abb. 3.

1966a\* *Deflandrius cretaceus cretaceus* (ARCHANGELSKY 1912) REINHARDT, Taf. 10: 1 a, b, Bild 14.

1966a\* *Deflandrius cretaceus intercisis* (DEFLANDRE 1954) REINHARDT, Bild 20 b.

1966 *Discolithus incohatus* STOVER: 143, Taf. 2:23, 34; Taf. 8:17.

Bemerkungen: 1957 hat GORKA eine ähnliche Form beschrieben unter dem Namen *Discolithus propinquus*, von welchem sie 9 bis 12 randliche Einschnitte erwähnt. Wenn hier der Artnamen der jüngeren Art, *D. spinosus*, die 16 Randelemente hat, gebraucht wird, geschieht dies, weil ich in GORKAS Material bisher diese Form noch nicht finden konnte. Wir alle wissen ja, wie leicht man sich im Lichtmikroskop verzählen kann (für *D. cretaceus* nennt GORKA (1957) 18–48 Einschnitte und zeichnet deren 14 an einem runden Coccolithen – trotzdem kann in diesem Falle kein Zweifel bestehen, dass es sich um *D. cretaceus* handelt, da er in ihrem Material sehr häufig ist).

*D. spinosus* ist im untersuchten Material eher selten. Umso erfreulicher ist ein Fund von drei zusammenhängenden Coccolithen der Art, von denen 2 einen Stab tragen, dessen oberster Teil wahrscheinlich abgebrochen ist, während der dritte Coccolith stablos ist (Taf. 11, Fig. 1). Die Coccolithen greifen übereinander und ich nehme an, dass es sich um einen Teil einer Coccospaere handelt – zufällige Sedimentation einer solchen Gruppe auf dem Formvarfilm scheint sehr unwahrscheinlich.

Der Basicoccolith besteht aus zwei Randscheiben mit je 16 Platten. Das grosse Zentraffeld wird überbrückt durch ein Kreuz, dessen Balken aus Latten und Granulae bestehen und die über den Ellipsenachsen verlaufen. Ihnen kann zentral ein Fortsatz aufliegen, der sich an seiner Spitze verzweigt und der aus langen Leisten besteht

(Taf. 14, Fig. 3–8). In einigen Proben sind isolierte Stäbe sehr häufig, die den Fortsätzen von *D. spinosus* sehr ähnlich sind, die sich jedoch am einen Ende verjüngen und die meist um einiges länger sind als die längsten Fortsätze, die sicher als *D. spinosus* bestimmt werden können. Sie wurden Taf. 30, Fig. 2–4, als *Microrhabdulus* sp. abgebildet.

REINHARDT (1965, 1966) hat eine Form als *D. cretaceus arkhangelsky* beschrieben, die *D. spinosus* sehr nahe steht. Bei ihr ist die innere Randscheibe stark ausgebildet und füllt einen Grossteil des Zentraffeldes aus. Diese Form wurde auch im untersuchten Material angetroffen und scheint durchschnittlich etwas grösser zu sein als *D. spinosus*. Da jedoch von beiden Formen nur wenige Exemplare vorliegen, von denen eine zudem eine Zwischenform darzustellen scheint, wird hier aus dieser Unterart noch keine Art gemacht.

Vorkommen: Unteres Maastrichtien von Mön; nach BRAMLETT & MARTINI weltweit verbreitet im Maastrichtien.

*Deflandrius stoveri* n. sp.

Taf. 16, Fig. 11–13

Holotypus: Taf. 16, Fig. 13 (K. P.-N. 61/2).

Masse des Holotypus: Länge: ca. 5  $\mu$ , Breite: ca. 4,5  $\mu$ .

Locus typicus: Kjolby Gård, Dänemark.

Stratum typicum: Oberes Maastrichtien.

Diagnose: Breitelliptischer Coccoolith aus zwei ungleichgrossen Randscheiben aus je 16 nebeneinander liegenden Platten. Das Zentraffeld wird durch ein Kreuz in den Ellipsenachsen überbrückt und von sich überlagernden Keilen eingefasst.

Beschreibung: Sowohl die grössere als auch die kleinere Randscheibe besteht aus 16 Elementen, die etwas gegeneinander verschoben angeordnet sind und nebeneinander liegen. An ihrem inneren Rand werden sie eingefasst von sich überlagernden Keilen. Auf der einen Seite des Coccoolithen scheinen sie sich zum Teil aus den Randelementen der grösseren Scheibe heraus zu entwickeln und teils frei zu liegen. Auf der anderen Seite greifen sie über den kleineren Randring hinweg. Sie bilden eine Art Tubus um das Zentraffeld. Dieses wird von einem Kreuz überbrückt, das aus Latten besteht und oft ausgebrochen ist.

Bemerkungen: *D. stoveri* unterscheidet sich von den anderen *Deflandrius*-Arten durch seinen speziellen Aufbau des Zentraffeldrandes, sein kleineres Zentraffeld und durch seine breitelliptische Form. Er wurde nur zögernd zu *Deflandrius* gestellt, da er eine Art Tubus aufweist, der die beiden Randscheiben verbindet, ohne dass die Randscheiben sonst weit voneinander abstehen. Die Zuordnung wird motiviert durch den Fund einer Zwischenform von *D. spinosus* und *D. stoveri*. Sie zeigt einen elliptischen Coccoolithen mit zwei Randscheiben aus je 16 Elementen und einem grossen Zentraffeld, an dessen Rand z.T. ebenfalls Keile stehen, die jedoch noch nicht so schlank

sind wie diejenigen von *D. stoveri*. *D. stoveri* wurde noch nicht im Lichtmikroskop gefunden und konnte nicht stabtragend beobachtet werden.

**Vorkommen:** Unteres Maastrichtien von Møn und oberes Maastrichtien von Kjølby Gård.

*Deflandrius rhombicus* n. sp.

Taf. 16, Fig. 6, 7

Holotypus: Taf. 16, Fig. 7 (K. P.-N. 60/26).

Masse des Holotypus: Länge: ca. 6,5  $\mu$ , Breite: ca. 5  $\mu$ .

Locus typicus: Møn, A 10.

Stratum typicum: Unteres Maastrichtien.

**Diagnose:** Elliptischer Coccolith aus zwei Randscheiben aus je 16 nebeneinanderliegenden Platten. Das grosse Zentrafeld wird durch ein Kreuz in den Ellipsenachsen eingenommen, das im Zentrum durch weitere Elemente verstärkt ist, die zu einem Rhombus angeordnet sind.

**Beschreibung:** Die beiden Randscheiben bestehen je aus 16 Platten, die gegeneinander verschoben sich überlagern und deren eine am inneren Rand nur wenig hervor steht. Das zentrale Kreuz besteht aus Latten und Granulae und ist in den Ellipsenachsen gelegen oder etwas darüber erhoben. Weitere Latten bilden einen Rhombus mit Zentrum im Mittelpunkt des Coccolithen, so dass in jedem Quadranten zum inneren Rand des Randringes nur noch ein schmaler Durchbruch bleibt. *D. rhombicus* wurde nie mit einem Fortsatz gefunden und konnte auch nicht im Lichtmikroskop gefunden werden.

**Bemerkungen:** *D. rhombicus* unterscheidet sich von den anderen *Deflandrius*-Arten durch die zusätzlichen Elemente, die den Mittelpunkt des Coccolithen umgeben. BRAMLETTE & MARTINI (1964) haben Elektronenmikroskopbilder von *Coccolithus helis* STRADNER 1963 publiziert, der im Zentrafeld eine ähnliche Struktur aufweist wie *D. rhombicus*. *C. helis* hat jedoch auch Durchbrüche zwischen dem Zentrum des Coccolithen und den Querlatten und hat fast 40 Randelemente. Er wurde aus dem Danien verschiedener Lokalitäten beschrieben.

**Vorkommen:** Unteres Maastrichtien von Møn.

### 3.3. Familie *Ellipsagelosphaeraceae* NOEL 1965.

Coccolithen, die aus Randscheiben bestehen, deren Elemente sich fächerförmig überlagern oder nebeneinander liegen und die meist nur ein kleines Zentrafeld haben.

Die Familie wird in zwei Unterfamilien geteilt:

*Ellipsagelosphaeroideae* NOEL 1965 2 und mehr Randscheiben, wovon die eine aus sich fächerförmig überlagernden Elementen besteht.

*Discorhabdoideae* NOEL 1965 2 und mehr Randscheiben aus nebeneinander liegenden Elementen.

REINHARDT (1967 a) fasst *Ellipsagelosphaearceae* NOEL als jüngeres Synonym von *Coccolithaceae* POCHE (1913) auf. Da ich jedoch von der Nomenklatur der rezenten Coccolithen unabhängig sein möchte folge ich diesem Vorschlag nicht, sondern behalte NOELS Familie bei, obschon inzwischen verschiedene Arten von *Coccolithus*, u. a. *Coccolithus pelagicus* im Elektronenmikroskop aus rezentem Material abgebildet worden sind (BLACK 1965) und absolut ins Bild passen würden.

Die Unterteilung in Unterfamilien erfolgt wie bei NOEL, jedoch ohne die Unterfamilie der *Actinosphaeroideae* abzutrennen, da dem Vorhandensein oder Fehlen eines Tubus nicht ein so grosser Wert beigemessen wird, der eine Trennung von *Ellipsagelosphaeroideae* rechtfertigen würde. Die Abtrennung einer Unterfamilie für Formen mit nur 1 Randscheibe ist bis jetzt nicht nötig, da solche aus dem Mesozoikum noch nicht im Elektronenmikroskop beschrieben worden sind. Dagegen wird die Unterfamilie der *Discorhabdoideae* von NOEL mit dem Vermerk übernommen, dass sie neben den runden Formen mit Fortsatz auch elliptische Formen aus nebeneinanderliegenden Randelementen und Formen ohne Fortsatz enthalten soll.

#### Unterfamilie *Ellipsagelosphaeroideae* NOEL 1965 emend.

Coccolithen aus 1 Randscheibe, die sich aus fächerförmig übereinander liegenden Elementen zusammensetzt und einer oder mehreren weiteren Randscheiben, die sich aus nebeneinanderliegenden Elementen zusammensetzen.

*Coccolithus* – *Tergestiella* – *Colvillea* – *Watznaueria* – *Ellipsagelosphaera* – *Maslovella*.

Bevor ich zur Beschreibung der einzelnen Gattungen dieser Familie übergehe, sei hier ein Überblick über die Gattungen der Unterfamilie der *Ellipsagelosphaeroideae* und verwandter Formen gegeben. REINHARDT (1966 b) hat diese Unterfamilie als Synonym von *Tergestilloideae* (KAMPTNER 1958) emend. REINHARDT 1966 b angesehen. Ich folge diesem Vorschlag nicht, da *Tergestilloideae* auf einen rezenten Genus gegründet ist, dessen Generotypus zudem noch nicht im Elektronenmikroskop bekannt ist.

<i>Coccolithus</i>	rezente Formen, ev. tertiäre Formen:	elliptisch
<i>Tergestiella</i>	rezente Formen	rund
<i>Colvillea</i>	–	elliptisch
<i>Watznaueria</i>	Formen ohne „Tubus“ (kretazisch?)	elliptisch
<i>Ellipsagelosphaera</i>	Formen mit „Tubus“ (jurassisch?)	elliptisch
<i>Maslovella</i>	–	elliptisch
<i>Cyclagelosphaera</i>	Formen mit „Tubus“, fossil	rund
<i>Markalius</i>	Formen ohne „Tubus“, fossil	rund

#### Genus *Watznaueria* REINHARDT 1964

Generotypus: *Watznaueria barnesae* (BLACK 1959) n. comb.

BLACK (1959, in BLACK & BARNES) hat *Tremalithus barnesae* von der distalen und der basalen Seite im Elektronenmikroskop abgebildet. Später (1964) hat er auf dieser

Art eine neue Gattung gegründet, *Colvillea*, die 1966 von TAPPAN & LOEBLICH als jüngeres Homonym von *Colvillea* Boj. ex HOOK. der Leguminosae erkannt wurde. TAPPAN & LOEBLICH haben deshalb an die Stelle von *Colvillea* den Namen *Maslovella* gestellt. Nun hat aber auch REINHARDT (1964) eine Gattung aufgestellt (*Watznaueria*), deren Generotypus, *W. angustoralis* REINHARDT 1964, ich als jüngeres Synonym von *Tremalithus barnesae* BLACK 1959 betrachte. REINHARDT selbst hat *Watznaueria barnesae* (BLACK 1959) n. comb. verschiedentlich als runde Form aufgefasst, abgebildet und beschrieben (1966 a, 1966 b).

*Watznaueria* kann als Zwischenform zwischen *Ellipsagelosphaera* NOEL 1965 und *Actinosphaera* NOEL 1965 betrachtet werden. Bei *Ellipsagelosphaera* sind am inneren Rand der distalen Randscheibe und am inneren Rand der basalen Randscheibe Elemente sichtbar, die das Zentrafeld einrahmen. Bei *Watznaueria* sind diese Elemente in Form einer Granulaerie auch vorhanden auf der distalen Seite. Auf der basalen Seite dagegen erreichen die Randelemente das Zentrum, wo sie höchstens winzige Schlitze offen lassen, es sei denn sie seien ausgebrochen. Der innerste Granulaering der distalen Ansicht ist wahrscheinlich aus den innersten Teilen der basalen Randelementen gebildet, die hier „durchstossen“. Damit sind wir in der Nähe der Gattung *Actinosphaera*, bei welcher auf der distalen Seite ein Granulaering ein grosses Zentrafeld einrahmt, das mit den Randelementen der basalen Seite ausgefüllt ist. Die drei Gattungen stehen einander sehr nahe und werden vielleicht später zusammengefasst werden.

#### *Watznaueria barnesae* (BLACK 1959) n. comb.

Fig. 32; Taf. 22, Fig. 1–7; Taf. 23, Fig. 1, 4, 5, 16

- 1959\* *Tremalithus barnesae* BLACK in BLACK & BARNES: 325, Taf. 9:1, 2.
- 1964\* *Colvillea barnesae* (BLACK 1959) BLACK: 311.
- 1964 *Coccolithus cf. C. barnesae* (BLACK) in BRAMLETTE & MARTINI: 298, Taf. 1:13–14.
- NON 1964 *Tergestiella barnesae* (BLACK 1959) REINHARDT: 753.
- 1964\* *Watznaueria angustoralis* REINHARDT: 753, Taf. 2:2; Abb. 4.
- 1966a\* *Tergestiella barnesae* (BLACK 1959) REINHARDT 1964 in REINHARDT: Taf. 2:1 a, b, Taf. 12:2, Taf. 23:6.
- NON 1966a\* *Tergestiella barnesae* (BLACK 1959) REINHARDT in REINHARDT: 15, Bild 2 a, b, c; Taf. 1:1, 2 a, b.
- 1966a\* *Watznaueria angustoralis* REINHARDT 1964 in REINHARDT: 16, Taf. 2:2 a, b; Taf. 3:1 a, b, 2 a, b, 3 a, b. Taf. 23:4. Bild 5 a, b.
- 1966 *Maslovella barnesae* (BLACK 1959) TAPPAN & LOEBLICH: 43.
- 1966 *Coccolithus paenepelagicus* STOVER: 139, Taf. 1:10–11, Taf. 3:22 B, Taf. 8:5.
- 1966 *Coccolithus pelagicus* (WALLICH) SCHILLER 1930 in Arbeiten über mesozoische (v. a. kretazische) Formen von vielen Autoren.

Bemerkungen: *W. barnesae* gleicht stark der von NOEL (1965) aufgestellten Art *Actinosphaera deflandrei*. Die basale Seite des Coccolithen besteht in beiden Fällen aus keilförmigen Elementen, die nicht ganz radial stehen und sich in der Mitte nicht ganz oder knapp berühren. Die Randelemente der distalen Seite überragen in beiden

Arten die basalen sind plattenförmig, schräggestellt, sich fächerförmig überlagernd. Im einwärts anschliessenden Zentrafeld folgt nun ein Granulaering, der bei *A. deflandrei* schwächer ausgebildet ist als bei *W. barnesae*. Dementsprechend ist das übrigbleibende Zentrafeld bei *A. deflandrei* bedeutend grösser und umfasst ca. 45%

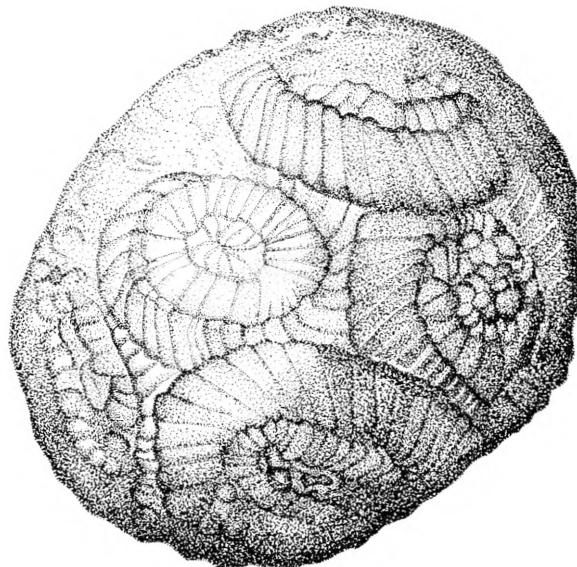


Fig. 32. *Watznaueria barnesae* (BLACK) n. comb. Teil einer Coccospaere aus dem unteren Maastrichtien von Mön. Vergrösserung ca. 5000×.

der Länge und ca. 30% der Breite des Coccolithen, während es bei *W. barnesae* nur 35% der Länge und ca. 15% der Breite des Coccolithen beansprucht. Während bei *A. deflandrei* die zentralen Teile des basalen Schildes das Zentrafeld innerhalb des Granulaeringes ganz ausfüllen oder längs der längeren Ellipsenachse eine Spalte offen lassen, ist es bei *W. barnesae* schwierig zu entscheiden, ob die das kleine Zentrafeld füllenden Granulae die Spitzen der basalen Elemente sind oder ob sie diese als selbständige Elemente überlagern.

**Vorkommen:** Weltweit verbreitet im Mesozoikum, vor allem in der Kreide.

#### Genus *Ellipsagelosphaera* NOEL 1965

Generotypus: *Ellipsagelosphaera communis* (REINHARDT 1964) n. comb.

REINHARDT (1966 b) hat *Ellipsagelosphaera* NOEL 1965 als Synonym von *Watznaueria* REINHARDT 1964 betrachtet. Da ich *Ellipsagelosphaera* beibehalte ergeben sich gegenüber seinen Namenkombinationen einige Änderungen, die hier angeführt seien, auch wenn die Formen nicht im untersuchten Material gefunden wurden.

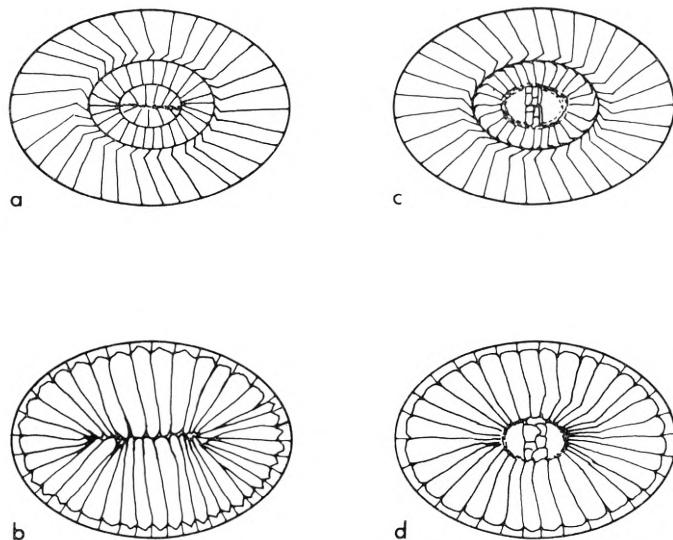


Fig. 33. Schematische Zeichnungen von *Watznaueria barnesae* (a distal, b basal), und *Ellipsagelosphaera communis* (c distal, d basal).

*Ellipsagelosphaera communis* (REINHARDT 1964) n. comb.

1964\* *Watznaueria communis* REINHARDT: 756, Taf. 2:5; Abb. 6.

1965\* *Ellipsagelosphaera frequens* NOEL: Fig. 35–40; Taf. 11:7–10, Taf. 12:1–10, Taf. 13:1–10.

*Ellipsagelosphaera britannica* (STRADNER 1963) n. comb.

1963 *Coccolithus britannicus* STRADNER: 10, Taf. 1:7.

1964\* *Watznaueria britannica* (STRADNER 1963) REINHARDT: 753, Taf. 2:3; Abb. 5.

1965\* *Ellipsagelosphaera lucasi* NOEL: 126, Fig. 41, 42; Taf. 11:1–6.

1965\* *Coccolithus britannicus* STRADNER 1963 in BLACK: 132, Fig. 6.

1966a\* *Watznaueria britannica* (STRADNER 1963) REINHARDT 1964 in REINHARDT: 17, Taf. 4:7 a, b; Bild. 4 a, b.

Genus *Markalius* BRAMLETTE & MARTINI 1964 emend.

Generotypus: *Markalius inversus* (DEFLANDRE 1954) BRAMLETTE & MARTINI 1964

Das von BRAMLETTE & MARTINI (1964) publizierte Elektronenmikroskopbild von *M. inversus* gehört meines Erachtens nicht zu dieser Art, wie sie im Lichtmikroskop definiert wurde. Da der Holotypus von *M. inversus* eine Lichtmikroskopaufnahme ist, halte ich mich im folgenden an die Coccolithen, die ich im Lichtmikroskop als *M. inversus* erkennen konnte, und die ich anschliessend im Elektronenmikroskop wiederfinden konnte. Die von BRAMLETTE & MARTINI von ihrer Elektronenmikroskopaufnahme abgeleiteten Merkmale haben für den Gattungsbegriff keine Bedeutung und ich emendiere deshalb *Markalius* wie folgt.

**Diagnose:** Runde Coccolithen mit zwei Randscheiben. Die distale Randscheibe besteht aus fächerförmig angeordneten Platten, die einen Kegelstumpf bilden. Die basale Randscheibe besteht aus Keilen oder Säulen, die das Zentrum des Coccolithen fast oder ganz erreichen. Verschiedene Elemente können basal und distal das Zentralfeld bedecken. Kein „Tubus“.

Damit ist die Diagnose erweitert worden, sodass *Markalius* nicht mehr monotyp bleibt sondern ihm zwei andere Arten beigegeben werden können, für die sonst ein neuer Genus hätte geschaffen werden müssen.

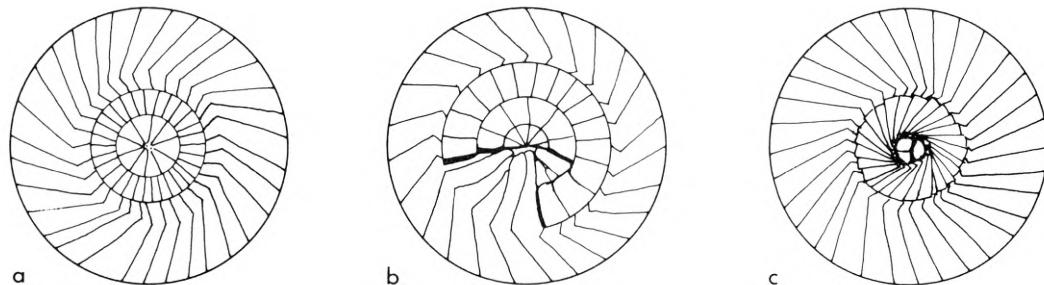


Fig. 34. Schematische Zeichnungen der Markaliusarten *M. inversus* (a), *M. circumradiatus* (b) und *M. reinhardti* (c), alle in distaler Sicht. Bei *M. circumradiatus* sind in einem Viertel die zentralen Elemente weggelassen.

#### *Markalius inversus* (DEFLANDRE 1954) BRAMLETTE & MARTINI 1964

Fig. 35; Taf. 24, Fig. 1–8; Taf. 25, Fig. 1

- 1954 *Cyclococcolithus leptoporus* MURRAY & BLACKMAN var. *inversus* DEFLANDRE in DEFLANDRE & FERT: 150, Taf. 9:4, 5 NON 6,7.
- 1963 *Cyclococcolithus astroporus* STRADNER: 75, Taf. 9:5–7, Fig. 3 (2 a, b).
- 1964 *Markalius inversus* (DEFLANDRE 1954) BRAMLETTE & MARTINI: 302, Taf. 2:4–9. NON Taf. 7:2 a, b.
- 1966\* *Cyclococcolithus inversus* DEFLANDRE 1954 in HAY et al.: 389, Taf. 7:2.

**Beschreibung:** Wie aus den abgebildeten Exemplaren hervorgeht, besteht die distale Randscheibe aus fächerförmig angeordneten Platten, die einen Kegelstumpf aufbauen. Von dessen innerem Rand fallen die Randelemente trichterförmig gegen das Zentrum ein. Im Inneren des flachen Trichters befinden sich zwei Granulaeringe, wobei der innerste das Zentrum überdeckt. Die basale Seite besteht aus einer Randscheibe, die aus kegel- oder säulenförmigen Elementen aufgebaut ist, die nicht ganz radial angeordnet sind. Die basale Randscheibe ist kleiner als die distale und senkt sich ebenfalls trichterförmig gegen die Mitte ein. Diese wird hier von einer kleineren Scheibe keilförmiger Elemente überlagert, in deren Zentrum einige Granulae sitzen.

**Coccospaere:** Die Coccospaere (Taf. 24, Fig. 2; Taf. 25, Fig. 1) trägt 8–? Coccolithen, die sich gegenseitig randlich überlappen. Ihr Umriss ist kugelig bis ellipsoid.

**Bemerkungen:** *M. inversus* unterscheidet sich von *Cyclagelosphaera margereli* NOEL 1965 durch das Fehlen eines „Tubus“, von *M. circumradiatus* (STOVER 1966)

n. comb. und *M. reinhardtii* n. sp. durch die verschiedenen Zentraffelder und durch die verschiedene Orientierung der distalen Randelemente, was ein unterschiedliches Verhalten zwischen gekreuzten Nicols zur Folge hat.

Vorkommen: Maastrichtien und Danien von Dänemark; weltweit verbreitet in der Kreide und dem Alttertiär.

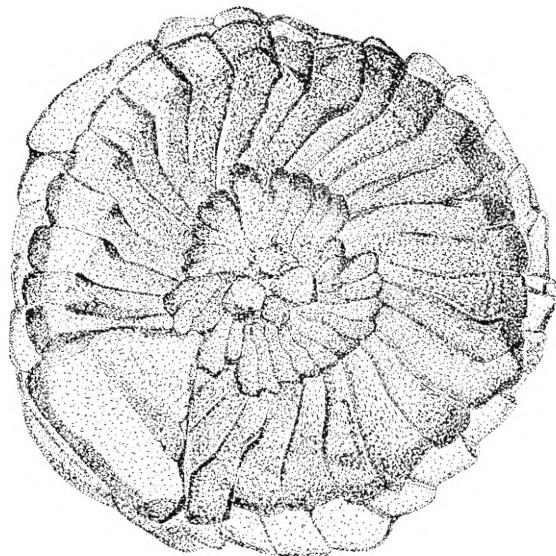


Fig. 35. *Markalius inversus* (DEFLANDRE) BRAMLETTE & MARTINI. Basale Ansicht eines Exemplares aus dem unteren Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

#### *Markalius circumradiatus* (STOVER 1966) n. comb.

Fig. 36, 37; Taf. 25, Fig. 2–7; Taf. 26, Fig. 1–7

? 1954 *Cyclococcolithus cf. leptoporus* MURRAY & BLACKMAN in DEFLANDRE & FERT: 36, Taf. 9:8, 9.

1966 *Coccolithites circumradiatus* STOVER: 138, Taf. 5:2–4, Taf. 9:10 (?).

Die Beschreibung und Abbildung im Lichtmikroskop von *M. circumradiatus* STOVER 1966 passt recht gut auf eine Form, die hie und da im untersuchten Material auftritt. Leider steht mir von dem Material (Albien von Holland), aus dem der Holotypus beschrieben wurde, nichts zur Verfügung, sodass die Identität der Formen nicht mit der wünschbaren Sicherheit festgestellt werden konnte. Anchliessend soll für die hier im Elektronenmikroskop und im Lichtmikroskop bestimmte Form eine neue Diagnose und Beschreibung gegeben werden.

Diagnose: Runder Coccolith, bestehend aus zwei Randscheiben, die sich im Zentrum durchdringen können. Die distale Scheibe besteht aus fächerförmig angeordneten Platten, die einen niedrigen Kegelstumpf bilden und deren Ausläufer ins Zentrum reichen. Die basale Randscheibe besteht aus Säulen, die gegen den Uhrzeigersinn von der radialem Orientierung abgedreht sind. Sie wachsen im Zentrum

mit den distalen Elementen zusammen. Das Zentrafeld der distalen Seite kann Granulaeringe tragen.

**Beschreibung:** Die distale Seite der Coccolithen wird durch einen Kranz von plattenförmig erscheinenden Elementen gebildet, die dextral einfallen. Einige dieser Elemente verbreitern sich, gleichzeitig in der anderen Dimension verdünnernd, zu Säulen, die in den zentralen Teil des Coccolithen vordringen und diesen grösstenteils ausfüllen. Von der höchsten Stelle des Randes des niedrigen Kegelstumpfes fallen die

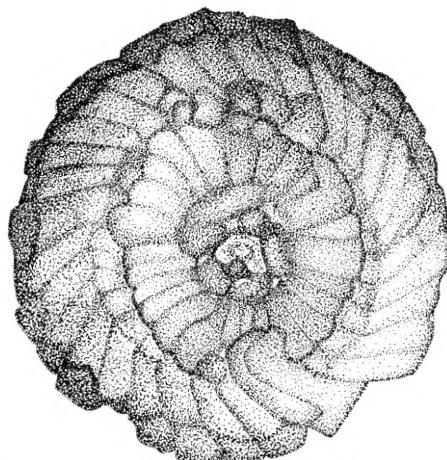


Fig. 36. *Markalius circumradiatus* (STOVER) n. comb. Distale Ansicht eines Exemplares, dessen Zentrafeld fast gänzlich durch Platten überdeckt ist. Unteres Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

Elemente zuerst etwas gegen das Zentrum ab um dann als Säulen ungefähr horizontal zu verlaufen. Im so entstehenden Knick können Elemente angelagert sein, die einen Kranz bilden. An einigen Exemplaren ist der Kranz vollständig, an anderen ist er nur noch in Bruchstücken vorhanden und an einigen fehlt er ganz, wie z.B. an der Cocco-sphaere Taf. 26, Fig. 1. Endlich können, wie am Exemplar Taf. 26, Fig. 3. Granulæ erhalten sein, die das Zentrum ganz bedecken und die in der Mitte eine seichte Vertiefung bilden. Bei sehr schlecht erhaltenen Exemplaren kann das Mittelstück ausgebrochen sein. Die basale Seite wird durch Säulen aufgebaut, die gegen den Uhrzeigersinn gedreht sind und im zentralen Raum zu annähernd radialer Orientierung abknicken. An Taf. 25, Fig. 5, die eine basale Seite wiedergibt, ist die äusserste Randpartie an einer Stelle abgebrochen. Hier ist ersichtlich, auf wie kurzer Strecke die beiden Randscheiben „selbständige“ sind und voneinander abstehen. Sie fügen sich schon zusammen, bevor sie das auch auf der basalen Seite eingetiefte Zentrafeld erreichen, ohne dass dadurch die Oberflächen der beiden Seiten des Zentrafeldes des Coccolithen identisch werden.

Die Anzahl der Randelemente variiert, ebenso die Grösse des Coccolithen, die im Durchschnitt jedoch hinter derjenigen von *M. inversus* zurückbleibt. Im Lichtmikroskop erscheint *M. circumradiatus* als runde Form mit fast radialen, gegen den

Uhrzeigersinn abgedrehten Strahlen und einer untergeordnet erscheinenden konzentrischen Einteilung. Zwischen gekreuzten Nicols hellt er in allen durch ein Auslöschungskreuz getrennten Quadranten gleichzeitig auf. Das Kreuz, das im innersten Teil ausbiegt, läuft beim Drehen des Objektisches gleichmässig über den ganzen Coccoolithen.

Coccospaere: Die Coccospaere ist kugelig und besteht aus 12 Coccoolithen, die je eine Fläche eines Pentagondodekaeders einnehmen. Sie gleicht damit der Cocco-

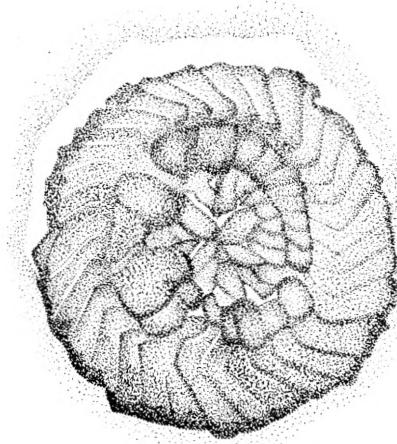


Fig. 37. *Markalius circumradiatus* (STOVER) n. comb. Distale Ansicht eines Exemplares, dessen Zentrafeld nur teilweise mit Platten überdeckt ist. Unteres Maastrichtien von Mon. Vergrösserung ca. 7500×.

sphaere von *Tergestiella adriatica* KAMPTNER 1941 aus dem Mittelmeer. In den dreieckigen Zwischenräumen zwischen den Coccoolithen und unter einem ausgebrochenen Zentrafeld ahnt man eine weitere Lage mit Coccoolithen.

Bemerkungen: *M. circumradiatus* unterscheidet sich schon im Lichtmikroskop deutlich von *M. inversus*. Zwischen gekreuzten Nicols hellt *M. inversus* nur unvollständig auf und im zentralen Raum zeigt er in distaler Sicht Aufhellung mit einem Auslöschungskreuz, während in basaler Sicht das Kreuz so verbreitert wird, dass nur in jedem Quadranten ein kleines Segment aufhellt. Die Orientierung der Randelemente ist bei *M. inversus* und *M. circumradiatus* entgegengesetzt. Die Coccospaeren der beiden Arten sind ebenfalls verschieden, indem sich die Coccoolithen bei *M. inversus* gegenseitig überlagern, während sie sich bei *M. circumradiatus* nur berühren. *Coccolithus leptoporus* hat, wenn mit dem Elektronenmikroskopbild von BLACK (1961) verglichen wird, distale Randelemente, die sich als solche länger ins Zentrum erstrecken und dort steil zu einer Öffnung abfallen, ohne Platz für Granulaekränze zu lassen. Sie fallen sinistral ein und bilden eine Scheibe, die die basale um mehr überragt als bei *M. inversus* oder *M. circumradiatus*.

Vorkommen: Unteres Maastrichtien von Mon; Albien bis Turonien von Holland.

*Markalius reinhardtii* n. sp.

Fig. 38; Taf. 23, Fig. 6–8

Pro parte 1966a\* *Tergestiella barnesae* (BLACK 1959) REINHARDT: Taf. 1:1, 2; Bild 2.

Holotypus: Taf. 1, Fig. 2 in REINHARDT 1966 a.

Masse des Holotypus: Durchmesser: ca. 5,5  $\mu$ .

Locus typicus: Rügen, Kreidewerk Sassnitz, Deutschland.

Stratum typicum: Unteres Maastrichtien.

**Diagnose:** Runder Coccolith mit zwei Randscheiben. Die distale Scheibe besteht aus dextral einfallenden Platten. Im Zentrum erhebt sich ein Kranz aus



Fig. 38. *Markalius reinhardtii* n. sp. Distale Ansicht eines beschädigten Exemplares aus dem unteren Maastrichtien von Mön. Vergrößerung ca. 7500  $\times$ .

entgegengesetzt orientierten Platten, die von Granulae überdeckt sein können. Die basale Scheibe besteht aus dextral abgebogenen Säulen.

**Beschreibung:** Die Elemente der distalen Randscheibe fallen dextral ein und bilden einen Kegelstumpf. Der innere Durchmesser des Kegelstumpfes misst knapp 60 % des äusseren. Über der Mitte folgt ein weiterer Kranz aus Platten, die den Randplatten entgegengesetzt orientiert sind. Sie ragen ebenfalls kegelförmig auf und auf ihrem oberen Rand können Granulae sitzen. Die basale Seite ist nur aus der „Durchsicht“ bei distalen Aufnahmen bekannt, da diese hohen, auch gesamthaft kegelförmigen Formen sich kaum je bei der Sedimentation auf den Formvarfilm auf die Spitze legen. Es lassen sich Säulen erkennen, die in basaler Sicht entgegen dem Uhrzeigersinn von der radialen Richtung abweichen.

Die Coccospaere besteht aus etwa 12 Coccolithen, die sich randlich überschneiden (Taf. 1, Fig. 1 in REINHARDT 1966 a).

**Bemerkungen:** Die neue Art unterscheidet sich von *M. inversus* durch die inverse Orientierung der Randelemente der jeweiligen Randscheiben und durch das

Zentralfeld, das bei *M. inversus* eingesenkt ist, während es sich bei *M. reinhardtii* als Kegel über den Rand erhebt und manchmal durch einen seichten Graben von ihm getrennt ist. Von *M. circumradiatus* unterscheidet sich die neue Art durch ihren breiteren Randsaum und durch das kegelförmige Zentralfeld gegenüber dem flach trichterförmigen bei *M. circumradiatus*. Die Anordnung der Coccoolithen auf der Coccopshaere ist bei *M. inversus* und *M. reinhardtii* ähnlich: die einzelnen Coccoolithen überlagern sich randlich. Bei *M. circumradiatus* tangieren sich die Coccoolithen nur.

Im Lichtmikroskop verhält sich *M. reinhardtii* zwischen gekreuzten Nicols ähnlich wie *M. circumradiatus*. Sein Zentralfeld erscheint jedoch bedeutend dicker als bei letzterem.

Als Holotypus wurde REINHARDTS Abbildung gewählt, weil die Exemplare aus der Rügener Kreide besser erhalten sind als diejenigen, die ich auf Møn finden konnte. REINHARDTS Bestimmung dieser Form als *Tergestiella barnesae* (BLACK) REINHARDT soll anhand nachstehender Aufstellung über die distale Ansicht widerlegt werden.

<i>W. barnesae</i>	<i>M. reinhardtii</i>
elliptisch	rund
Zentralfeld mit 1–2 Kränzen aus neben-einander liegenden Granulae	Zentralfeld mit einem Kranz schrägstehen-der, sich überlagernder Platten
leicht vertieftes Zentralfeld	kegelförmiges Zentralfeld

Vorkommen: Unteres Maastrichtien von Rügen und Møn.

#### Unterfamilie *Discorhabdoideae* NOEL 1965

Coccoolithen aus zwei oder mehr Randscheiben, die aus nebeneinanderliegenden und ineinander greifenden Elementen gebildet werden. Kleines Zentralfeld.

#### Genus *Biscutum* BLACK 1959

Generotypus: *Biscutum constans* (GORKA 1957) BLACK 1967

Die ursprüngliche Diagnose von *Biscutum* erwähnt imperforate Coccoolithen, die aus mehr als einer Lage von Platten bestehen und wo die Platten der einen Lage eng an die Platten der anderen Lage oder Lagen anliegen. Es wird nicht erwähnt, ob die Coccoolithen rund oder elliptisch sein sollen. Dagegen enthält die Diagnose des Generotypus die Beschreibung des Umrisses der Art als elliptisch. REINHARDT (1966 a) kann den Genus deshalb nicht auf circuläre Arten beschränken, da er sonst den Generotypus ausschliesst. Wenn aber *Biscutum* elliptische Formen enthält kann die Form nicht mehr als ein Unterscheidungsmerkmal gegenüber *Cribrophaerella* gebraucht werden, wie dies REINHARDT (1966 a) vorschlug. Es bleibt aber noch das minime Zentralfeld von *Biscutum* gegenüber dem grossen, granulaten und perforaten

von *Cribrosphaerella*. Die Gattung *Biscutum* BLACK braucht deshalb nicht emendiert zu werden, wie dies REINHARDT (1966 a:30) getan hat.

Bis jetzt sind meines Wissens 4 Arten zu *Biscutum* gestellt worden. Die runde Form, *Biscutum tredenale* REINHARDT 1965, wird hier zu *Discorhabdus* NOEL 1965 gestellt. Neben dem Generotypus *B. testudinarium* hat BLACK (1959) eine weitere Art in *Biscutum* aufgestellt, *B. castrorum*, und hat eine von GORKA (1957) beschriebene Form als *B. constans* (GORKA) BLACK 1967 beschrieben.

*Biscutum constans* (GORKA 1957) BLACK 1967

Fig. 39; Taf. 27, Fig. 1-11

- 1957 *Discolithus constans* GORKA: 279, Taf. 4:7.
- 1957 *Discoaster floridus* GORKA: 283, Taf. 5:11.
- 1959\* *Biscutum testudinarium* BLACK: 325, Taf. 10:1.
- 1963 *Coccolithus cf. C. tenuis* KAMPTNER 1937 in CARATINI: 42, Taf. 4:71, 72.
- 1964\* *Cribrosphaerella tectiforma* REINHARDT: 758, Taf. 2:4.
- NON 1966a\* *Biscutum testudinarium* BLACK 1959 in REINHARDT: 30, Taf. 19:1.
- 1967 *Coccolithus oregus* STOVER: 139, Taf. 1:8, 9; Taf. 8:4.

Bemerkungen: 1967 hat BLACK zwei von GORKA (1957) beschriebene Formen der Gattung *Biscutum* zugesellt als eigene Art. Da aber in GORKAS Typusmaterial die von BLACK (1959) als *B. testudinarium* beschriebene Form mit 16 Randelementen gefunden werden konnte, gebührt *B. constans* Priorität vor *B. testudinarium*.

Die in der Kreide von Møn gefundenen Exemplare dieser Art haben 13–20 Elemente, die die Randscheiben aufbauen. Auf der distalen Seite deckt die grössere

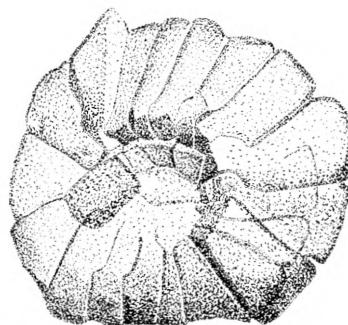


Fig. 39. *Biscutum constans* (GORKA) BLACK. Distale Ansicht eines leicht beschädigten Exemplares aus dem unteren Maastrichtien von Møn. Vergrösserung ca. 7500×.

Randscheibe die kleinere, basale zu und lässt nur im Zentrum manchmal deren innerste Teile in einer elliptischen, flach trichterförmigen Vertiefung hervortreten. Der basalen Randscheibe sind in der Mitte oft Granulae angelagert.

REINHARDT (1964, 1966 a) erwähnt für *Cribrosphaerella tectiforma* ca. 20 Randelemente und zwei gleichgroße Randscheiben. Er gibt jedoch sowohl 1964 als auch

1966 a nur Abbildungen der als distal benannten Seite des Coccolithen. Hier verdecken jedoch die Elemente der grösseren Randscheibe diejenigen der kleineren. 1967 a erwähnt er 30 Randblättchen, was jedoch ein Druckfehler sein dürfte.

STOVER (1966) zählte an seinem *Coccolithus oregus* 14–20, meist 16 Randblättchen und zeichnete Taf. 8:4 deren 32.

**Vorkommen:** Unterer Maastrichtien von Mön; weltweit verbreitet in der oberen Kreide. Vereinzelt auch im Danien von Dänemark.

*Biscutum castrorum* BLACK 1959

Fig. 40; Taf. 28, Fig. 1–5

1959 *Biscutum castrorum* BLACK in BLACK & BARNES: 326, Taf. 10:2.

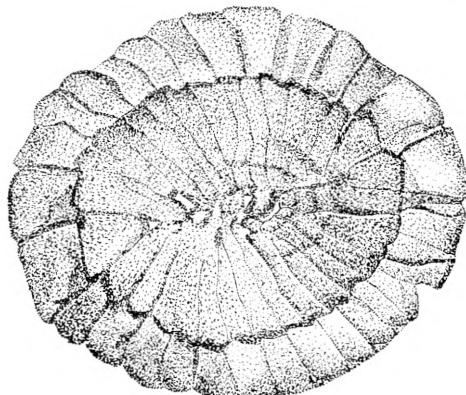


Fig. 40. *Biscutum castrorum* BLACK. Basale Ansicht eines Coccolithen aus dem unteren Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

**Bemerkungen:** *B. castrorum* ist *B. constans* sehr ähnlich. Nach BLACK (1959) sind bei *B. castrorum* die die Randscheiben aufbauenden Elemente schlanker und zahlreicher. *B. castrorum* ist denn auch durchgehend grösser als *B. constans*, wenn wir die Grenze bei 22 Randelementen setzen (der Holotypus hat soviele). In einer Darstellung des Verhältnisses von Elementanzahl zur Länge der Coccolithen gruppieren sich die Werte nur undeutlich in zwei Felder. Die Anzahl der gemessenen Exemplare ist jedoch nicht gross genug, um einerseits die Zusammenlegung der beiden Arten oder andererseits deren Beibehaltung zu motivieren; ich ziehe vorläufig vor, den status quo beizubehalten.

*Biscutum castrorum* erscheint nicht selten als perforate Form, indem der zentrale, dünne Teil ausgebrochen ist.

**Vorkommen:** Unterer Maastrichtien von Mön; weltweit verbreitet in der oberen Kreide.

*Biscutum asymmetricum* n. sp.

Taf. 23, Fig. 2, 3, 13–15

Holotypus: Taf. 23, Fig. 2 (K. P.-N. 54/3).

Masse des Holotypus: Länge: ca. 6,5  $\mu$ , Breite: ca. 5  $\mu$ .

Locus typicus: Møn, B 22.

Stratum typicum: Unteres Maastrichtien.

**Diagnose:** Elliptische Coccolithen mit zwei Randscheiben. Die distale Randscheibe besteht aus nebeneinanderliegenden, etwas ineinander greifenden Elementen und bildet einen Kranz auf der basalen Scheibe, die aus Säulen besteht, die im Zentrafeld gegen den Uhrzeigersinn von der radialen Richtung abknicken und an der längeren Ellipsenachse meist zwei Durchbrüche offen lassen.

**Beschreibung:** Der distale Schild ist aus einer variablen Anzahl  $\pm$  radial stehenden Elementen zusammengesetzt, die nebeneinander liegen und leicht ineinander greifen. Die basale Seite des Coccolithen ist eingetieft und durch einen Säulenring gebildet. Die Säulen sind im Randbereich radial gerichtet und knicken im zentralen Bereich ab. Im Zentrum des Coccolithen, der oft einen unregelmässigen Umriss hat, treffen sich die Elemente der basalen Randscheibe auf kurzer Strecke und lassen oft innerhalb, in oder ausserhalb der Brennpunkte der Ellipse zwei Durchbrüche offen.

**Bemerkungen:** *B. asymmetricum* wird zu *Biscutum* gestellt, trotzdem diese Gattung als imperforat definiert worden ist, da nicht entschieden werden kann, ob die Durchbrüche primär sind oder ob sie nur durch Ausbrechen von Stücken der Elemente der basalen Randscheibe entstanden sind. *B. asymmetricum* nahe stehen dürfte *Biscutum polycingulatum* (REINHARDT 1965) n. comb. *B. polycingulatum* hat nach REINHARDT einen „Zentralring“ (?). Im recht grossen Zentrafeld der distalen Ansicht des Coccolithen in REINHARDT (1965:Taf. 3:4) stehen die Elemente radial, während sie bei *B. asymmetricum* fast diagonal stehen.

Eine weitere Art, die im Elektronenmikroskop in *Biscutum* beschrieben worden ist, ist *B. tredenale* REINHARDT 1965. Da sie circulär ist, muss sie aus der Gattung verstoßen werden, die REINHARDT als runde Formen enthaltend aufgefasst hat. Es zeigt sich hier die Schwierigkeit, dass einander sehr ähnliche Formen wegen ihrem Umriss zu verschiedenen Gattungen gestellt werden müssen. Theoretisch können wir *B. constans* oder *B. castrorum* schrumpfen lassen, indem wir uns die Randelemente, die senkrecht zur längeren Ellipsenachse stehen nach und nach entfernt denken, bis wir nur noch eine runde Form übrig haben. Dann sollten die runden Formen aber durchgehend weniger Randelemente besitzen als die elliptischen, was nicht der Fall ist.

**Vorkommen:** Unteres Maastrichtien von Møn.

*Biscutum? supraretaceum* (REINHARDT 1965) n. comb.

Taf. 23, Fig. 9–12

1965 *Coccolithites supraretaceus* REINHARDT: 40, Taf. 2:7, 8.

Bemerkungen: REINHARDT (1965, 1966 a) hat diese Art aus dem oberen Albien und Turonien nur im Lichtmikroskop beschrieben und die Zuweisung der hier abgebildeten Form ist unsicher. Das Verhalten des Exemplares im Lichtmikroskop und zwischen gekreuzten Nicols das REINHARDT (1966 a:20) beschreibt, passt nicht recht mit der Form überein, die hier aus dem Maastrichtien von Møn abgebildet wird und deren Verhalten im Lichtmikroskop ebenfalls abgebildet wird. Das Verhalten zwischen gekreuzten Nicols ist dasselbe, doch konnte ich keinen zentralen Buckel beobachten und auch das Elektronenmikroskopbild zeigt zentral keinen Buckel sondern eine Eintiefung.

Vorkommen: Unteres Maastrichtien von Møn; Oberes Albien und Turonien von Deutschland.

Genus *Discorhabdus* NOEL 1965

Generotypus: *Discorhabdus patulus* (DEFLANDRE 1954) NOEL 1965

*Discorhabdus* wurde aufgestellt für Arten mit einer runden Basalscheibe aus zwei aneinander liegenden Scheiben und einer Öffnung, durch die der granulat Fortsatz stossen kann. NOEL hat darin als Basalscheiben von *Discorhabdus* auch Formen untergebracht, deren Fortsatz abgebrochen war. Wie ich an anderer Stelle dargelegt habe, anerkenne ich die An- oder Abwesenheit eines Fortsatzes nicht als Gattungen oder Arten bestimmendes Merkmal und stelle daher die untenstehenden Arten zu dieser Gattung, obschon sie nicht in Verbindung mit einem Fortsatz gefunden wurden. Ich fand auch keine Anzeichen, dass je ein Fortsatz vorhanden war, obschon dies ja nie mit Sicherheit ausgeschlossen werden kann.

*Discorhabdus ignotus* (GORKA 1957) n. comb.

Fig. 41, 42; Taf. 28, Fig. 6-9

- 1957 *Tremalithus ignotus* GORKA: 248, Taf. 2:9.
- 1957 *Tremalithus postremus* GORKA: 248, Taf. 2:10.
- 1957 *Tremalithus similis* GORKA: Taf. 2:1.
- 1957 *Tremalithus pulaviensis* GORKA: 271, Taf. 2:2.
- 1965\* *Biscutum tredenale* REINHARDT: 32, Taf. 1:3, Abb. 2.
- 1966a\* *Biscutum tredenale* REINHARDT in REINHARDT: 31, Taf. 2:3 a, b; Bild 13.

Bemerkungen: Im Material, das GORKA (1957) bearbeitet hat, konnten nur runde Formen gefunden werden, die aus zwei Randscheiben aus nebeneinanderliegenden Elementen bestehen. GORKA (1957) beschrieb 4 Arten, die alle zwischen 4 und 5  $\mu$  messen und einen glatten oder radial unterteilten Rand haben und deren Zentrum glatt oder strukturiert ist. Da drei der genannten Arten in GORKAS Material nach der Autorin häufig sind und die vierte nicht selten, andererseits im Elektronenmikroskop nur eine Form gefunden wurde, kann angenommen werden, dass die 4 Arten Erhaltungszustände darstellen, die im Lichtmikroskop als verschiedene Arten gedeutet wurden. Ich fasse daher die 4 Arten unter der einen zusammen.

1965 hat REINHARDT dieselbe Form als *Biscutum tredenale* aus dem Maastrichtien von Deutschland beschrieben und elektronenoptisch abgebildet.

*D. ignotus* besteht aus zwei aneinander liegenden Randscheiben, die aus einer variierenden Anzahl nebeneinander liegenden Elementen bestehen. Die distale Scheibe überragt die basale allseitig und ihre Elemente sind gegenüber denen der Basalscheibe verschoben. Die beiden Randscheiben bilden einen Schild, der in der Mitte durchbrochen sein kann, wenn die ausgedünnten Teile der Randelemente, die sonst den kleinen Zentralraum ausfüllen, ausgebrochen sind. Die zentrale kleine Eintiefung wird

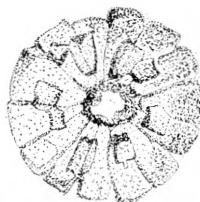


Fig. 41. *Discorhabdus ignotus* (GORKA) n. comb. Beschädigtes Exemplar aus dem unteren Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

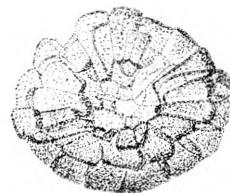


Fig. 42. *Discorhabdus ignotus* (GORKA) n. comb. Schräge Ansicht eines Coccoolithen aus dem unteren Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

in gut erhaltenen Exemplaren von 4 Granulae eingenommen, die zu einem Kreuz zusammenstehen, von denen aber oft auch nur 1 bis 3 erhalten sind.

Im Lichtmikroskop erscheint *D. ignotus* zart und hellt zwischen gekreuzten Nicols kaum auf, wenn er flach liegt. Die Randelemente der distalen Scheibe sind manchmal verschieden lang (Erhaltungszustand?) und geben dem Cocco lithen ein zerzaustes Aussehen.

Vorkommen: Unterer Maastrichtien von Mön; weltweit verbreitet im Maastrichtien.

### 3.4. Familie *Microrhabdulaceae* DEFLANDRE 1963.

DEFLANDRE (1963) hat diese Familie geschaffen, um die zahlreichen isolierten Stäbe, die keine Basalplatte besitzen oder die nicht in Zusammenhang mit einer Basalplatte und damit einer Art der Cocco lithen gebracht werden können, einordnen zu können. Er nahm an, dass einige davon selbständige, komplett Nannofossilien darstellen.

Im folgenden möchte ich diejenigen Stäbe hier einordnen, deren Zuordnung zu einer Art der bisher beschriebenen Familien nicht möglich ist.

Genus *Microrhabdulus* DEFLANDRE 1959 emend. DEFLANDRE 1963Generotypus: *Microrhabdulus decoratus* DEFLANDRE 1959

Die Formen der Familie der *Microrhabdulaceae* sind elektronenoptisch noch schlecht bekannt. So fehlen meines Wissens Elektronenmikroskopaufnahmen der Generotypen der Gattungen *Lithraphidites*, *Microrhabdulinus* und *Microrhabduloidus*. Es ist deshalb noch zu früh, die Genera neu zu definieren. Ich ordne deshalb alle aus kürzeren oder längeren Latten bestehenden Formen mit ± rundem Querschnitt in *Microrhabdulus*, der typischen Gattung der Familie, ein.

*Microrhabdulus decoratus* DEFLANDRE 1959

Taf. 30, Fig. 10, 11

1959 *Microrhabdulus decoratus* DEFLANDRE: 140, Taf. 4:1–5.1966a\* *Microrhabdulus decoratus* REINHARDT: Taf. 16:5. NON Taf. 16:2.

Bemerkungen: *M. decoratus* ist im Lichtmikroskop leicht an der für ihn charakteristischen Aufhellung in Feldern zwischen gekreuzten Nicols zu erkennen. Im Elektronenmikroskop unterscheidet er sich von anderen ähnlichen isolierten Stäben dadurch, dass die ihn aufbauenden Lamellen in Ringen angeordnet sind. Die Lamellen überlagern sich in der Längsrichtung kaum, sondern sind durch einen Absatz voneinander getrennt. Sie sind auch seitlich voneinander durch einen Graben getrennt, sodass der Stab aus dicken Zahnrädern, die übereinander gestapelt sind, aufgebaut erscheint. *M. decoratus* konnte nicht in Verbindung mit einer Basalplatte gefunden werden. An dem von REINHARDT (1966 a) abgebildeten Exemplar und an dem Taf. 30, Fig. 10 dargestellten trägt der Stab am einen Ende eine granulare Anordnung von Elementen, die vielleicht von einer Basalplatte herausgebrochen wurde.

Vorkommen: Unteres Maastrichtien von Mön; weltweit verbreitet in der Oberen Kreide. Selten im oberen Maastrichtien.

*Microrhabdulus attenuatus* (DEFLANDRE 1959) DEFLANDRE 1963

Taf. 30, Fig. 1, 5–9

1959 *Microrhabdulus decoratus* var. *attenuatus* DEFLANDRE: 441, Taf. 4:6–8.1963 *Microrhabdulus attenuatus* (DEFLANDRE 1959) DEFLANDRE: 3486, Fig. 11.1963 *Microrhabdulus* aff. *helicoideus* DEFLANDRE 1959 in STRADNER: 13, Taf. 4:15.1964 *Microrhabdulus stradneri* BRAMLETTE & MARTINI: 316, Taf. 6:3, 4.1966a\* *Microrhabdulus attenuatus* (DEFLANDRE 1959) DEFLANDRE 1963 in REINHARDT: 42, Taf. 16:1.1966a\* *Microrhabdulus decoratus* DEFLANDRE 1959 in REINHARDT, Taf. 16:2, NON Taf. 16:5.

Bemerkungen: Neben dem Holotypus von *M. attenuatus*, der aus dem Santonien von Texas stammt, hat DEFLANDRE (1959) ein Exemplar von Mioti-Grodno, (ehemals Polen), abgebildet. Exemplare dieser Art konnten in Probematerial dieser Lokalität gefunden werden und mit Exemplaren von *M. stradneri* BRAMLETTE &

MARTINI 1964, aus dessen Typusmaterial von Bellocq, Frankreich, verglichen werden. Trotzdem die Exemplare, die ich im Licht- und im Elektronenmikroskop beobachten konnte, nicht sehr gut erhalten sind, glaube ich, dass die beiden Arten identisch sind. *M. attenuatus* wird als älterer Namen beibehalten.

*M. attenuatus* unterscheidet sich von *M. decoratus* oft schon durch seine äussere Form: langgestreckt, an beiden Enden spitz auslaufend. An der Oberfläche ist er aus Latten aufgebaut, die sich paarweise der Länge nach ineinander verzahnen und in einem Winkel zueinander stehen. Ein Stab besteht aus ca. 12 Lattenreihen, die parallel verlaufen.

Vorkommen: Unteres Maastrichtien von Mön; weltweit verbreitet in der oberen Kreide.

*Microrhabdulus* sp.

Taf. 30, Fig. 2-4

1966a\* *Lucianorhabdus* sp. in REINHARDT: Taf. 16:4.

Bemerkungen: Die als *Microrhabdulus* sp. hier abgebildeten langen Stäbe sind im untersuchten Material in einigen Proben recht häufig. Sie bestehen aus Latten, die neben- und übereinander liegen und dieselbe Länge wie der Stab haben. Der Stab verjüngt sich am einen Ende und weicht darin von den Fortsätzen von *Deflandrius spinosus* BRAMLETTE & MARTINI 1964 ab, dessen Stäbe gleichmässiger dick sind und nicht so lang werden wie *Microrhabdulus* sp. Im Lichtmikroskop fällt *Microrhabdulus* sp. vor allem zwischen gekreuzten Nicols auf, wo er auf der ganzen Länge längs geteilt aufhellt oder auslöscht.

Vorkommen: Unteres Maastrichtien von Mön und Rügen.

Genus *Lithraphidites* DEFLANDRE 1963

Generotypus: *Lithraphidites carniolensis* DEFLANDRE 1963

*Lithraphidites* umfasst diejenigen Stäbe, die aus gleichorientierten Elementen bestehen, die dem Stab einen kreuzförmigen Querschnitt geben.

*Lithraphidites quadratus* BRAMLETTE & MARTINI 1964

Taf. 25, Fig. 8, 9

1964\* *Lithraphidites quadratus* BRAMLETTE & MARTINI: 310, Taf. 6:16, 17; Taf. 7:8.

Bemerkungen: *L. quadratus* wurde bereits von BRAMLETTE & MARTINI in einer Elektronenmikroskopaufnahme vorgestellt. Er ist im untersuchten Material selten, sonst aber häufig und auch im Lichtmikroskop leicht zu erkennen.

Vorkommen: Maastrichtien von Dänemark; weltweit verbreitet im Maastrichtien.

Genus *Lucianorhabdus* DEFLANDRE 1959  
 Generotypus: *Lucianorhabdus cayeuxi* DEFLANDRE 1959

Stäbe mit unregelmässigem Umriss, die aus 4 parallelen, länglichen Elementen bestehen. Die Elemente sind längs einer geraden oder gekrümmten Naht zusammen gewachsen.

*Lucianorhabdus cayeuxi* DEFLANDRE 1959

Taf. 30, Fig. 12–15

1959 *Lucianorhabdus cayeuxi* DEFLANDRE: 142, Taf. 4:11–25; Taf. 3:30.

Bemerkungen: *L. cayeuxi* ist im untersuchten Material nur im unteren Maastrichtien gefunden worden und kann dort recht häufig sein. Durch seinen unregelmässigen Umriss und seine verhältnismässig breite Form unterscheidet er sich auch im Lichtmikroskop leicht von anderen stabförmigen Nannofossilien.

Vorkommen: Unteres Maastrichtien von Møn; weltweit verbreitet in der oberen Kreide; unbekannt aus dem oberen Maastrichtien.

### 3.5. Familie *Braarudosphaeraceae* DEFLANDRE 1947.

Genus *Braarudosphaera* DEFLANDRE 1947

Generotypus: *Braarudosphaera bigelowi* (GRAN & BRAARUD 1935) DEFLANDRE 1947  
*Braarudosphaera bigelowi* (GRAN & BRAARUD 1935) DEFLANDRE 1947

Taf. 32, Fig. 1–3

1935 *Pontosphaera bigelowi* GRAN & BRAARUD: 388, Fig. 67.

1947 *Braarudosphaera bigelowi* (GRAN & BRAARUD 1935) DEFLANDRE: 439, Fig. 1–5.

1962a\* *Braarudosphaera bigelowi* (GRAN & BRAARUD 1935) DEFLANDRE 1947 in HAY & TOWE: 427, Fig. 1.

1965\* *Braarudosphaera bigelowi* (GRAN & BRAARUD 1935) DEFLANDRE 1947 in BLACK: 135, Fig. 23.

Bemerkungen: Indem ich diese charakteristischen Pentalithe *Braarudosphaera* zuordne breche ich meinen Forsatz, die Coccolithen unabhängig vom natürlichen System der rezenten Formen zu klassieren. Fossile und rezente Exemplare von *Braarudosphaera* können morphologisch jedoch kaum voneinander unterschieden werden. Während sich der Feinbau der heliolithischen Formen von ihrem ersten Auftreten im Infralias bis zu den rezenten Coccolithen verändert hat, ist derjenige dieser ortholithischen Gattung unverändert geblieben seit der oberen Kreide, in der sie erstmals auftritt. Dies mag die Unkonsequenz entschuldigen.

Vorkommen: Unteres Maastrichtien von Møn, oberes Maastrichtien von Kjølby Gård; weltweit verbreitet von der oberen Kreide bis jetzt.

### 3.6. Incertae sedis.

Hier werden *Zygodiscus*, der mit seinem gegenwärtigen Inhalt in keiner der behandelten Familien plaziert werden kann, und ortholithische Formen untergebracht, deren Stellung innerhalb des fossilen Nannoplanktons noch unklar ist.

#### Genus *Marthasterites* DEFLANDRE 1959

Generotypus: *Marthasterites furcatus* (DEFLANDRE 1954) DEFLANDRE 1959

Dreiarmige, sternförmige Körper, deren Arme von einem undifferenzierten Zentrum aus gehen und die gerade oder gebogen, einfach oder aufgespalten sein können.

#### *Marthasterites inconspicuus* DEFLANDRE 1959

Taf. 31, Fig. 9

1959 *Marthasterites inconspicuus* DEFLANDRE: 140, Taf. 3:6–14.

Bemerkungen: DEFLANDRE beschreibt *M. inconspicuus* als sehr kleine Form aus dem Maastrichtien von Vanves, von Grodno und aus Texas. Die aus dem oberen Maastrichtien stammende, abgebildete Form ist etwas grösser als die von DEFLANDRE genannten Exemplare und nähert sich schon der tertiären Form, *M. tribachiatus*. Im untersuchten Material tritt *M. inconspicuus* nur im oberen Maastrichtien und da nur selten auf, während *M. tribachiatus* vor allem im Untereozän massenhaft auftritt.

Vorkommen: Oberes Maastrichtien von Kjølby Gård; weltweit verbreitet im Maastrichtien, vor allem im oberen Maastrichtien.

#### Genus *Micula* VEKSINA 1959

Generotypus: *Micula staurophora* (GARDET 1955) STRADNER 1963

*Micula staurophora* (GARDET 1955) STRADNER 1963

Fig. 43; Taf. 31, Fig. 1–5

1955 *Discoaster staurophorus* GARDET: 534, Taf. 10:96.

1959\* *Micula decussata* VEKSINA: 71, Taf. 1:6; Taf. 2:11.

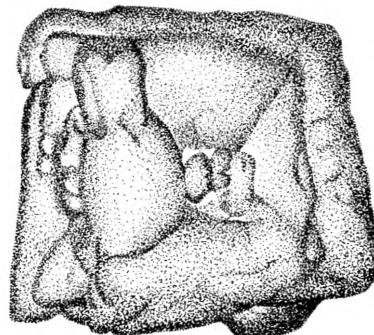


Fig. 43. *Micula staurophora* (GARDET) STRADNER aus dem Maastrichtien von Mön. Vergrösserung ca. 7500 ×.

- 1959 *Trochoaster staurophorus* (GARDET 1955) STRADNER: 480, Fig. 49, 50.  
 1960 *Nannotetrastraster staurophorus* (GARDET 1955) MARTINI & STRADNER: 266, Fig. 1.  
 1960 *Nannotetrastraster concavus* STRADNER in MARTINI & STRADNER: 269, Fig. 18 a-d.  
 1963 *Micula staurophora* (GARDET 1955) STRADNER: 13, Taf. 4:12.

**Bemerkungen:** Von dieser Form werden hier 4 Exemplare abgebildet, die alle aus dem unteren Maastrichtien von Mon stammen. Die kleinste Form (Taf. 31, Fig. 5) ist relativ flach und zeigt wenig Relief. In Fig. 4, Taf. 31 ist eine etwas grössere Form abgebildet, deren Zentrum eingetieft ist und Taf. 31, Fig. 1 zeigt eine grosse Form von *M. staurophora* in schiefer Lage, sodass ihre Ähnlichkeit mit zwei sich auf den Spitzen treffenden Pyramidenstümpfen erkennbar wird. Die Grundflächen der Pyramiden können übereinander liegen oder etwas gegeneinander verdreht sein.

**Vorkommen:** Maastrichtien von Dänemark; weltweit verbreitet im oberen Turonien bis Maastrichtien, aufgearbeitet (?) im Tertiär.

#### Genus *Tetralithus* GARDET 1955

Generotypus: *Tetralithus pyramidus* GARDET 1955

*Tetralithus obscurus* DEFLANDRE 1959

Fig. 44; Taf. 31, Fig. 6-8, 10, 11

- 1959 *Tetralithus obscurus* DEFLANDRE: 138, Taf. 3:26-29.

**Bemerkungen:** Der Generotypus von *Tetralithus* ist mir nicht im Elektronenmikroskop bekannt. Trotzdem glaube ich die abgebildeten Formen hier einordnen zu dürfen, da ihr Verhalten im Lichtmikroskop demjenigen entspricht, das DEFLANDRE (1959) für *Tetralithus* beschrieben hat. DEFLANDRE beschrieb *T. obscurus* auch von Grodno, von wo zwei der Taf. 31 abgebildeten Exemplare stammen.

Im Elektronenmikroskop kann man 4 dicke Platten erkennen, die auf charakteristische Weise zusammengefügt sind. Sie bilden eine flache Erhebung, an deren

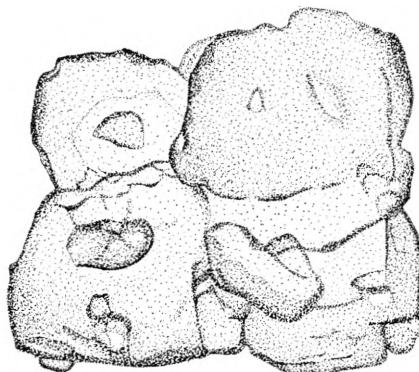


Fig. 44. *Tetralithus obscurus* DEFLANDRE aus dem unteren Maastrichtien von Mon. Vergrösserung ca. 7500 ×.

Aussenseite sich zwei diagonal liegende Platten in den Ecken überschneiden. Auf der inneren Seite stossen die beiden anderen Platten aneinander.

**Vorkommen:** Maastrichtien von Dänemark; weltweit verbreitet in der oberen Kreide.

Genus *Zygodiscus* BRAMLETTE & SULLIVAN 1961, emend. REINHARDT 1966 a

Generotypus: *Zygodiscus adamas* BRAMLETTE & SULLIVAN 1961

*Z. adamas*, der Generotypus von *Zygodiscus*, wurde von BRAMLETTE & SULLIVAN (1961) aus dem Paleozän und Eozän beschrieben und ist mir nicht im Elektronenmikroskop bekannt. REINHARDT (1966 a) hat *Zygodiscus* aufgrund von elektronenoptischen Beobachtungen an kretazischen Coccolithen wie folgt emendiert: „Ein Quersteg überspannt einen basalen elliptischen Ring. Marginal liegt ihm ein Wall auf. Der Quersteg trägt z.T. einen Zentralfortsatz. Dimorphismus wahrscheinlich. Quersteg aus optisch unterschiedlich orientierten Elementen“. Er hat damit die ursprüngliche Forderung nach zumindest Resten einer Basalplatte verlassen.

Ich stelle im folgenden diejenigen Arten mit mindestens 2 Randringen zu *Zygodiscus*, die schon von BRAMLETTE & MARTINI (1964) und von REINHARDT (1966 a) dorthin gestellt worden sind. Ich bin aber überzeugt, dass die elektronenoptische Untersuchung des Generotypus den Ausschluss einiger Arten aus *Zygodiscus* zur Folge haben wird, da *Z. adamas* in seinem Aufbau *Lophodolithus nascens* BRAMLETTE & SULLIVAN (1961), der im Elektronenmikroskop bekannt ist (PERCH-NIELSEN 1967 a), wahrscheinlich sehr nahe steht. Mit seinem jetzigen Inhalt kann *Zygodiscus* keiner der hier angenommenen Familien einverlebt werden und wurde deshalb hierher gestellt.

*Zygodiscus ponticulus* (DEFLANDRE 1954) REINHARDT 1966 a

Taf. 29, Fig. 1, 2

1954 *Discolithus ponticulus* DEFLANDRE in DEFLANDRE & FERT: 144, Taf. 13:18, 19, Abb. 32, 54.

1966a\* *Zygodiscus ponticulus* (DEFLANDRE 1954) REINHARDT: 40, Taf. 10:3.

**Bemerkungen:** *Z. ponticulus* müsste aus dem Typusmaterial (Maastrichtien von Frankreich) im Elektronenmikroskop beschrieben werden, um mit Sicherheit von den anderen, im Lichtmikroskop ähnlich erscheinenden Formen abgetrennt werden zu können.

**Vorkommen:** Unteres Maastrichtien von Mon; weltweit verbreitet im Maastrichtien.

*Zygodiscus acanthus* (REINHARDT 1965) REINHARDT 1966 a

Taf. 29, Fig. 3–6

1965\* *Zeugrhabdotus acanthus* REINHARDT: 37, Taf. 3:1.

1966a\* *Zygodiscus acanthus* (REINHARDT 1965) REINHARDT: 40, Taf. 15:5.

Bemerkungen: *Z. acanthus* unterscheidet sich von der als *Z. ponticulus* abgebildeten Form im Lichtmikroskop kaum und im Elektronenmikroskop vor allem durch den Aufbau des Randes. Der Feinbau der Brücken der beiden Formen stimmt beinahe überein. Bei *Z. ponticulus* scheinen die Randblättchen der Randringe nebeneinander zu liegen, bei *Z. acanthus* dagegen besteht der innere Ring aus dachziegelartig übereinander lagernden Plättchen. Bei beiden Formen sind die zwei „Poren“ gross, während sie bei *Z. spiralis*, der meist auch weniger Randelemente besitzt, kleiner sind.

Vorkommen: Unteres Maastrichtien von Mön; Albien bis Turonien und Maastrichtien von Deutschland.

*Zygodiscus spiralis* BRAMLETTE & MARTINI 1964

Taf. 29, Fig. 7-13

1964 *Zygodiscus spiralis* BRAMLETTE & MARTINI: 303, Taf. 4:6-8.

1964\* *Glaukolithus ? fibuliformis* REINHARDT: 758, Taf. 1:4.

1966 a\* *Glaukolithus fibuliformis* REINHARDT 1964 in REINHARDT: 41, Taf. 9:1-3, Taf. 22:22.

Bemerkungen: *Z. spiralis* konnte im Typusmaterial von Bellocq, Frankreich, studiert werden, wo die gefundenen Exemplare jedoch nicht so gut erhalten sind wie in der dänischen Kreide. Der Rand und die Brücke zeigen einen komplexen Aufbau, der von demjenigen von *Z. ponticulus* und *Z. acanthus* abweicht. Die Brücke trägt in den Exemplaren aus dem oberen Maastrichtien meist einen kurzen Fortsatz, während die Formen aus dem unteren Maastrichtien oft eine schwächere Brücke haben.

Vorkommen: Unteres und oberes Maastrichtien von Dänemark; weltweit verbreitet im Maastrichtien.

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## INDEX DER ZITIERTEN NAMEN

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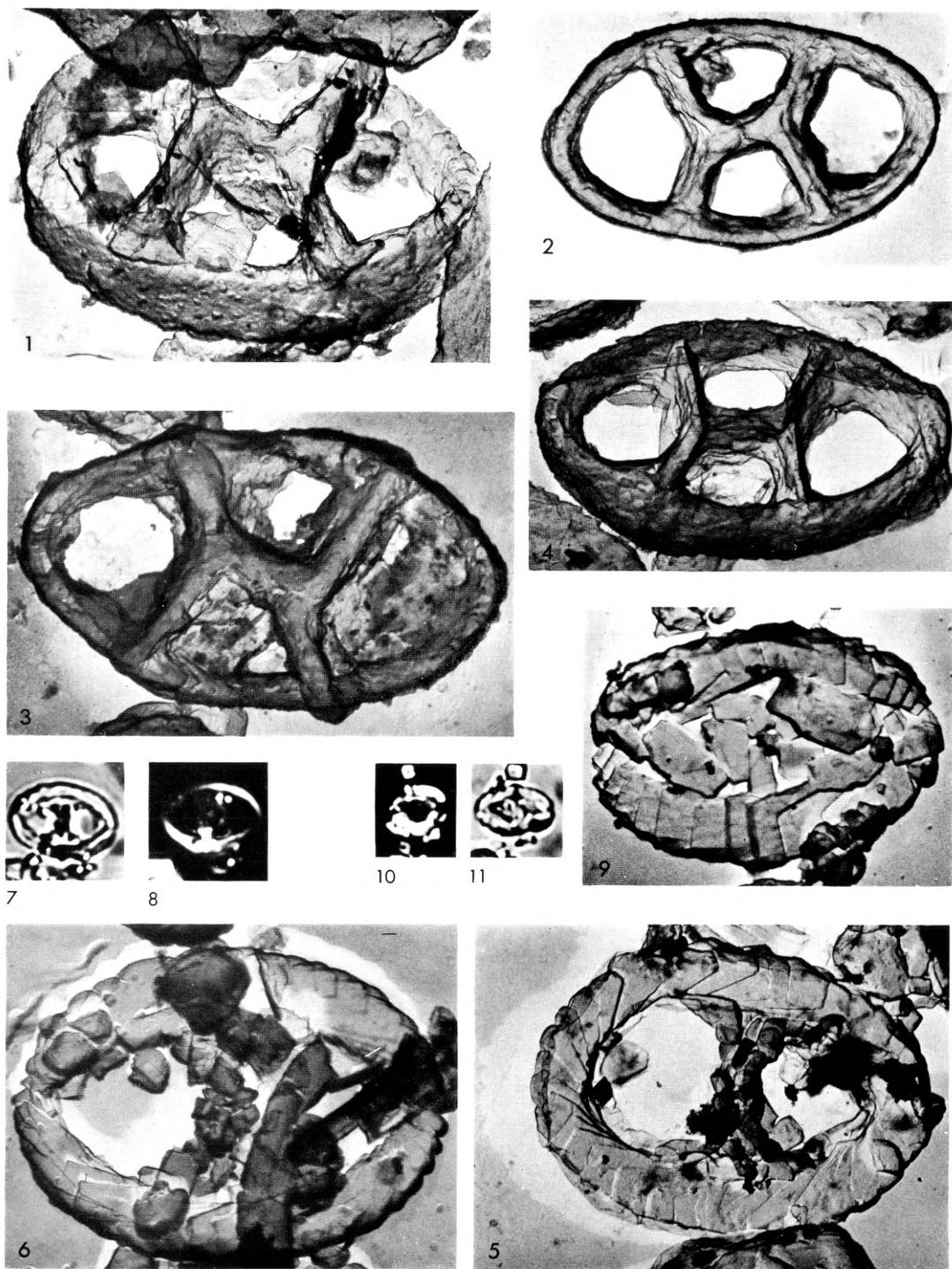
# TAFELN

TAFEL I

- Fig. 1. *Zygolithus dubius* DEFLANDRE. Elektronenmikroskopphotographie 51/3, u. Eozän von Rosnæs. Ansicht von schräg oben, die die Höhe des Randringes zeigt und dessen Aufbau aus sehr geneigten Lamellen. Die H-förmige Brücke überragt den Rand.
- Fig. 2. *Zygolithus dubius* DEFLANDRE. Elektronenmikroskopphotographie 49/15, u. Eozän von Rosnæs. Ansicht von senkrecht unten.
- Fig. 3. *Zygolithus dubius* DEFLANDRE. Elektronenmikroskopphotographie 51/5, u. Eozän von Rosnæs. Ansicht fast senkrecht von oben. Das H ist durch Kalkanlagerung verunstaltet und auch der Rand ist nur zum Teil ganz frei von sekundärer Kalkanlagerung; die Schrägstellung der Randelemente ist jedoch z.T. noch zu sehen.
- Fig. 4. *Zygolithus dubius* DEFLANDRE. Elektronenmikroskopphotographie 49/32, u. Eozän von Rosnæs. Ansicht von schräg unten, wo die H-förmige Brücke den Rand nicht überragt.
- Fig. 5. *Zygolithus bussoni* NOEL. Elektronenmikroskopphotographie 44/9, Danien Stevns Klint.
- Fig. 6. *Zygolithus bussoni* NOEL. Elektronenmikroskopphotographie 41/23, Mon A 18.
- Fig. 7, 8. Dasselbe Exemplar wie Fig. 6, im Lichtmikroskop DN 1,2. Fig. 8 zwischen gekreuzten Nicols.
- Fig. 9. *Ahmüllerella?* sp. Elektronenmikroskopphotographie 44/14 aus dem unteren Maastrichtien von Mon, B 13.
- Fig. 10, 11. Dasselbe Exemplar wie Fig. 9, im Lichtmikroskop DO 106, 107. Fig. 10. Zwischen gekreuzten Nicols.

Vergrosserung: Alle Lichtmikroskopphotographien 1800  $\times$ , alle Elektronenmikroskopphotographien ca. 7500  $\times$ .

TAFEL I

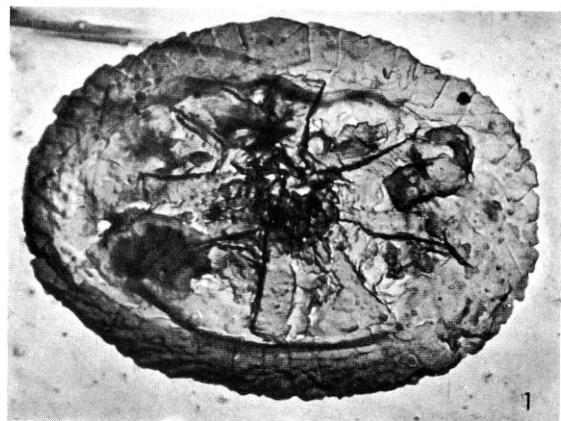


## TAFEL II

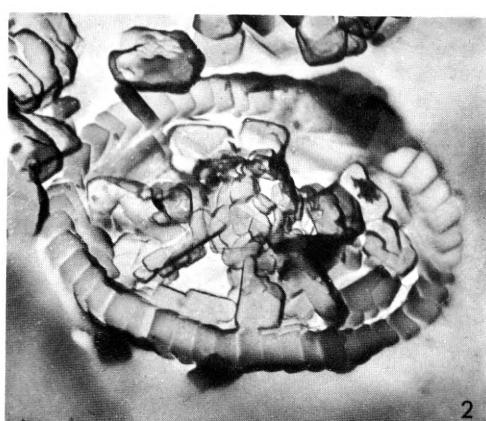
- Fig. 1. *Ahmuellerella octoradiata* (GORKA) REINHARDT. Elektronenmikroskopphotographie 45/15, Maastrichtien von Mecmierz, Polen. Die Zwischenräume sind mit sekundärem Calcit ganz ausgefüllt.
- Fig. 2. *Ahmuellerella octoradiata* (GORKA) REINHARDT. Elektronenmikroskopphotographie BCH 4, unteres Maastrichtien Mön. Zwischen den 8 Stützen sind die Zwischenräume leer. Granulae bilden einen Kegelstumpf.
- Fig. 3. *Staurolithites mielnicensis* (GORKA) n. comb. Elektronenmikroskopphotographie 45/17, oberes Maastrichtien von Mecmierz, Polen.
- Fig. 4, 5. *Staurolithites mielnicensis* (GORKA) n. comb. Lichtmikroskopaufnahmen des Exemplares der Text-flur 4; DO 40, 41. Fig. 5 zwischen gekreuzten Nicols.
- Fig. 6. *Staurolithites cruciatus* (NOEL) REINHARDT. Elektronenmikroskopphotographie 54/28, Mön B 22.
- Fig. 7. *Crepidolithus cohenii* n. sp. Holotypus. Elektronenmikroskopphotographie 58/8, unteres Maastrichtien von Mön, A 11. Grosses Exemplar mit zwei fast vollständigen Ringen im „Boden“.
- Fig. 8. *Crepidolithus* sp. Elektronenmikroskopphotographie 57/10, unteres Maastrichtien von Mön, A 11. Ansicht des Kegelstumpfes von innen.
- Fig. 9. *Crepidolithus neocrassus* n. sp. Holotypus. Elektronenmikroskopphotographie 61/20, oberes Maastrichtien von Kjolby Gård.
- Fig. 10. *Crepidolithus cohenii* n. sp. Elektronenmikroskopphotographie 55/26, unteres Maastrichtien von Mön, A 10.
- Fig. 16. *Crepidolithus* sp. im Lichtmikroskop, D1 40, aus dem unteren Maastrichtien von Mön.
- Fig. 12–15. *Ahmuellerella octoradiata* (GORKA) REINHARDT im Lichtmikroskop, DO 91–94, aus dem Maastrichtien von Gora Pulawska, Polen. Fig. 12 hohe Einstellung, Fig. 13 tiefe Einstellung, Fig. 14, 15 zwischen gekreuzten Nicols, unter verschiedenen Winkeln.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500 ×, die Lichtmikroskopaufnahmen 1800 ×.

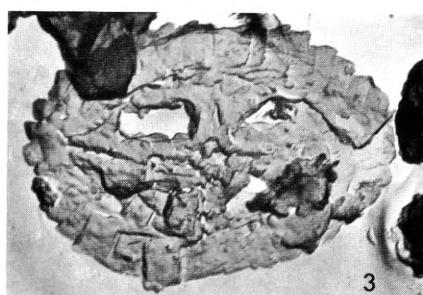
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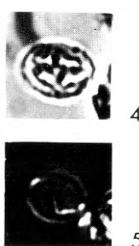
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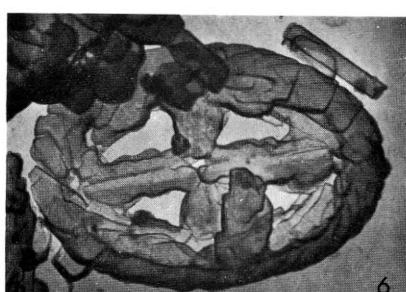


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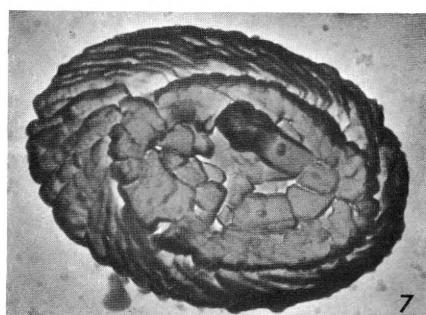


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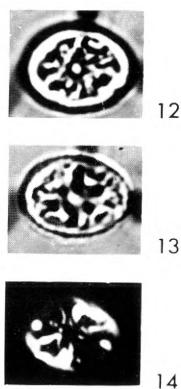
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6



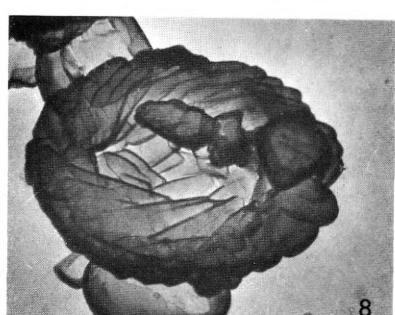
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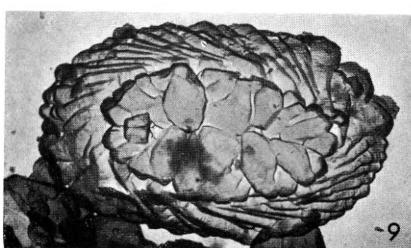
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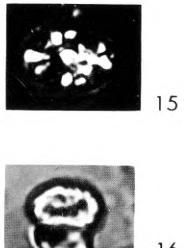
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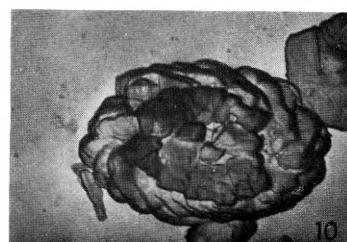


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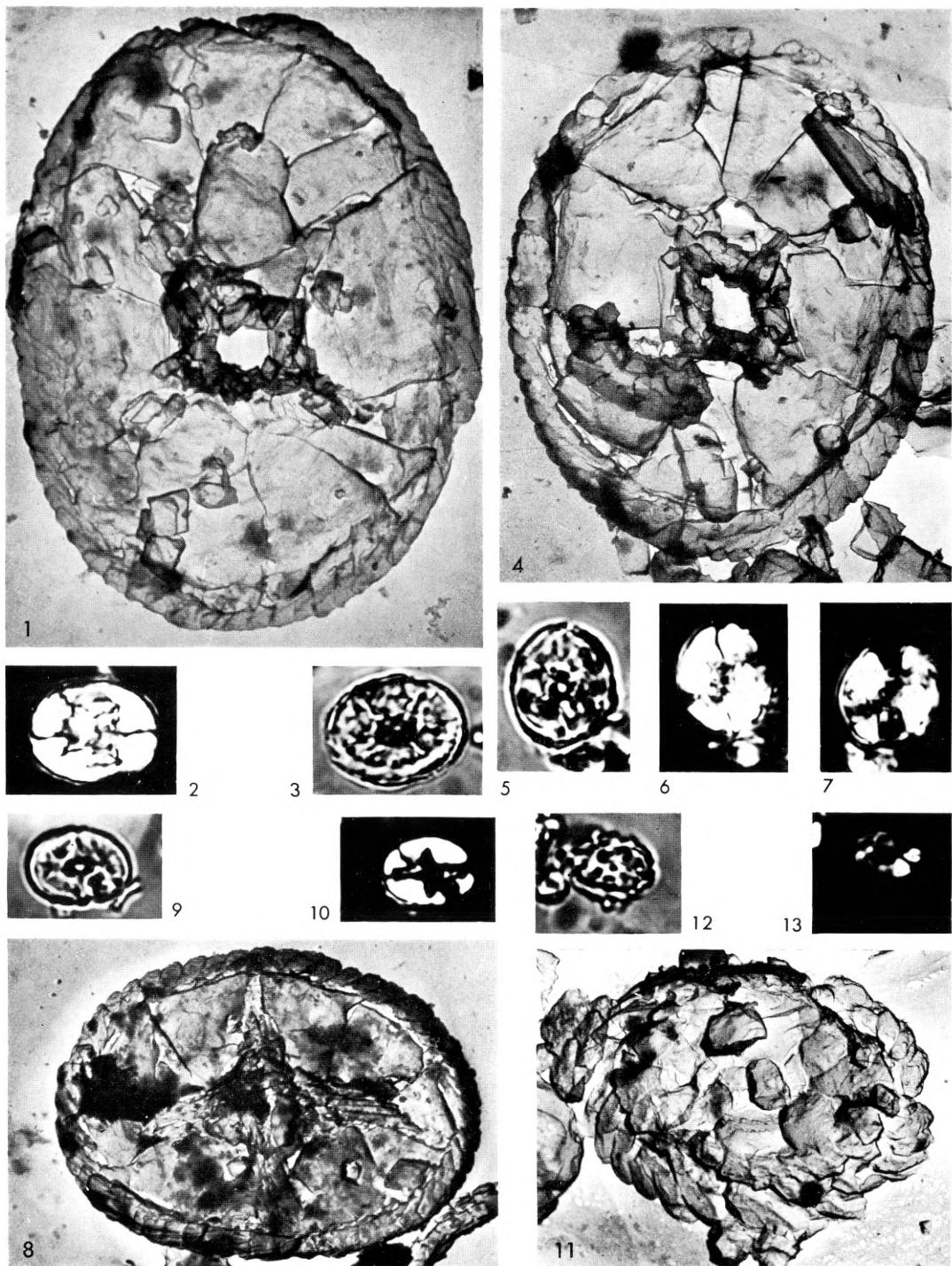
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TAFEL III

- Fig. 1. *Eiffellithus turriseiffeli* (DEFLANDRE) REINHARDT. Elektronenmikroskopphotographie 46/4, unteres Maastrichtien von Mon, B 13.
- Fig. 2, 3. Dasselbe Exemplar wie Fig. 1 im Lichtmikroskop, DP 28, 29. Fig. 2 zwischen gekreuzten Nicols.
- Fig. 4. *Eiffellithus turriseiffeli* (DEFLANDRE) REINHARDT. Elektronenmikroskopphotographie 40/8, unteres Maastrichtien von Mon, A 10.
- Fig. 5–7. Dasselbe Exemplar wie Fig. 4 im Lichtmikroskop, DM 70–72. Fig. 6, 7 zwischen gekreuzten Nicols.
- Fig. 8. *Eiffellithus eximius* (STOVER) n. comb. Elektronenmikroskopphotographie 44/21, Maastrichtien Mecmierz, Polen.
- Fig. 9, 10. Dasselbe Exemplar wie Fig. 8 im Lichtmikroskop, DO 86, 87. Fig. 10 zwischen gekreuzten Nicols.
- Fig. 11. *Eiffellithus gorkae* REINHARDT. Elektronenmikroskopphotographie 43/33, unteres Maastrichtien von Mon, A 10.
- Fig. 12, 13. Dasselbe Exemplar wie Fig. 11 im Lichtmikroskop, DN 95, 96. Fig. 13 zwischen gekreuzten Nicols.

Vergrösserung: Alle Lichtmikroskopphotographien 1800 ×, alle Elektronenmikroskopphotographien ca. 7500 ×.

TAFEL III

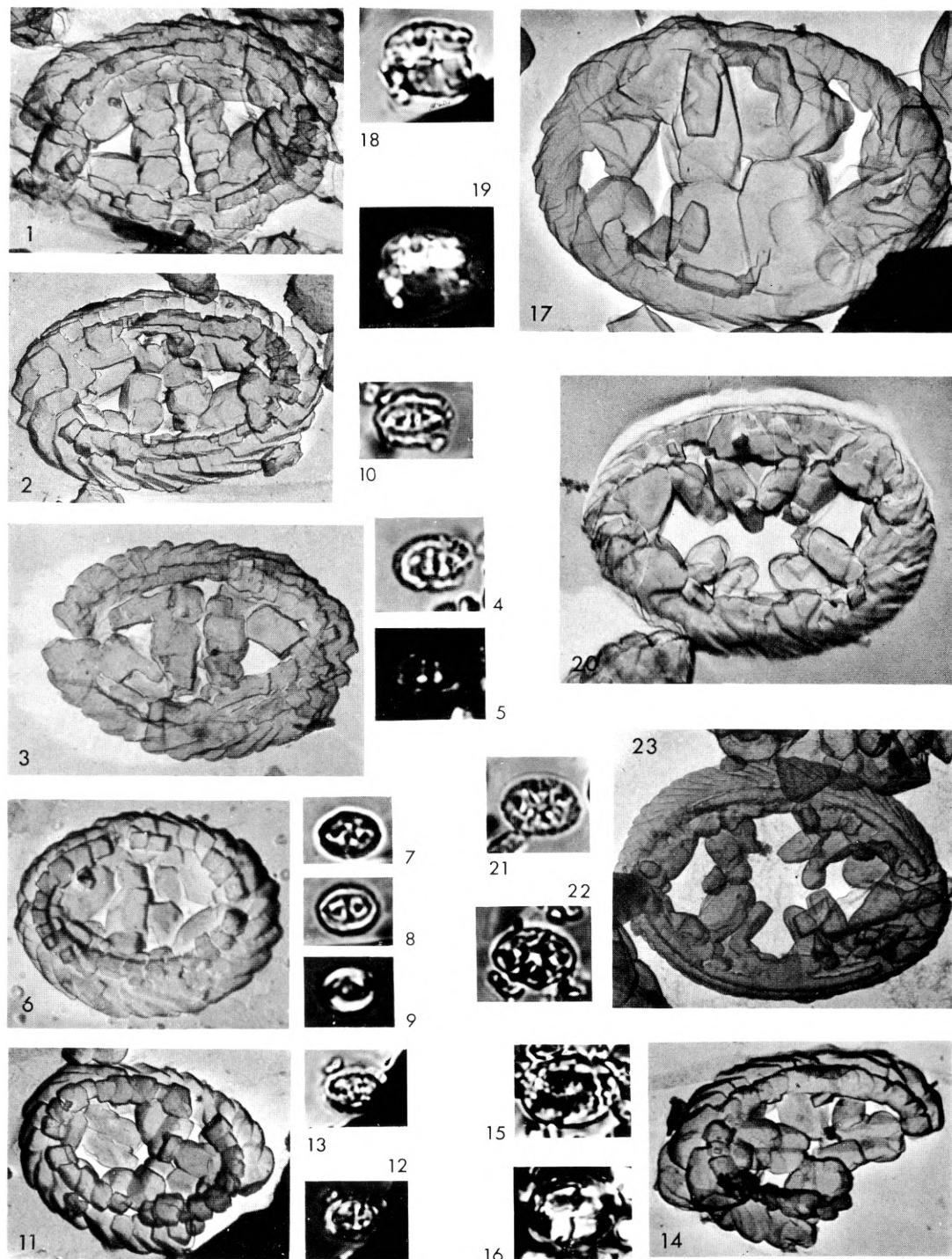


TAFEL IV

- Fig. 1. *Glaukolithus diprogrammus* (DEFLANDRE) n. comb. Elektronenmikroskopphotographie 40/15, unteres Maastrichtien von Mon, A 10. Schmale Querstege mit einem Zwischenraum.
- Fig. 2. *Glaukolithus diprogrammus* (DEFLANDRE) n. comb. Elektronenmikroskopphotographie 40/24, unteres Maastrichtien von Mon, A 10. Breitere Querstege als in Fig. 1, die keinen Zwischenraum mehr offen lassen und aus weniger Elementen aufgebaut sind.
- Fig. 3. *Glaukolithus diprogrammus* (DEFLANDRE) n. comb. Elektronenmikroskopphotographie 29/31, unteres Maastrichtien von Mon, A 10. Seitenverkehr?
- Fig. 4, 5. Dasselbe Exemplar wie Fig. 3 im Lichtmikroskop DH 38, 39. Fig. 5 zwischen gekreuzten Nicols.
- Fig. 6. *Glaukolithus diprogrammus* (DEFLANDRE) n. comb. Elektronenmikroskopphotographie 39/4, unteres Maastrichtien von Mon, A 22. Breitelliptische Form, deren Zentrafeld praktisch ganz ausgefüllt ist.
- Fig. 7-9. Dasselbe Exemplar wie Fig. 6, im Lichtmikroskop DL 84-86. Fig. 9 zwischen gekreuzten Nicols.
- Fig. 10. *Glaukolithus diprogrammus* (DEFLANDRE) n. comb. im Lichtmikroskop DG 10, unteres Maastrichtien von Mon, A 4.
- Fig. 11. *Glaukolithus boholnicae* (GORKA) n. comb. Elektronenmikroskopphotographie 43/13, unteres Maastrichtien von Mon, A 10.
- Fig. 12, 13. Dasselbe Exemplar wie Fig. 11, im Lichtmikroskop DN 67, 68. Fig. 12 zwischen gekreuzten Nicols.
- Fig. 14. *Glaukolithus boholnicae* (GORKA) n. comb. Elektronenmikroskopphotographie 43/9, unteres Maastrichtien von Mon, A 10.
- Fig. 15, 16. *Tranolithus orionatus* (REINHARDT) REINHARDT im Lichtmikroskop, DN 63, 64, aus dem unteren Maastrichtien von Mon, A 10.
- Fig. 17. *Tranolithus orionatus* (REINHARDT) REINHARDT. Elektronenmikroskopphotographie 23/32, unteres Maastrichtien von Mon.
- Fig. 18, 19. *Tranolithus orionatus* (REINHARDT) REINHARDT im Lichtmikroskop DH 55, 56, unteres Maastrichtien von Mon, A 11. Fig. 19 zwischen gekreuzten Nicols.
- Fig. 20. *Glaukolithus fessus* (STOVER) n. comb. Elektronenmikroskopphotographie 34/23, unteres Maastrichtien von Mon, A 10.
- Fig. 21. Dasselbe Exemplar wie Fig. 20, im Lichtmikroskop DH 73.
- Fig. 22. *Glaukolithus fessus* (STOVER) n. comb. Lichtmikroskopaufnahme DN 94 aus dem Maastrichtien von Grodno.
- Fig. 23. *Glaukolithus fessus* (STOVER) n. comb. Elektronenmikroskopphotographie 54/6, unteres Maastrichtien von Mon, B 22. Basale Ansicht.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500 ×, die Lichtmikroskopaufnahmen 1800 ×.

TAFEL IV



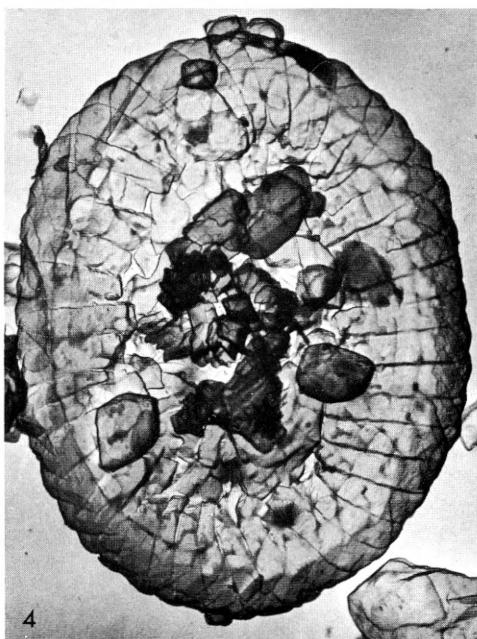
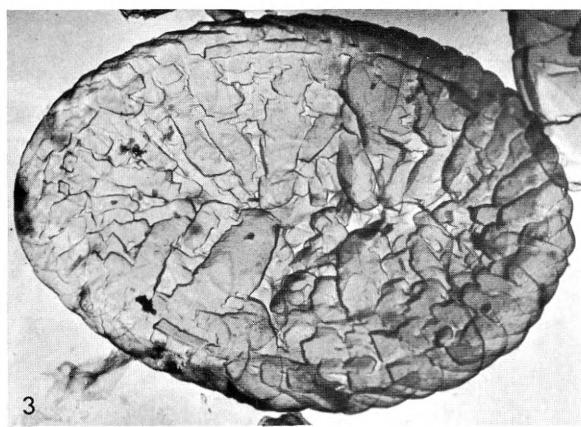
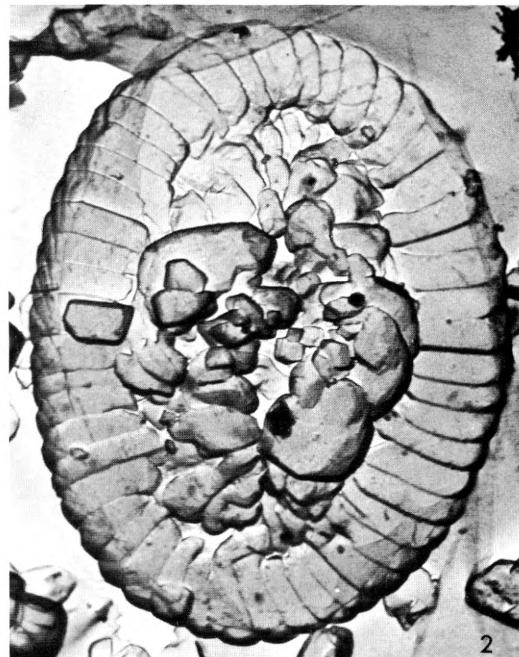
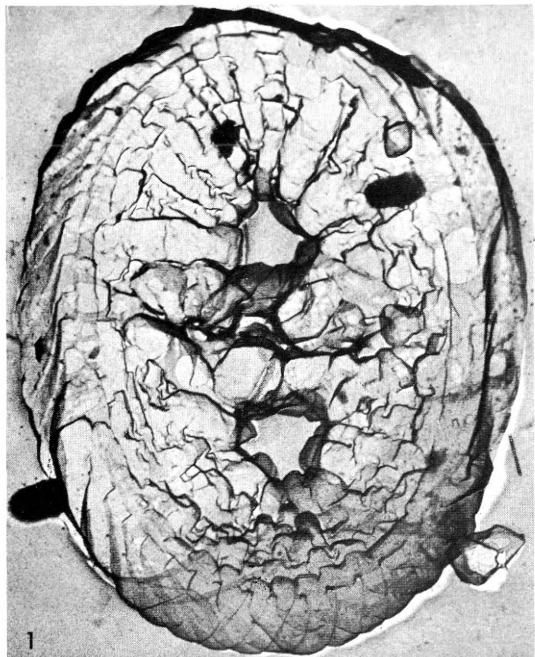
TAFEL V

*Reinhardtites anthophorus* (DEFLANDRE) n. comb.

- Fig. 1–4. Elektronenmikroskopphotographien 24/16 a, 43/7, 55/2, 54/12, unteres Maastrichtien von Mon, A 27, A 10, B 22, B 22.  
Fig. 1. Basale Seite des Coccolithen, dessen zwei Durchbrüche gut ausgebildet sind. Randpartie unten schwach „durchsichtig“.  
Fig. 2. Distale Seite des Coccolithen mit teils „durchsichtiger“ Randpartie, die die Schrägstellung der Randelemente verrät. Die beiden Durchbrüche sind klein und die Anordnung der Tabulae asymmetrisch in Bezug auf die Ellipsenachsen.  
Fig. 3. Basale Seite eines Coccolithen, dessen Durchbrüche geschlossen sind. Randpartie teilweise „durchsichtig“.  
Fig. 4. Distale Seite eines Coccolithen, dessen ganze Randpartie durchsichtig ist. Im Zentrum ein Ansatz zu einem Fortsatz.  
Fig. 5, 6. Exemplar mit grossen Öffnungen; im Lichtmikroskop, DH 78, 79, aus dem unteren Maastrichtien von Mon, A 11.  
Fig. 7, 8. Coccolith im Lichtmikroskop, DM 85, 86. Dasselbe Exemplar wie Textfigur 13. Fig. 8 zwischen gekreuzten Nicols.

Vergrösserung: Elektronenmikroskopphotographien ca. 7500  $\times$ , Lichtmikroskopphotographien 1800  $\times$ .

TAFEL V



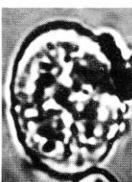
5



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7



8



TAFEL VI

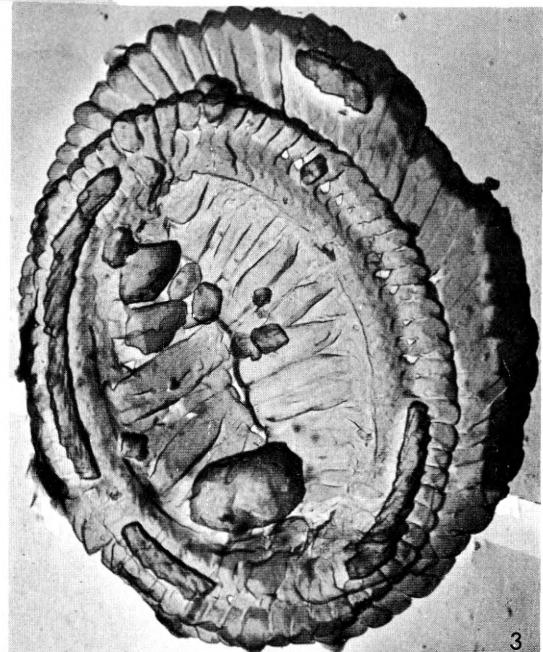
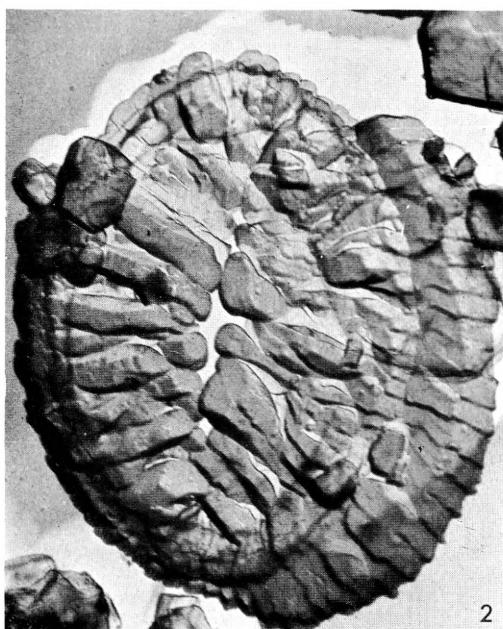
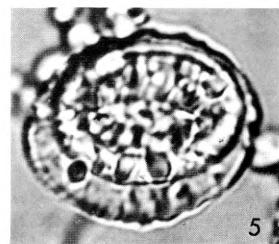
Fig. 1-3. *Kamptnerius magnificus* DEFLANDRE. Elektronenmikroskopphotographien 55/21, 36/19, 55/8, unteres Maastrichtien von Mon, A 10, A 11, B 22.

Fig. 4. *Kamptnerius ?tabulatus* n. sp. Elektronenmikroskopphotographie 54/27, unteres Maastrichtien Mon, B 22. Holotypus.

Fig. 5. *Kamptnerius magnificus* DEFLANDRE. Lichtmikroskopaufnahme DH 61, unteres Maastrichtien von Mon.

Vergrösserung: Elektronenmikroskopphotographien: Fig. 1 ca. 6300  $\times$ , übrige 7500  $\times$ . Lichtmikroskopaufnahme 1800  $\times$ .

TAFEL VI

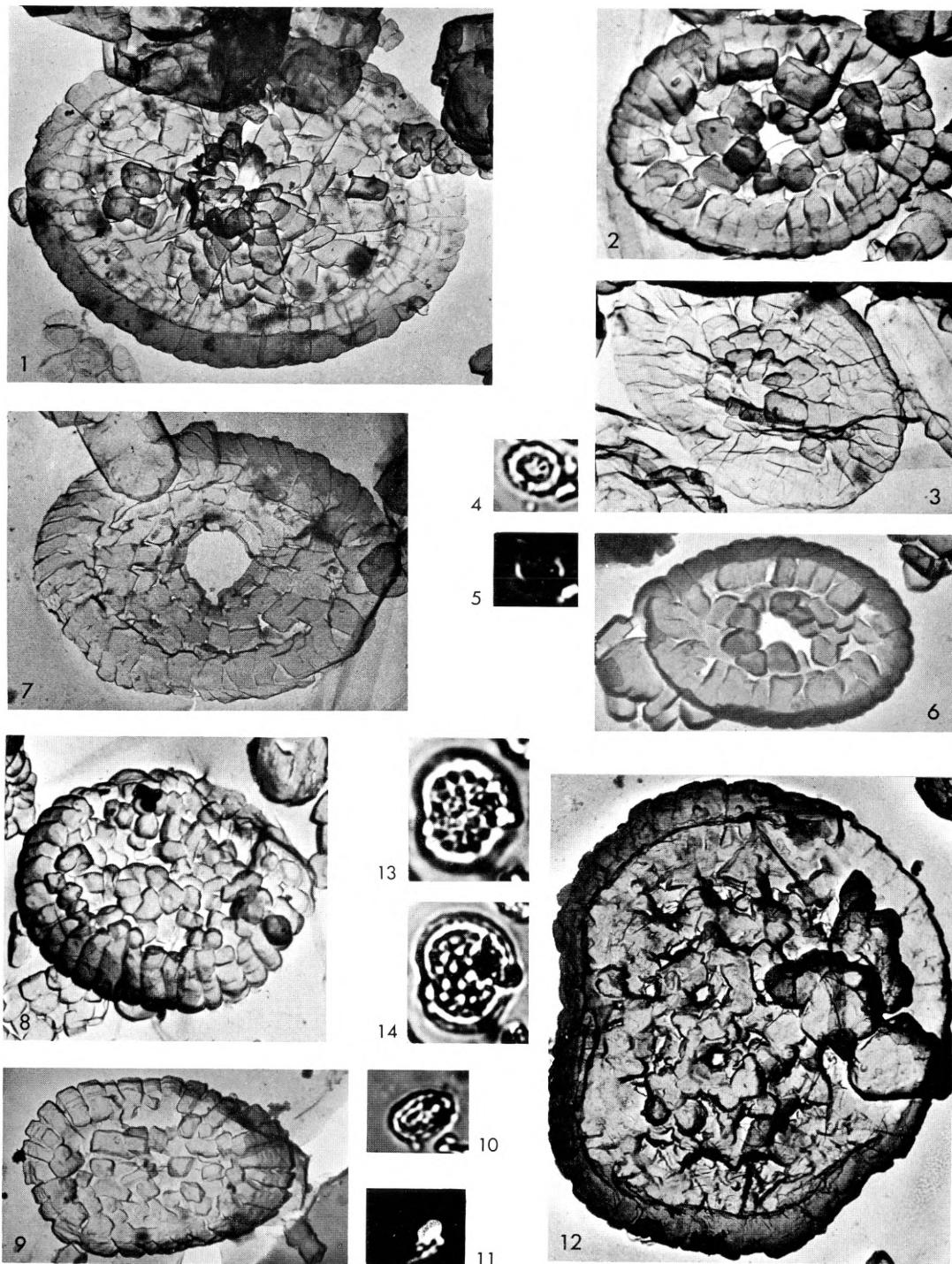


TAFEL VII

- Fig. 1. *Reinhardtites mirabilis* n. sp. Holotypus. Elektronenmikroskopphotographie 62/6 der distalen Seite, oberes Maastrichtien von Kjolby Gård.
- Fig. 2, 3, 6. *Rhagodiscus plebeius* n. sp. Elektronenmikroskopphotographien 43/10, 43/11, 59/30 aus dem unteren Maastrichtien von Mon, A 10, A 10, A 10.
- Fig. 2. Holotypus.
- Fig. 6. Kleine Form.
- Fig. 4, 5. Dasselbe Exemplar wie Fig. 3, im Lichtmikroskop, DN 63, 64. Fig. 5 zwischen gekreuzten Nicols.
- Fig. 7. *Rhagodiscus bispiralis* n. sp. Holotypus im Elektronenmikroskop, 40/23 aus dem unteren Maastrichtien von Mon, A 10. Das Zentralfeld wird aus zwei Spiralenreihen aus Granulae aufgebaut.
- Fig. 8, 9. *Rhagodiscus granulatus* n. sp. Elektronenmikroskopphotographien 43/6 und 46/11 aus dem unteren Maastrichtien von Mon, A 10 und B 13.
- Fig. 8. Holotypus.
- Fig. 10, 11. Dasselbe Exemplar wie Fig. 9, im Lichtmikroskop, DP 20, 21. Fig. 11 zwischen gekreuzten Nicols.
- Fig. 12. *Nephrolithus frequens* GORKA. Elektronenmikroskopphotographie 63/5 aus dem oberen Maastrichtien von Kjolby Gård.
- Fig. 13, 14. Dasselbe Exemplar wie Fig. 12, im Lichtmikroskop, DP 64, 65. Fig. 13 in hoher, Fig. 14 in tiefer Einstellung.

Vergrößerung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ , alle Lichtmikroskopphotographien 1800  $\times$ .

TAFEL VII



#### TAFEL VIII

Fig. 1–3. *Dodekapodorhabdus noelii* n. sp. Elektronenmikroskopphotographien 47/7, 43/6, 44/17 aus dem unteren Maastrichtien von Mon, A 10, A 10, B 13.

Fig. 1. Holotypus. Die Basisscheibe von unten gesehen. Rechts unten tritt der komplexe Aufbau der Randpartie hervor.

Fig. 2. Ansatzstelle des Fortsatzes.

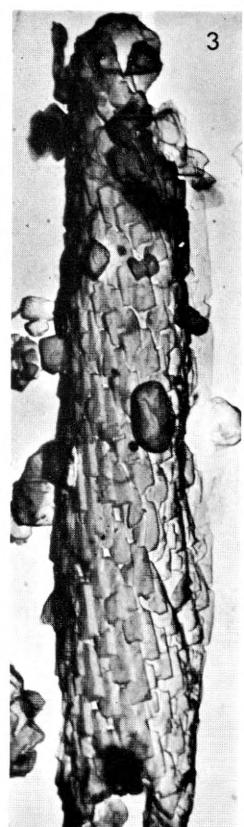
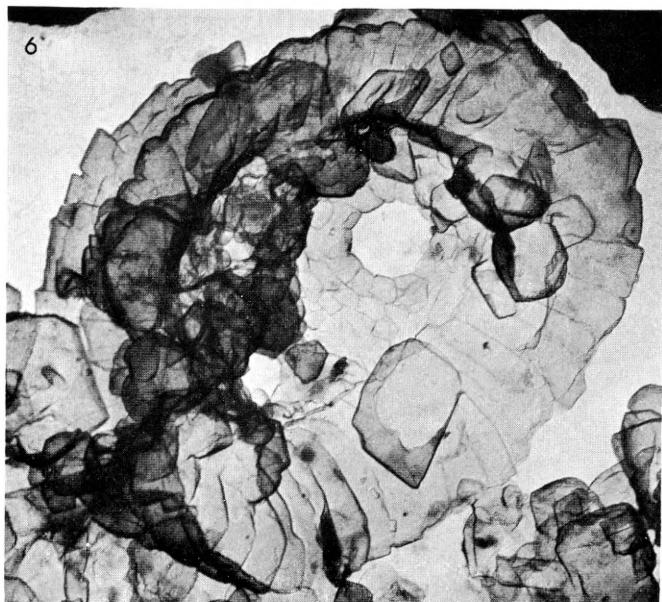
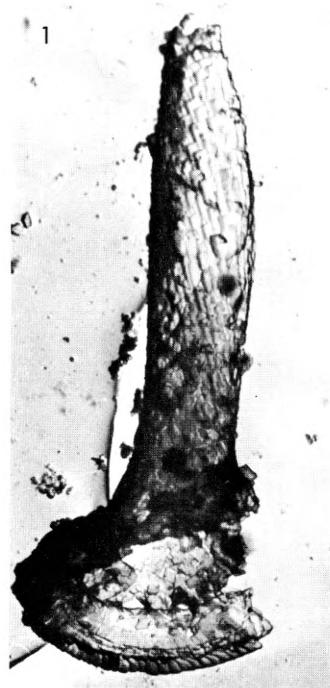
Fig. 3. Loser, abgebrochener Stab.

Fig. 4, 5. Dasselbe Exemplar wie Fig. 3, im Lichtmikroskop, DO 99, 100. Fig. 5 zwischen gekreuzten Nicols.

Fig. 6. *Podorhabdus dietzmanni* (REINHARDT) REINHARDT. Elektronenmikroskopphotographie 30/2 aus dem unteren Maastrichtien von Mon, A 10. Basale Ansicht.

Vergrösserung: Elektronenmikroskopphotographien der Fig. 1: ca. 2700 ×, Fig. 3 ca. 5000 ×, Fig. 2 und Fig. 6 ca. 7500 ×. Lichtmikroskopaufnahmen 1800 ×.

TAFEL VIII



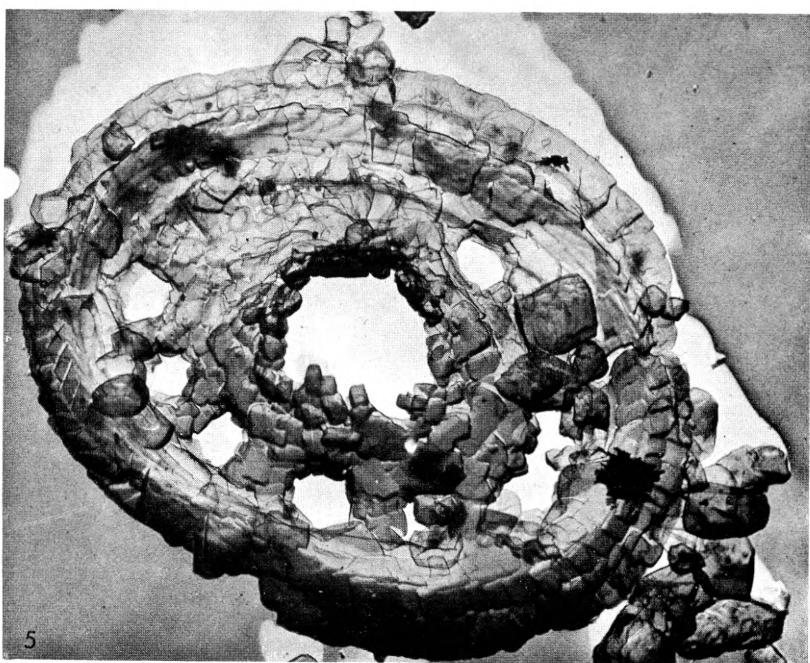
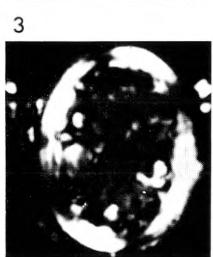
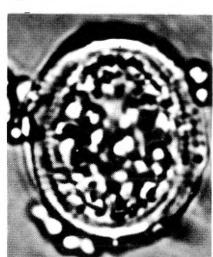
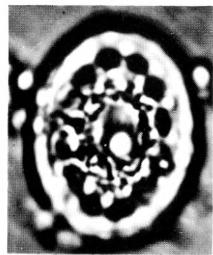
TAFEL IX

*Dodekapodorhabdus noelii* n. sp.

- Fig. 1, 5. Elektronenmikroskopphotographien 35/9 und 34/13 aus dem unteren Maastrichtien von Mon, A 11, A 11. Distale Ansichten. Ausgebrochener Stab.  
Fig. 2-4. Dasselbe Exemplar wie Fig. 1, im Lichtmikroskop, DH 31-33. Fig. 3 tiefe Einstellung, Fig. 2 höhere Einstellung, Fig. 4 zwischen gekreuzten Nicols.  
Fig. 6, 7. Dasselbe Exemplar wie Fig. 5, im Lichtmikroskop, DH 59, 60. Fig. 7 zwischen gekreuzten Nicols.

Vergrösserung: Fig. 1 ca. 6250  $\times$ , Fig. 5 ca. 5000  $\times$ ; die Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL IX



TAFEL X

Fig. 1-5. *Polypodorhabdus actinosus* (STROVER) n. comb. Elektronenmikroskopphotographien 46/3, 62/14, 55/32, 61/18, 57/8 aus dem unteren Maastrichtien von Mon (1:B 13, 3:A 18, 5:A 11) und dem oberen Maastrichtien von Kjolby Gård (2,4).

Fig. 1-3. Kleine Formen. Die Latten, die die zentrale Struktur tragen stehen weit voneinander. Der äusserste Rand scheint beschädigt zu sein.

Fig. 4. Exemplar aus dem oberen Maastrichtien mit recht flachem Zentralfeld.

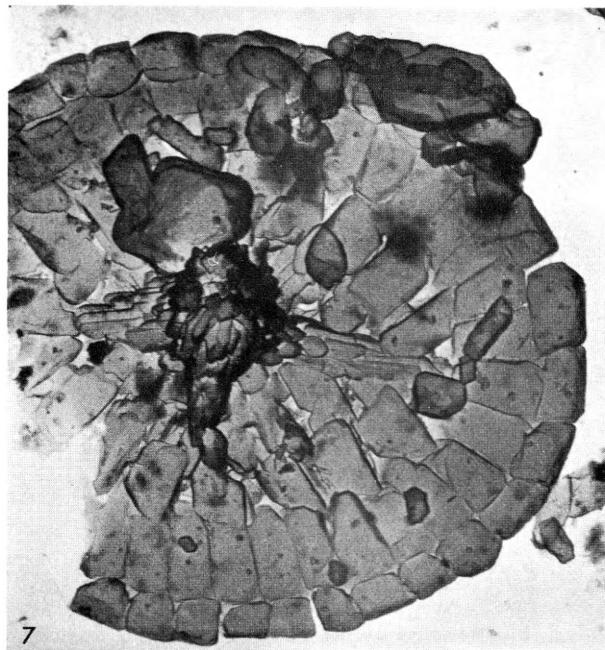
Fig. 5. Grosses Exemplar mit einem Ansatz zu einem Fortsatz, wie ihn *P. crenulatus* trägt.

Fig. 6. Dasselbe Exemplar wie Fig. 1, im Lichtmikroskop DP 27.

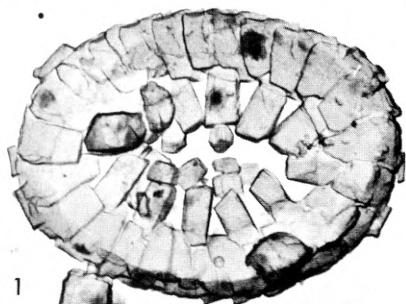
Fig. 7. *Stradneria limbicrassa* REINHARDT 1964. Elektronenmikroskopphotographie 62/8 aus dem oberen Maastrichtien von Kjolby Gård.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ . Die Lichtmikroskopaufnahme 1800  $\times$ .

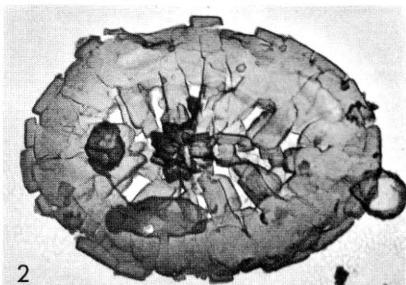
TAFEL X



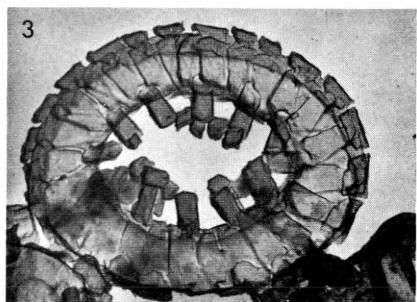
7



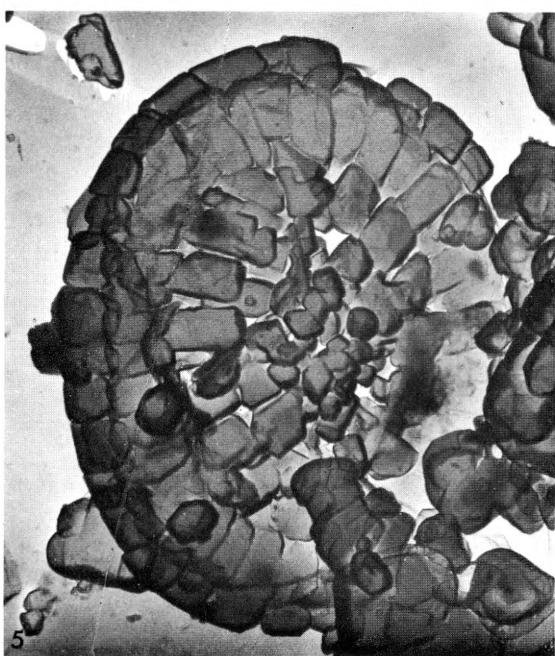
1



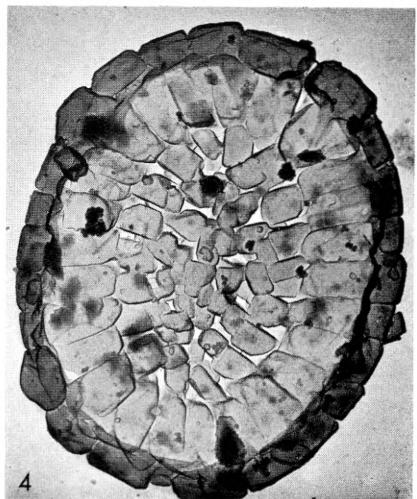
2



3



5



4



6

TAFEL XI

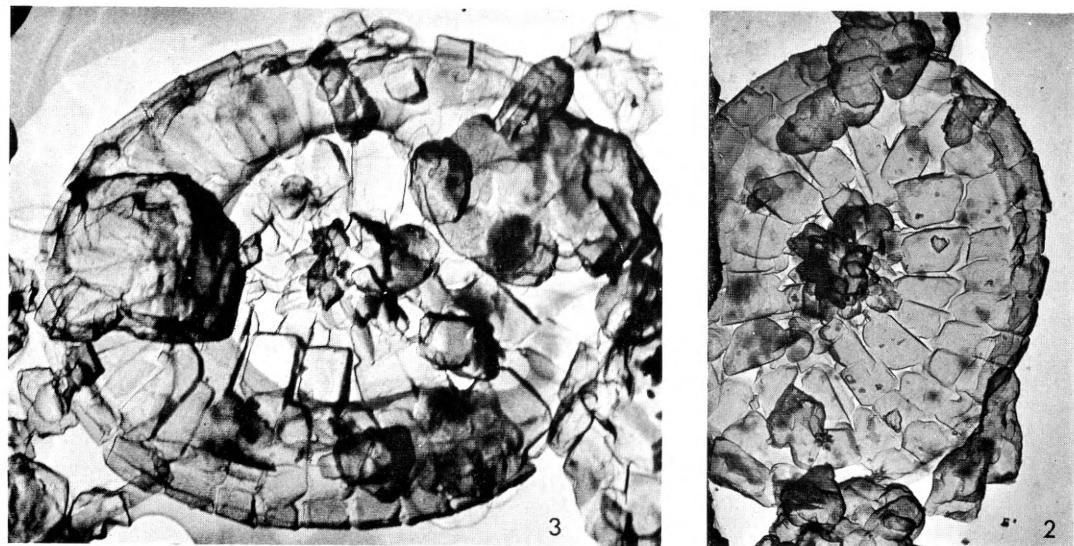
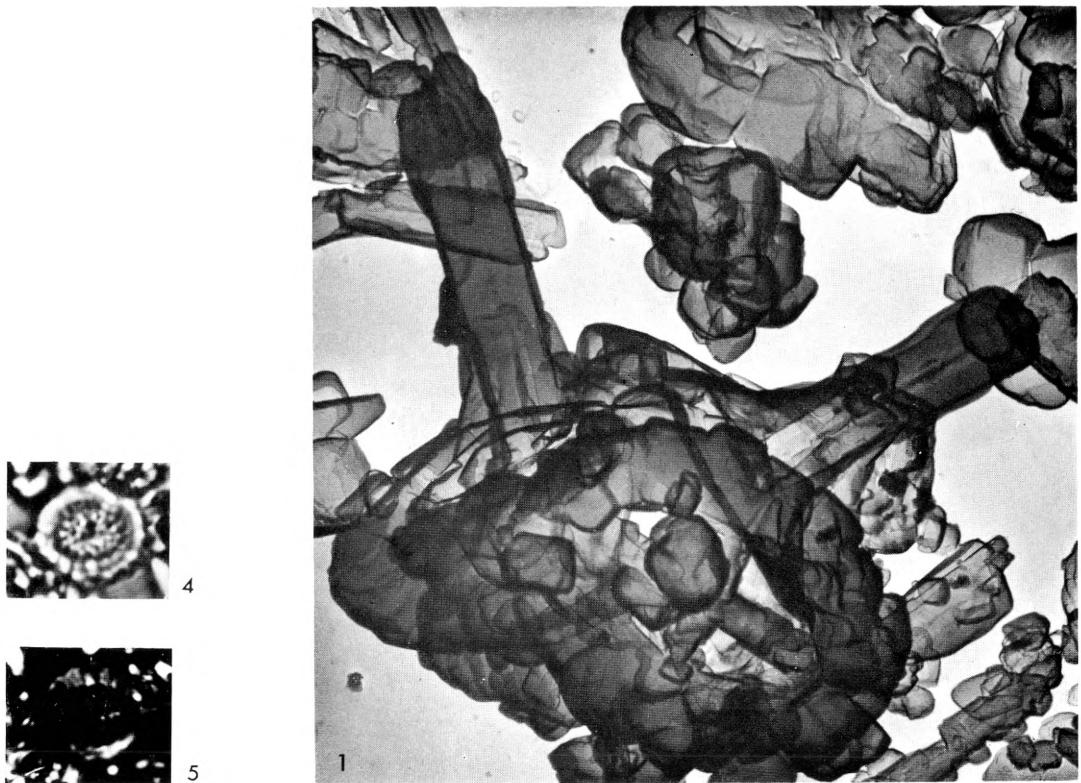
Fig. 1. *Deflandrius spinosus* BRAMLETTE & SULLIVAN. Elektronenmikroskopphotographie 57/12 aus dem unteren Maastrichtien von Mon, A 11. Teil einer Coccospaere mit 2 Coccolithen, die Stäbe (z.T. abgebrochen?) tragen und einem stablosen Coccolithen.

Fig. 2, 3. *Polypodorhabdus crenulatus* (BRAMLETTE & MARTINI) n. comb. Elektronenmikroskopphotographien 61/19 und 35/20 aus dem oberen Maastrichtien von Kjolby Gård (Fig. 2) und dem unteren Maastrichtien von Mon, A11 (Fig. 3).

Fig. 4, 5. Dasselbe Exemplar wie die Textfigur von *Polypodorhabdus crenulatus*, Fig. 18, im Lichtmikroskop DI 34, 35.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ . Die Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL XI



TAFEL XII

Fig. 1, 2. *Cretarhabdus conicus* BRAMLETTE & MARTINI. Elektronenmikroskopphotographie 44/19 und 34/20 aus dem unteren Maastrichtien von Mon, B 13, A 11.

Fig. 1. Basale Ansicht des Coccolithen.

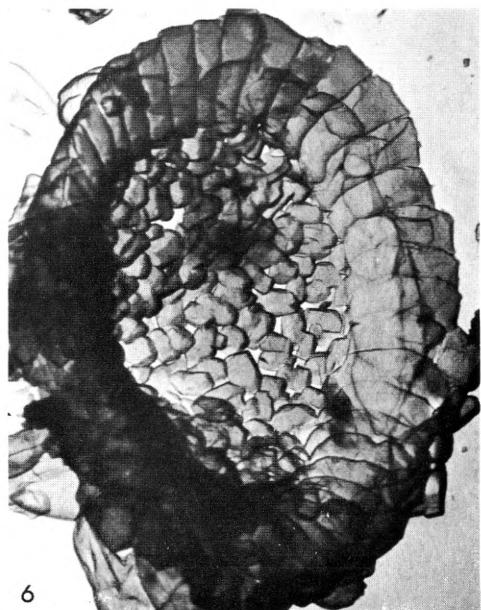
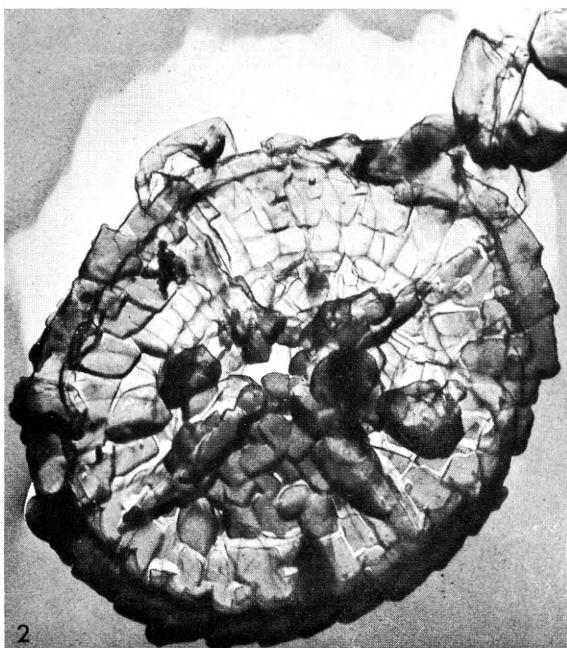
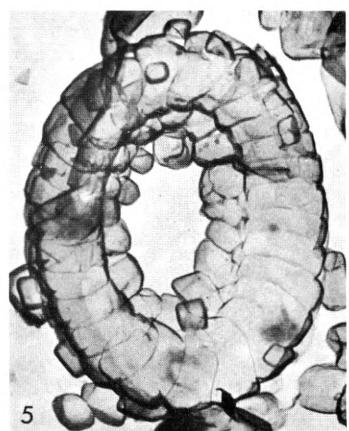
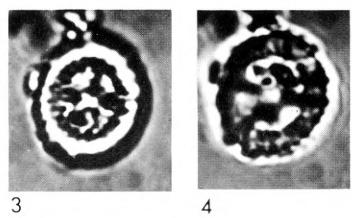
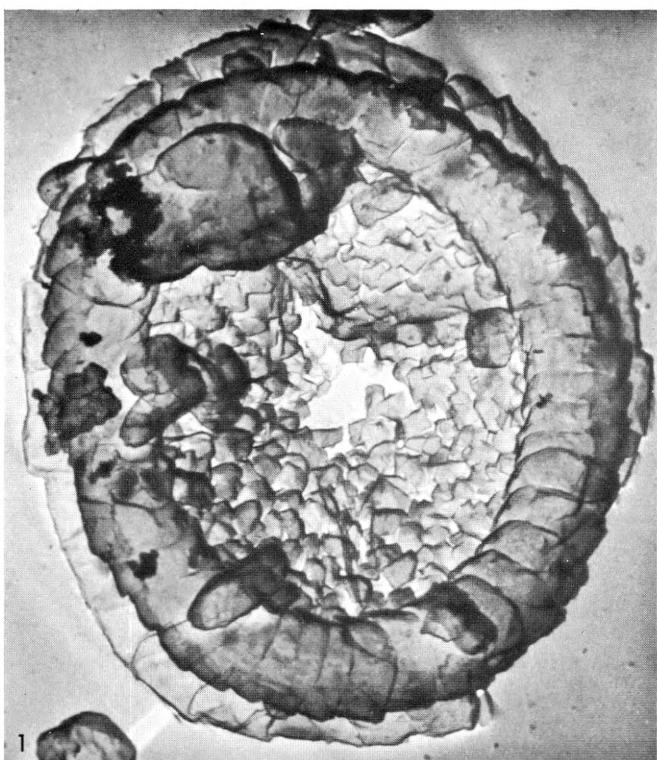
Fig. 2. Distale Ansicht des Coccolithen.

Fig. 3, 4. Dasselbe Exemplar wie Fig. 2, im Lichtmikroskop, DH 73, 74.

Fig. 5, 6. *Cribrosphaerella hilli* (BLACK) REINHARDT. Elektronenmikroskopphotographien 10/16 und 54/1 aus dem unteren Maastrichtien von Mon, B 26, B 22.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ . Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL XII



### TAFEL XIII

*Deflandrius cretaceus* (ARCHANGELSKY) BRAMLETTE & MARTINI.

Fig. 1-3. Elektronenmikroskopphotographien 53/30, 35/15, 33/22 aus dem unteren Maastrichtien von Mon, B 22, A 11, A 10.

Fig. 1. Sehr grosses Exemplar mit abgebrochenem Stab.

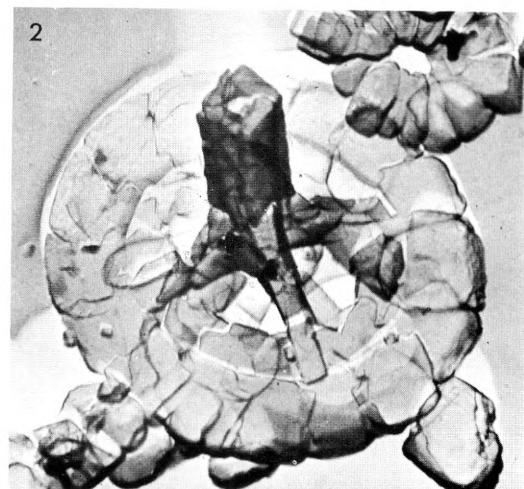
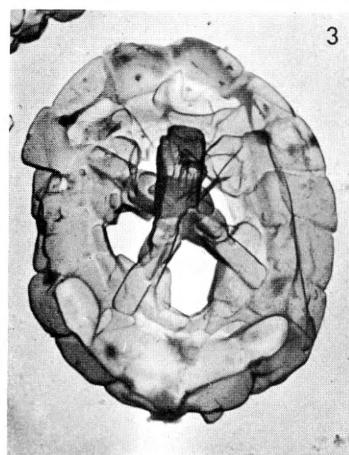
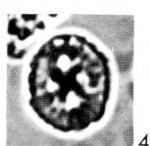
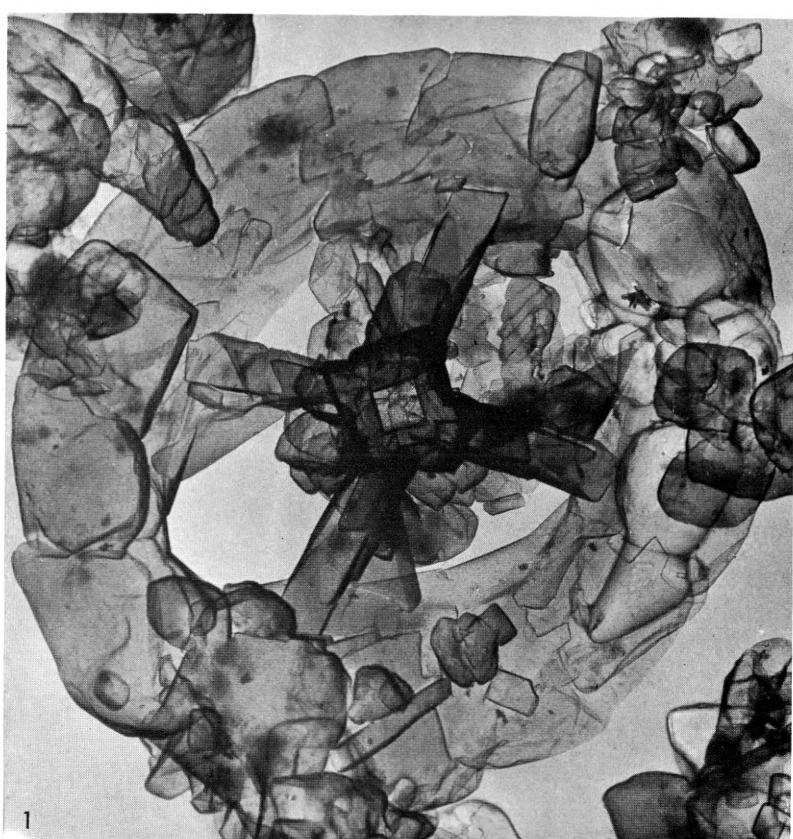
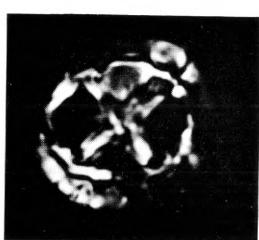
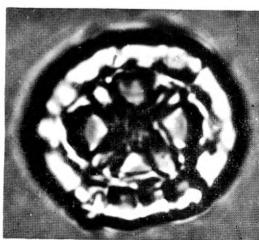
Fig. 2, 3. Kleinere Exemplare (weit häufiger als die grösseren) mit abgebrochenem Stab.

Fig. 4. Dasselbe Exemplar wie Fig. 3, im Lichtmikroskop, DG 71.

Fig. 5, 6. Grosser Coccolith im Lichtmikroskop DG 48/49.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ , die Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL XIII

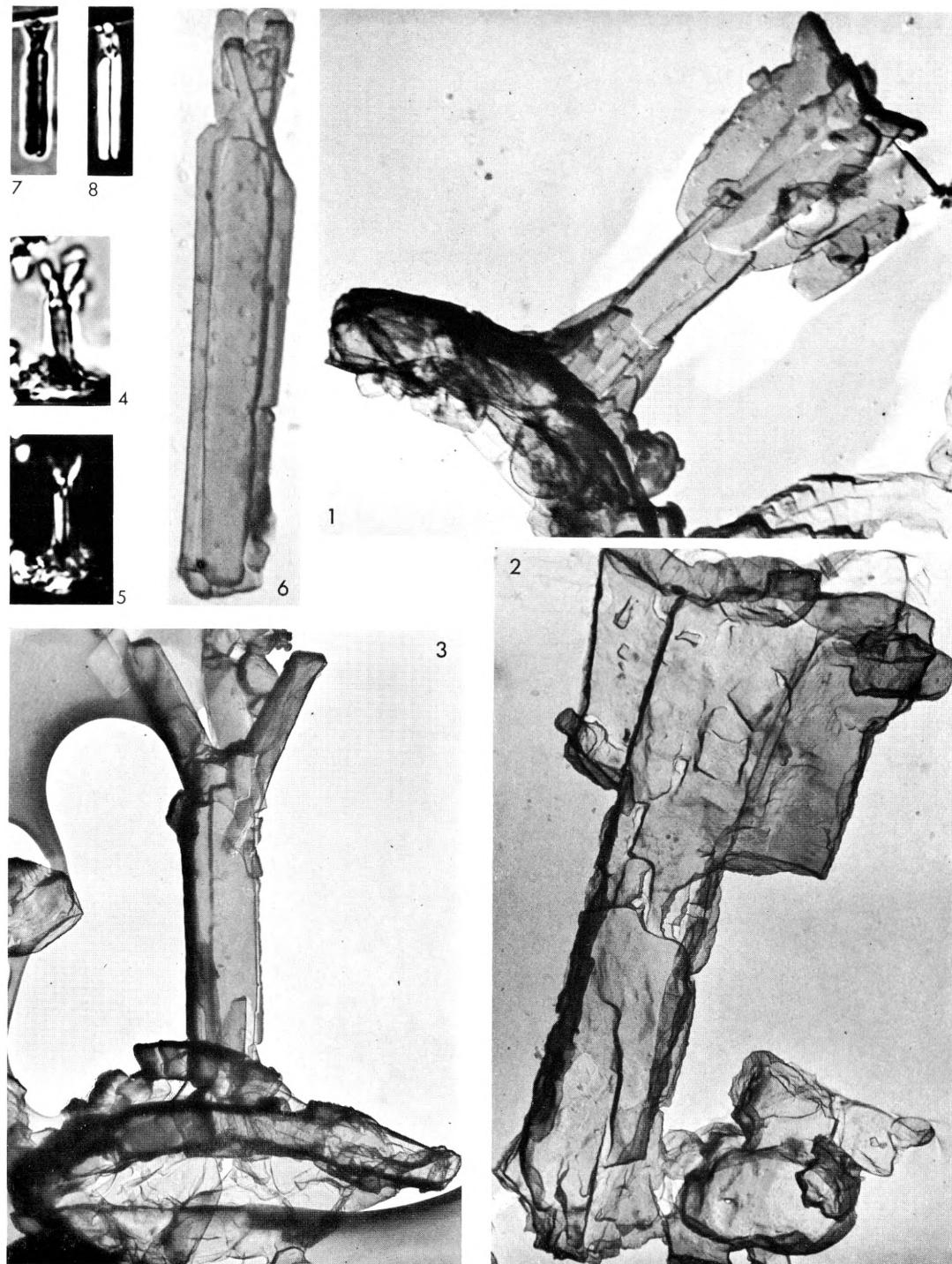


TAFEL XIV

- Fig. 1, 2. *Deflandrius cretaceus* (ARCHANGELSKY) BRAMLETTE & MARTINI. Elektronenmikroskopphotographien 36/7 und 55/20 aus dem unteren Maastrichtien von Mon, A 11, A 10.  
Fig. 1. Coccolith mit vollständigem Fortsatz.  
Fig. 2. Oberer Teil eines Fortsatzes eines sehr grossen Coccolithen.  
Fig. 3, 6. *Deflandrius spinosus* BRAMLETTE & MARTINI. Elektronenmikroskopphotographien 34/15 und 39/5 aus dem unteren Maastrichtien von Mon, A 11, A 22.  
Fig. 3. Coccolith mit vollständigem Stab.  
Fig. 6. Isolierter Stab, dessen oberster Teil abgebrochen ist.  
Fig. 4, 5. Dasselbe Exemplar wie Fig. 3, im Lichtmikroskop, DH 68, 67. Fig. 5 zwischen gekreuzten Nicols.  
Fig. 7, 8. Dasselbe Exemplar wie Fig. 6, im Lichtmikroskop DL 84, 85. Fig. 8 zwischen gekreuzten Nicols.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ , die Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL XIV



TAFEL XV

Fig. 1. *Deflandrius cretaceus* (ARCHANGELSKY) BRAMLETTE & MARTINI. Elektronenmikroskopphotographie 24/1 aus dem unteren Maastrichtien von Mon, A 27. Coccolith mit vollständigem Fortsatz.

Vergrösserung: ca. 11300  $\times$ .

TAFEL XV



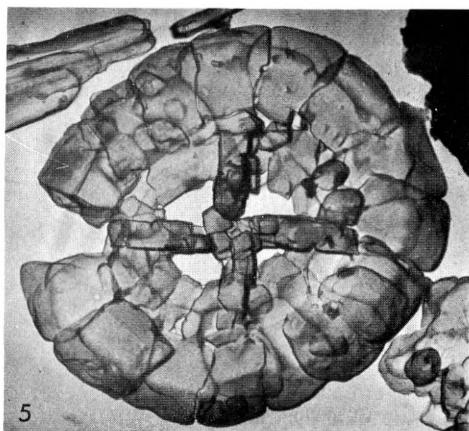
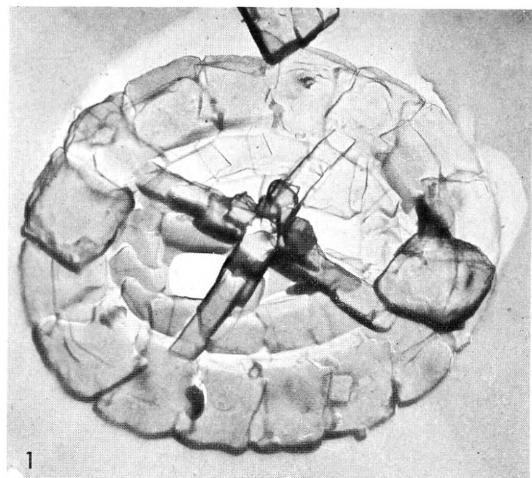
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TAFEL XVI

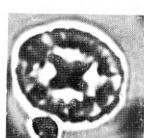
- Fig. 1, 5. *Deflandrius cretaceus* (ARCHANGELSKY) BRAMLETTE & MARTINI. Elektronenmikroskopphotographien 34/21 und 53/24 aus dem unteren Maastrichtien von Mön, A 11, B 22. Beides Formen ohne oder mit ausgebrochenem Stab.
- Fig. 2–4. Dasselbe Exemplar wie Fig. 1, im Lichtmikroskop DH 73–76. Fig. 4 zwischen gekreuzten Nicols, Fig. 2 hohe, Fig. 3 tiefe Einstellung.
- Fig. 6, 7. *Deflandrius rhombicus* n. sp. Elektronenmikroskopphotographien 57/23 und 60/26 aus dem unteren Maastrichtien von Mön, A 11 und A 10.
- Fig. 7. Holotypus.
- Fig. 8. *Deflandrius spinosus* BRAMLETTE & MARTINI. Elektronenmikroskopphotographie 34/9 aus dem unteren Maastrichtien von Mön, A 11. Ansicht der Basalplatte ohne Stab.
- Fig. 9, 10. *Deflandrius spinosus* im Lichtmikroskop, DG 74, 75 aus dem unteren Maastrichtien von Mön, A 10. Fig. 10 zwischen gekreuzten Nicols.
- Fig. 11–13. *Deflandrius stoveri* n. sp. Elektronenmikroskopphotographien aus dem unteren (Fig. 11) und dem oberen Maastrichtien (Fig. 12, 13), 57/11, 61/10, 61/2 von Kjolby Gård (Fig. 12, 13) und von Mön, A 11 (Fig. 11).
- Fig. 13. Holotypus.

Vergrößerung: Alle Elektronenmikroskopphotographien ca. 7500 ×, die Lichtmikroskopaufnahmen 1800 ×.

TAFEL XVI



2



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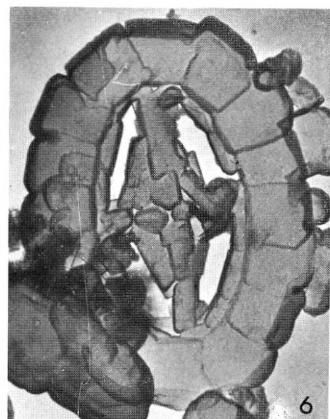
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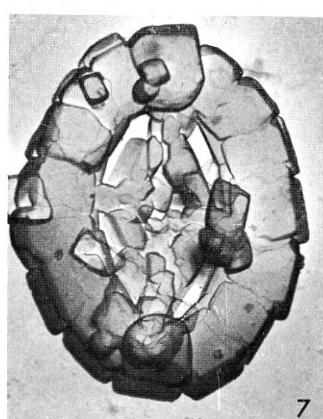
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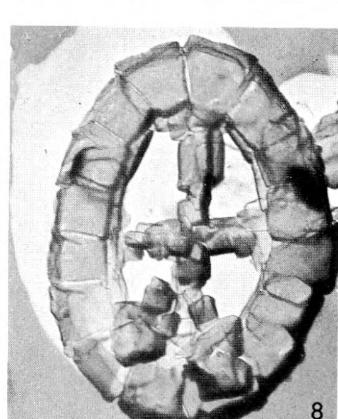
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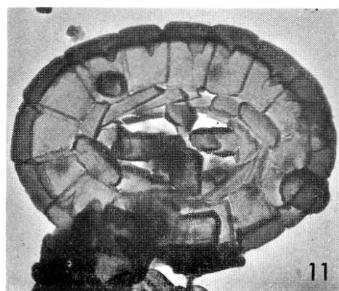
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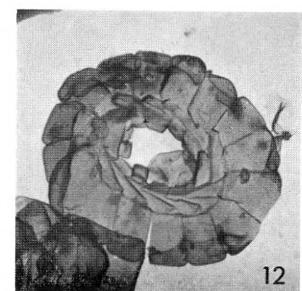
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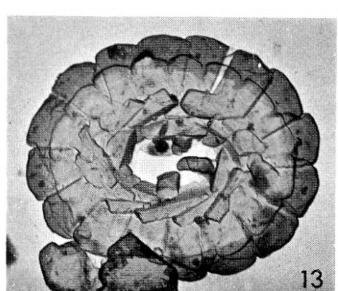
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TAFEL XVII

*Cribrosphaerella ehrenbergi* (ARCHANGELSKY) DEFLANDRE.

Fig. 1-6. Elektronenmikroskopphotographien 57/9, 58/4, 60/1, 60/24, 40/24, 43/8 aus dem unteren Maastrichtien von Mon, A 11, A 11, A 10, A 10, A 10.

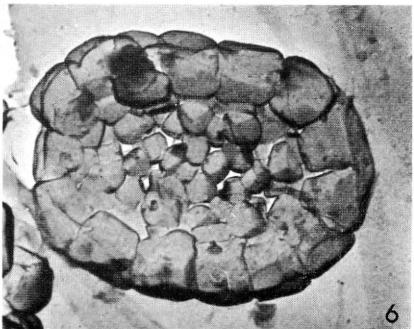
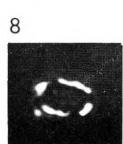
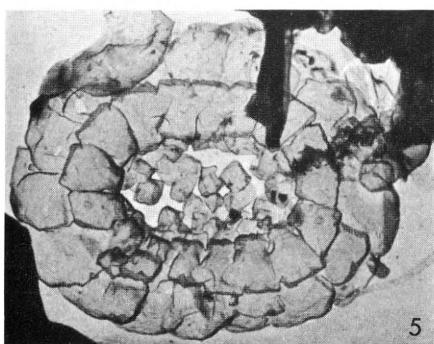
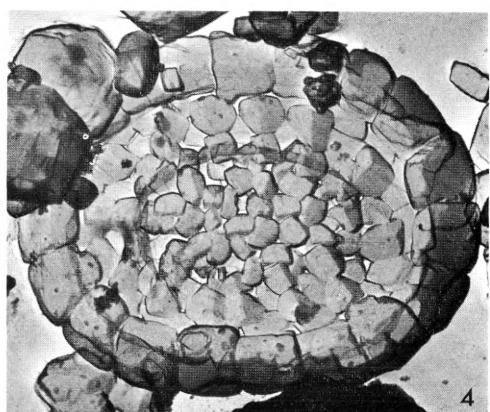
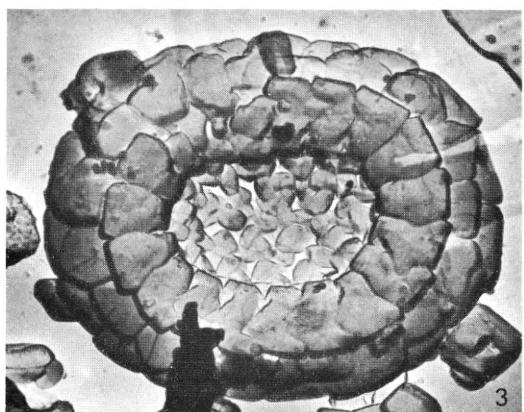
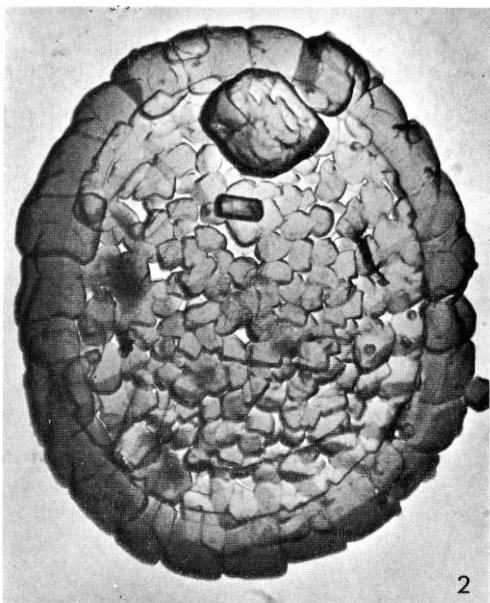
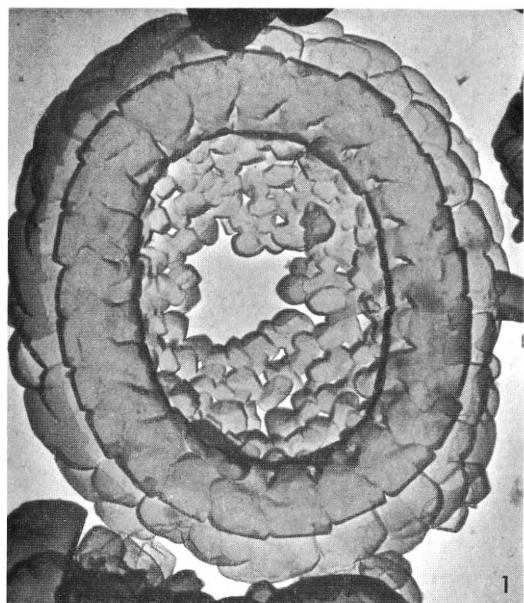
Fig. 1, 3, 5. Distale Seite verschieden grosser Cocco lithen. Die drei Randscheiben sind z.T. deutlich sichtbar, ebenso das ineinander greifen der Randelemente.

Fig. 2, 4, 6. Basale Seite verschieden grosser Cocco lithen. Das mit kleinen Granulae bedeckte Zentrafeld ist gleich gross wie das entsprechend grosser Cocco lithen von der distalen Seite her gesehen.

Fig. 7, 8. Dasselbe Exemplar wie Fig. 6, im Lichtmikroskop, DN 61, 62. Fig. 8 zwischen gekreuzten Nicols.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ , die Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL XVII



TAFEL XVIII

*Nephrolithus frequens* GORKA emend.

Fig. 1-8. Elektronenmikroskopphotographien 45/12, 61/14, 61/13, 61/3, 61/4, 61/21, 61/16, 61/26 aus dem oberen Maastrichtien von Mecmierz, Polen (Fig. 1) und Kjolby Gård (Fig. 2-9).

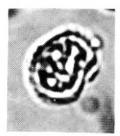
Fig. 1, 3-8. Distale Seite des Coccolithen (bei gleicher Orientierung wie bei *Cribrosphaerella ehrenbergi*).

Fig. 2. Basale Seite des Coccolithen.

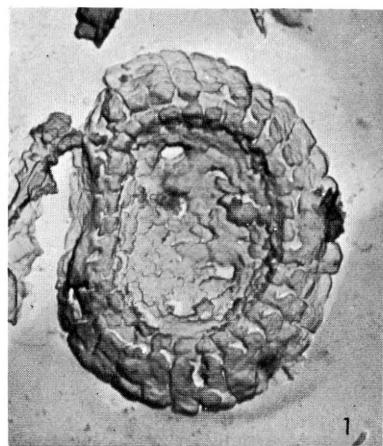
Fig. 9. Lichtmikroskopaufnahme DP 72, aus dem oberen Maastrichtien von Kjolby Gård.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ . Die Lichtmikroskopaufnahme 1800  $\times$ .

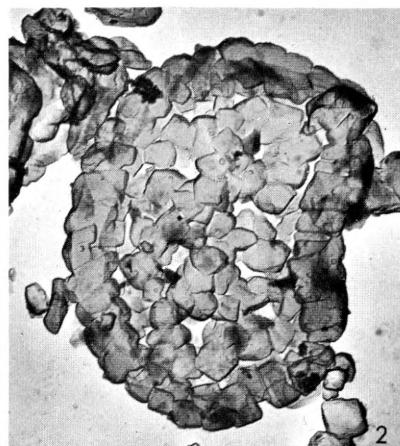
TAFEL XVIII



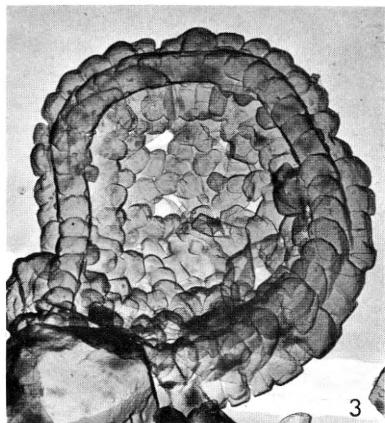
9



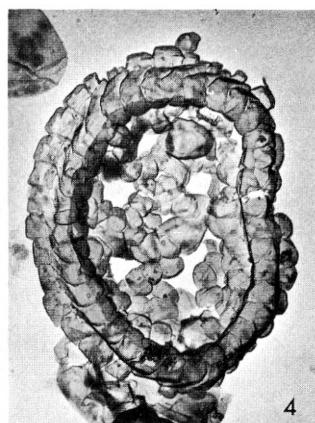
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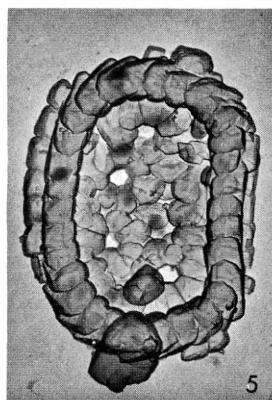
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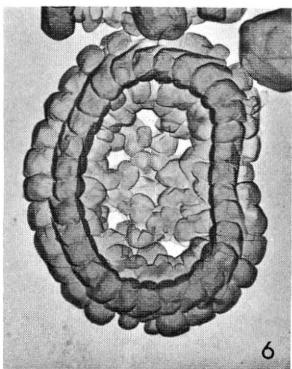
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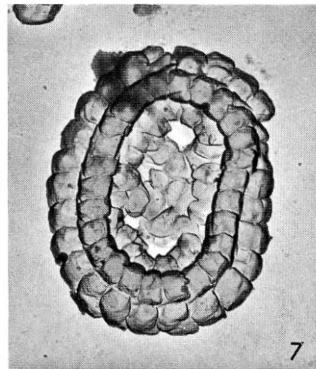
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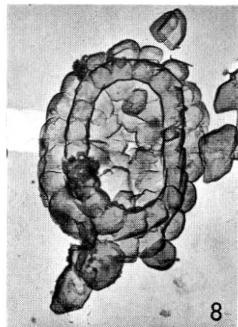
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## TAFEL XIX

Fig. 1, 2. *Arkhangelskiella cymbiformis* VEKSINA. Elektronenmikroskopphotographien 49/3 und 57/6 aus dem unteren Maastrichtien von Mon, A 10, A 11.

Fig. 1. Basale Ansicht eines sehr grossen Exemplars.

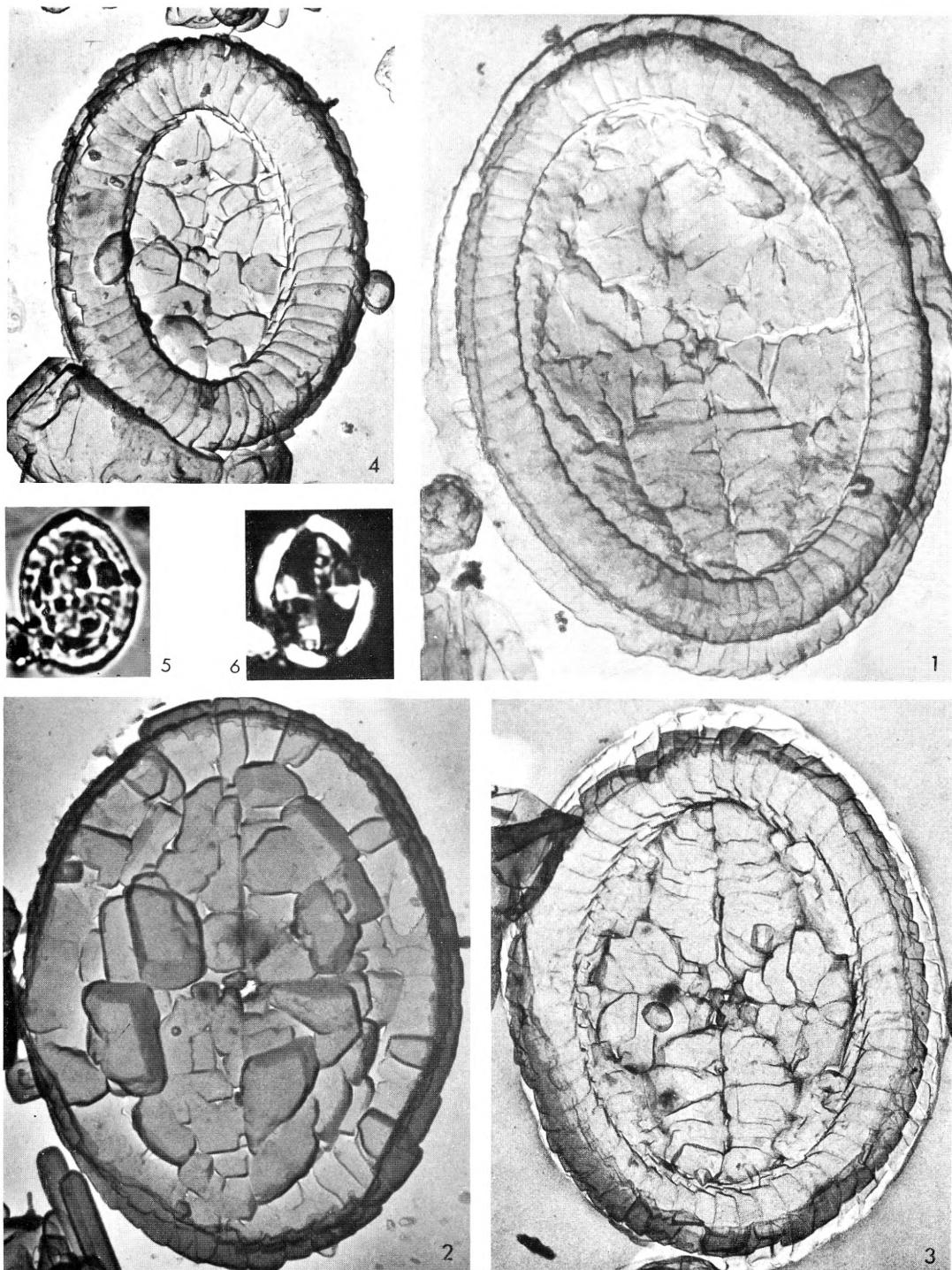
Fig. 2. Distale Ansicht eines grossen Exemplars. Die Tabulae bilden eine flache Kuppel, die über den Rand weg greift.

Fig. 3, 4. *Arkhangelskiella obliqua* STRADNER. Elektronenmikroskopphotographien 24/11 und 60/23 aus dem unteren Maastrichtien von Mon, A 27, A 11. Basale Ansichten eines grösseren und eines kleineren Exemplars, bei welchen die Trennungslinien der zentralen Struktur sich fast rechtwinklig treffen, wo die Randelemente aber deutlich schräg stehen.

Fig. 5, 6. *Arkhangelskiella obliqua* STRADNER. Lichtmikroskopaufnahmen DL 63, 64 aus dem unteren Maastrichtien von Mon, A 19.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ . Die Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL XIX



TAFEL XX

Fig. 1, 2. *Arkhangelskiella obliqua* STRADNER. Elektronenmikroskopphotographien 47/31 und 59/21 aus dem unteren Maastrichtien von Mon, A 10, A 10.

Fig. 1. Basale Ansicht eines grossen Exemplares mit ausgefranstem Rand aus 3 Randscheiben.

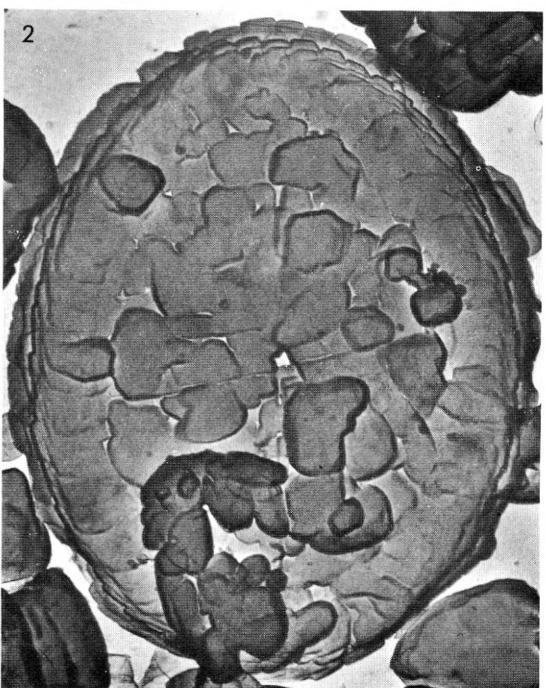
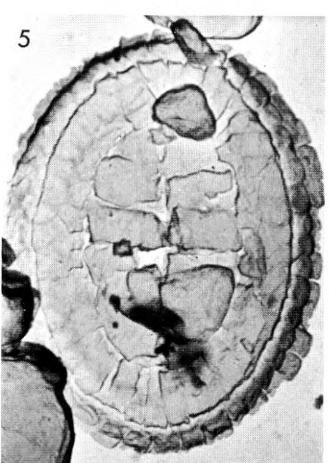
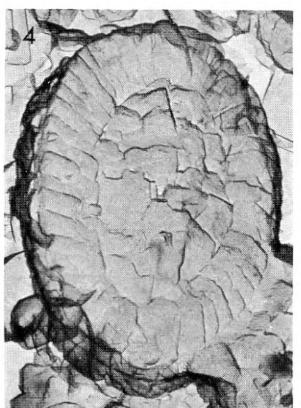
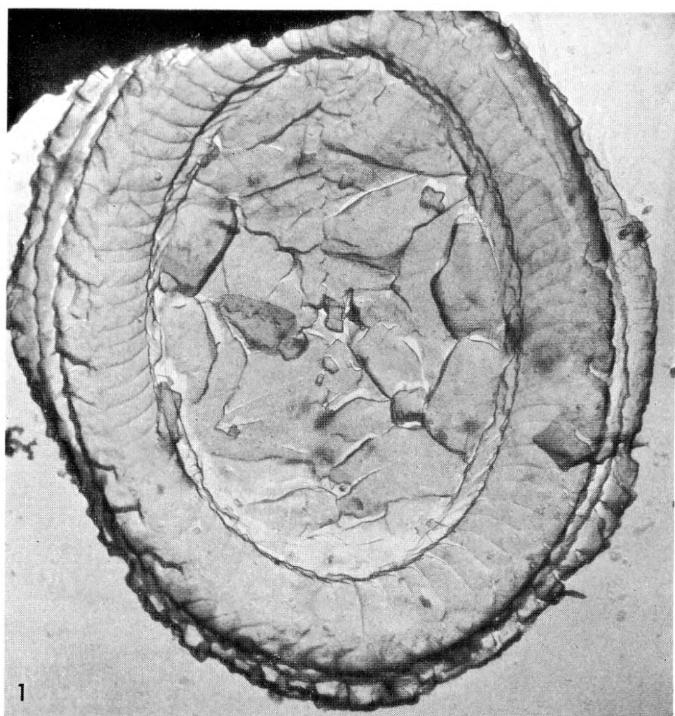
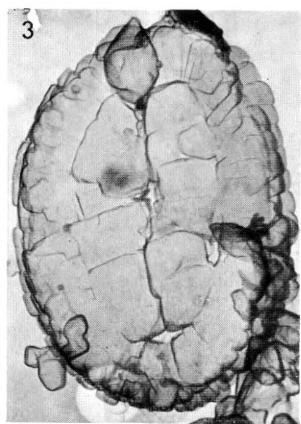
Fig. 2. Distale Ansicht eines grossen Exemplars. Die Schrägstellung der Randelemente ist gut zu erkennen.

Fig. 3–5. *Arkhangelskiella cymbiformis* VEKSINA. Elektronenmikroskopphotographien 9/30, 30/1, 45/24 aus dem unteren Maastrichtien von Mon, alle aus A 10. Distale Ansichten dreier verschiedener kleiner Formen, die vielleicht später z.T. aus dieser Art entfernt werden können.

Fig. 6–8. *Arkhangelskiella cymbiformis* VEKSINA. Lichtmikroskopaufnahmen DL 49–51, aus dem unteren Maastrichtien von Mon, A 19.

Vergrosserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ , die Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL XX



#### TAFEL XXI

Fig. 1, 2. *Arkhangelskiella parca* STRADNER. Elektronenmikroskopphotographien 54/32 und 41/17 aus dem unteren Maastrichtien von Mon, B 22, A 18.

Fig. 1. Distale Ansicht mit dem kleinen Zentrafeld und den merkwürdigen Randelementen.

Fig. 2. Basale Ansicht.

Fig. 3, 4. *Arkhangelskiella parca* STRADNER. Lichtmikroskopaufnahmen DG 46, 47 aus dem unteren Maastrichtien von Mon, A 25. Fig. 4 zwischen gekreuzten Nicols.

Fig. 5, 6. *Arkhangelskiella erratica* STOVER. Elektronenmikroskopphotographien 54/24 und 32/22 aus dem unteren Maastrichtien von Mon, B 22, A 25.

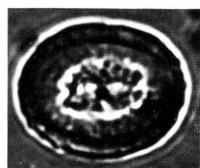
Fig. 5. Basale Ansicht.

Fig. 6. Distale Ansicht eines beschädigten Exemplars.

Fig. 7. Dasselbe Exemplar wie Fig. 6, im Lichtmikroskop, DG 39.

Vergrosserung: Elektronenmikroskopphotographien ca. 7500  $\times$  (Fig. 5 & 6) und ca. 6250  $\times$  (Fig. 1, 2).  
Lichtmikroskopaufnahmen 1800  $\times$ .

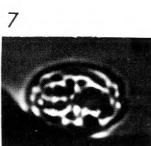
TAFEL XXI



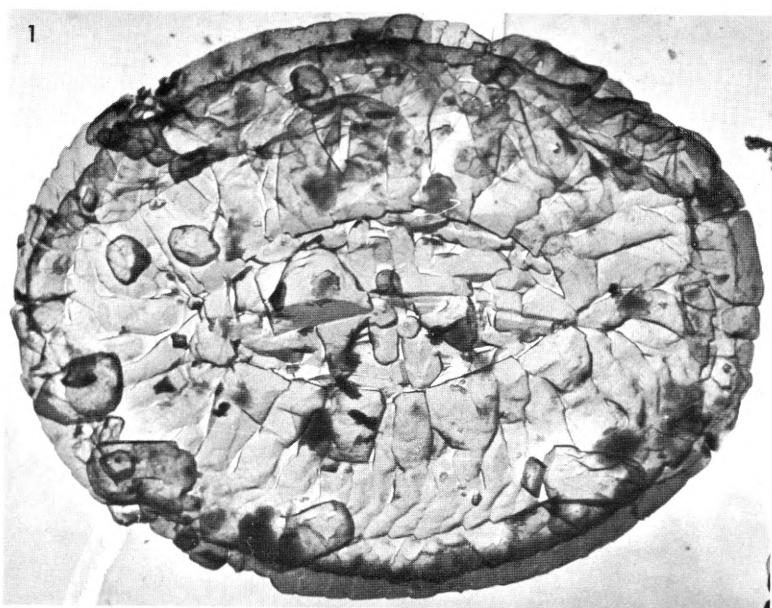
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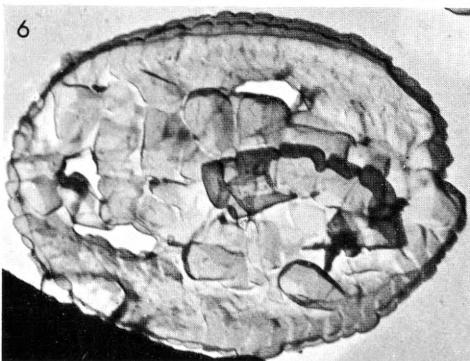
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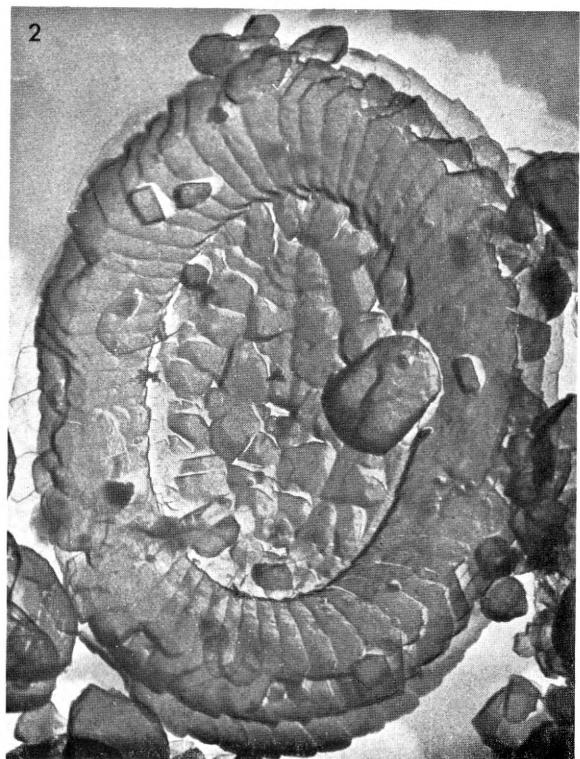
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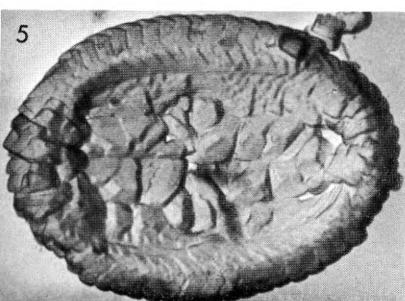
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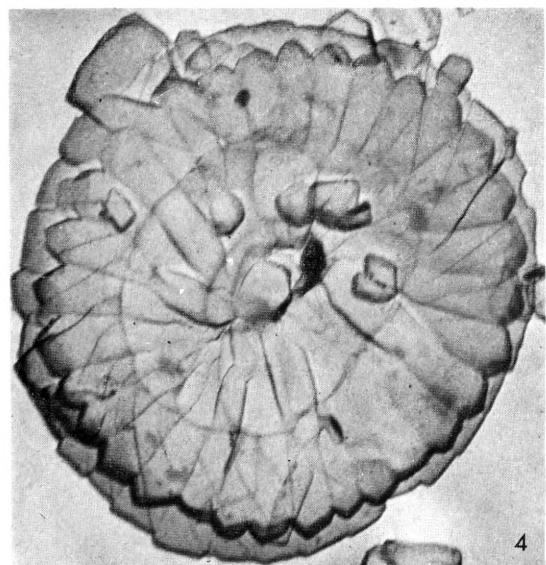
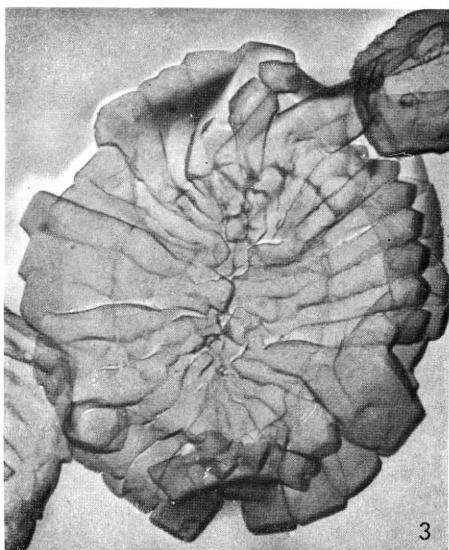
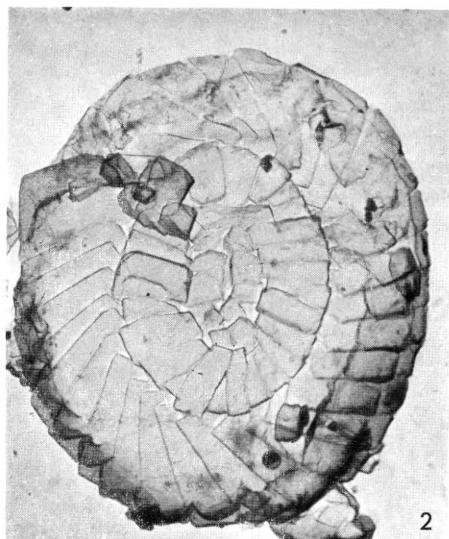
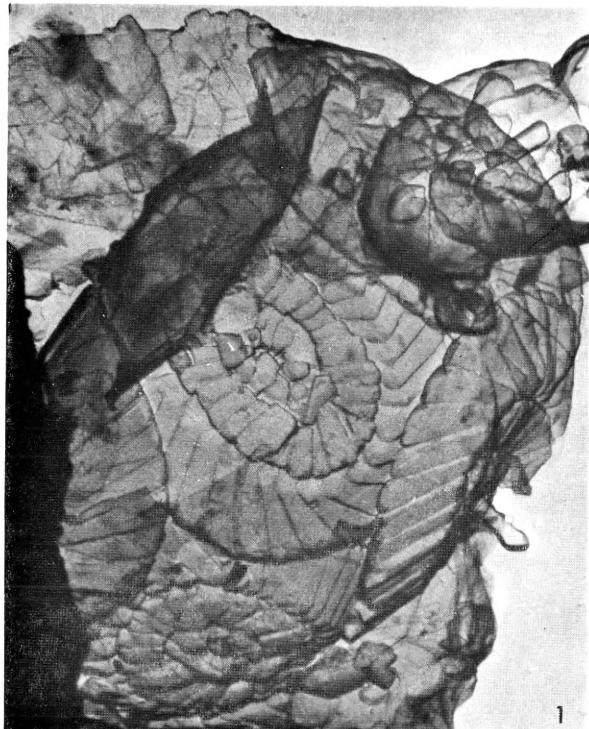
TAFEL XXII

*Watznaueria barnesae* (BLACK) n. comb.

- Fig. 1. Teil einer Coccospaere. Elektronenmikroskopphotographie 53/21 aus dem unteren Maastrichtien von Mon, B 22.  
Fig. 2. Distale Ansicht. Elektronenmikroskopphotographie 46/6 aus dem unteren Maastrichtien von Mon, B 13.  
Fig. 3, 4. Basale Ansicht, unterlagert von der Distalen („Transparenz“). Elektronenmikroskopphotographien 23/20 und 38/15 aus dem unteren Maastrichtien von Mon, A 27 und A 19.  
Fig. 5–7. Dasselbe Exemplar wie Fig. 4, im Lichtmikroskop, DL 52–54. Fig. 6 und 7 zwischen gekreuzten Nicols.

Vergrösserung: Fig. 1 ca. 6300 ×, Fig. 2–4 ca. 7500 ×. Lichtmikroskopaufnahmen 1800 ×.

TAFEL XXII

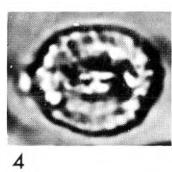
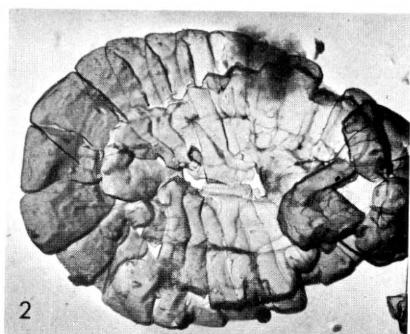
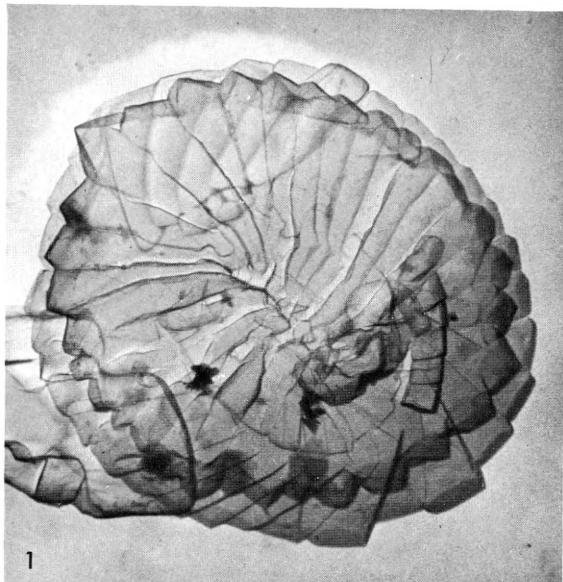


TAFEL XXIII

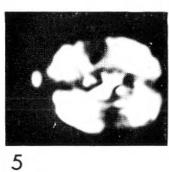
- Fig. 1. *Watznaueria barnesae* (BLACK) n. comb. Basale Ansicht unterlagert von der distalen Ansicht („Transparenz“). Elektronenmikroskopphotographie 23/18 aus dem unteren Maastrichtien von Mön, A 27.
- Fig. 2, 3. *Biscutum asymmetricum* n. sp. Fig. 2 Holotypus. Basale Ansichten. Elektronenmikroskopphotographien 54/3 und 23/23 aus dem unteren Maastrichtien von Mön, A 27 und B 22.
- Fig. 13–15. *Biscutum asymmetricum* n. sp. im Lichtmikroskop zwischen gekreuzten Nicols, DL 30–32 aus dem unteren Maastrichtien von Mön, A 19.
- Fig. 6. *Markalius reinhardtii* n. sp. Distale Ansicht eines beschädigten Exemplares. Elektronenmikroskopphotographie 41/25 aus dem unteren Maastrichtien von Mön, A 18.
- Fig. 7, 8. Dasselbe Exemplar wie Fig. 6, im Lichtmikroskop, DN 16, 17. Fig. 8 zwischen gekreuzten Nicols.
- Fig. 9. *Biscutum? supracretaceus* (REINHARDT) n. comb. Elektronenmikroskopphotographie 35/16 aus dem unteren Maastrichtien von Mön, A 11.
- Fig. 10–12. Dasselbe Exemplar wie Fig. 9, im Lichtmikroskop, DH 42–44. Fig. 11 und 12 zwischen gekreuzten Nicols.
- Fig. 4, 5, 16. *Watznaueria barnesae* (BLACK) n. comb. Distale Ansicht im Lichtmikroskop, DL 40–42. Fig. 5 und 16 zwischen gekreuzten Nicols.

Vergrösserung: Elektronenmikroskopphotographien ca. 7500 ×. Lichtmikroskopaufnahmen 1800 ×.

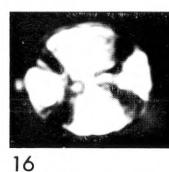
TAFEL XXIII



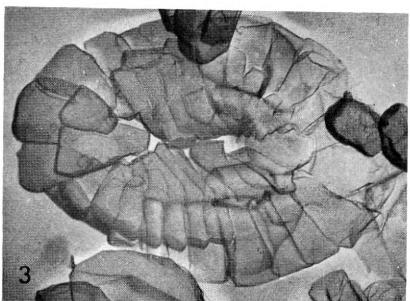
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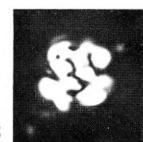
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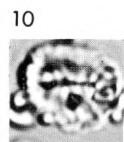
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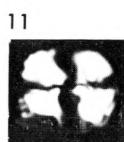
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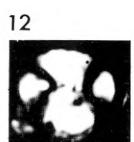
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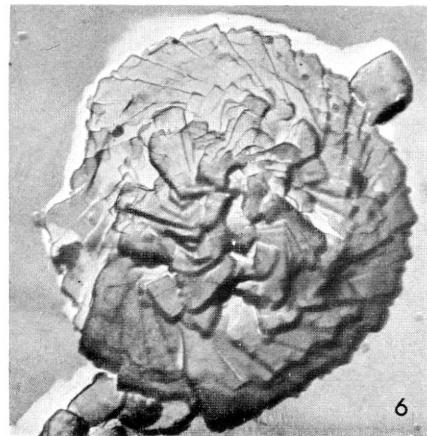
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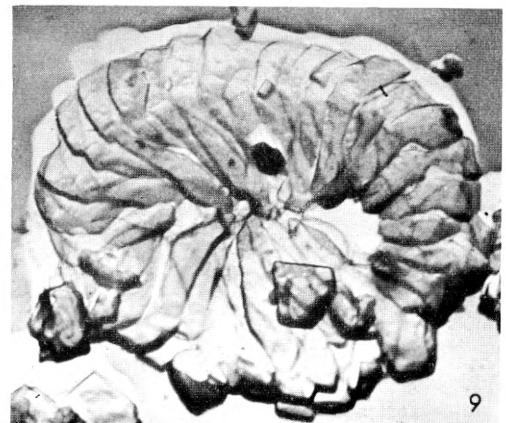
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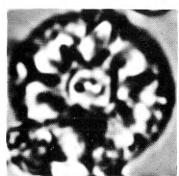
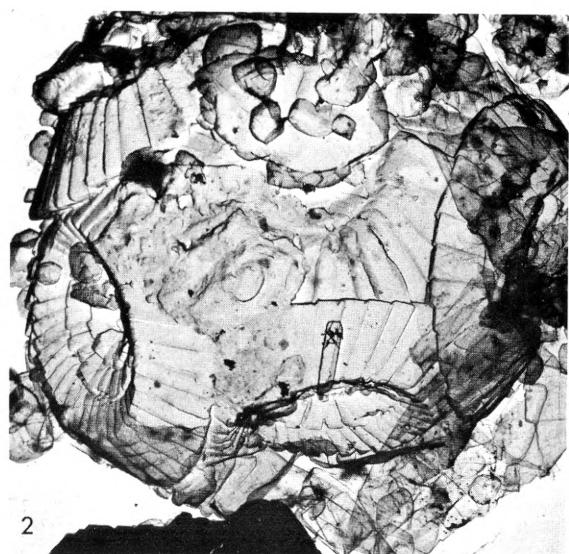
TAFEL XXIV

*Markalius inversus* (DEFLANDRE) BRAMLETTE & MARTINI.

- Fig. 1. Distale Ansicht eines schräg liegenden Exemplares. Elektronenmikroskopphotographie 36/20 aus dem unteren Maastrichtien von Mon, A 11.  
Fig. 2. Teil einer Coccoosphaere. Elektronenmikroskopphotographie 40/2 aus dem unteren Maastrichtien von Mon, A 18.  
Fig. 3, 4. Basale Ansicht desselben Exemplares unter verschiedenen Winkeln. Elektronenmikroskopphotographien 38/20 und 38/7 aus dem unteren Maastrichtien von Mon, A 19.  
Fig. 5, 6. Dasselbe Exemplar wie Fig. 3, 4 im Lichtmikroskop, DL 67, 68. Fig. 6 zwischen gekreuzten Nicols.  
Fig. 7, 8. Lichtmikroskopaufnahme in distaler Sicht, DL 38, 39, aus dem unteren Maastrichtien von Mon, A 19. Fig. 8 zwischen gekreuzten Nicols.

Vergrösserung: Fig. 1, 3, 4: ca. 7500  $\times$ , Fig. 2 ca. 5000  $\times$ . Alle Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL XXIV



7



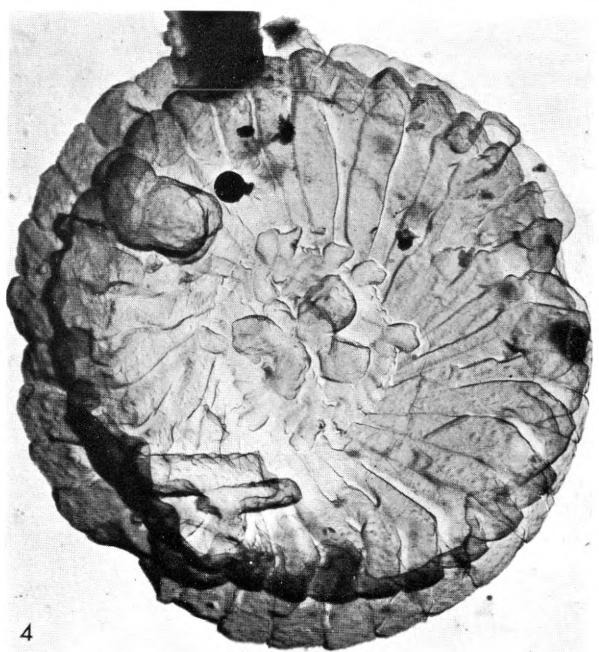
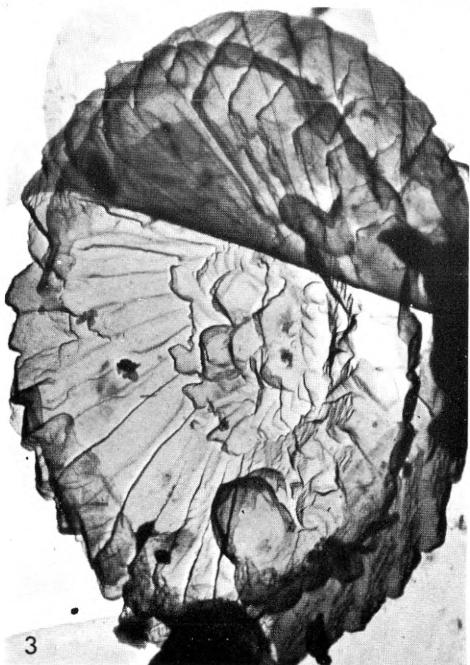
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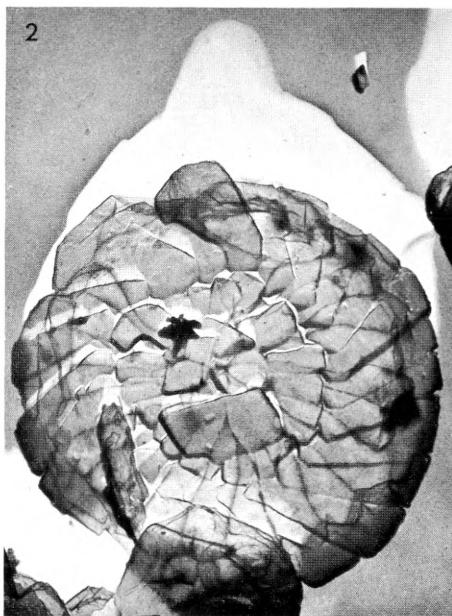
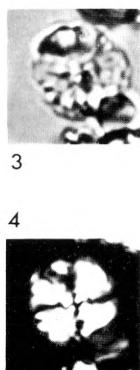
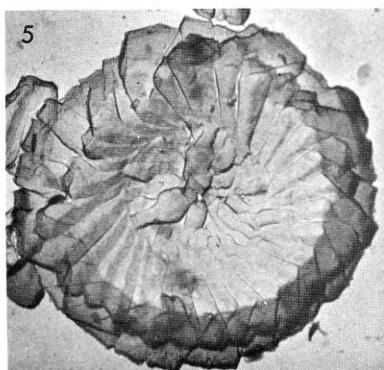
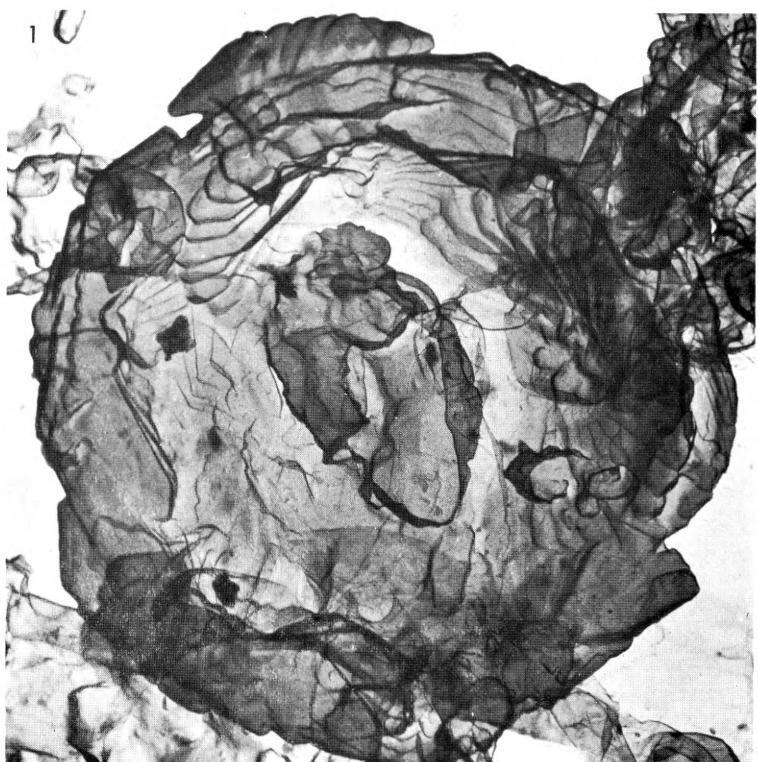
6



TAFEL XXV

- Fig. 1. *Markalius inversus* (DEFLANDRE) BRAMLETTE & MARTINI. Teil einer Coccospaere. Elektronenmikroskopphotographie 55/23 aus dem unteren Maastrichtien von Mon, A 10.
- Fig. 2. *Markalius circumradiatus* (STOVER) n. comb. Distale Ansicht eines Exemplares mit überdecktem Zentrum. Elektronenmikroskopphotographie 34/5 aus dem unteren Maastrichtien von Mon, A 11.
- Fig. 3, 4. Dasselbe Exemplar wie Fig. 2 im Lichtmikroskop, DH 45, 46. Fig. 4 zwischen gekreuzten Nicols.
- Fig. 5. *Markalius circumradiatus* (STOVER) n. comb. Basale Ansicht. Der an einer Stelle abgebrochene Rand zeigt, dass die beiden Scheiben auf weniger als 1/3 ihres Radius voneinander unabhängig sind. Elektronenmikroskopphotographie 54/30 aus dem unteren Maastrichtien von Mon, B 22.
- Fig. 6, 7. *Markalius circumradiatus* (STOVER) n. comb. Dasselbe Exemplar wie die Textfigur 37, im Lichtmikroskop, DN 5, 6. Fig. 7 zwischen gekreuzten Nicols.
- Fig. 8. *Lithraphidites quadratus* BRAMLETTE & SULLIVAN. Elektronenmikroskopphotographie 63/8 aus dem oberen Maastrichtien von Kjolby Gård.
- Fig. 9. Dasselbe Exemplar wie Fig. 8, im Lichtmikroskop, DP 71.

Vergrösserung: Fig. 1 ca. 6300  $\times$ , Fig. 2, 5, 8 ca. 7500  $\times$ . Alle Lichtmikroskopaufnahmen 1800  $\times$ .



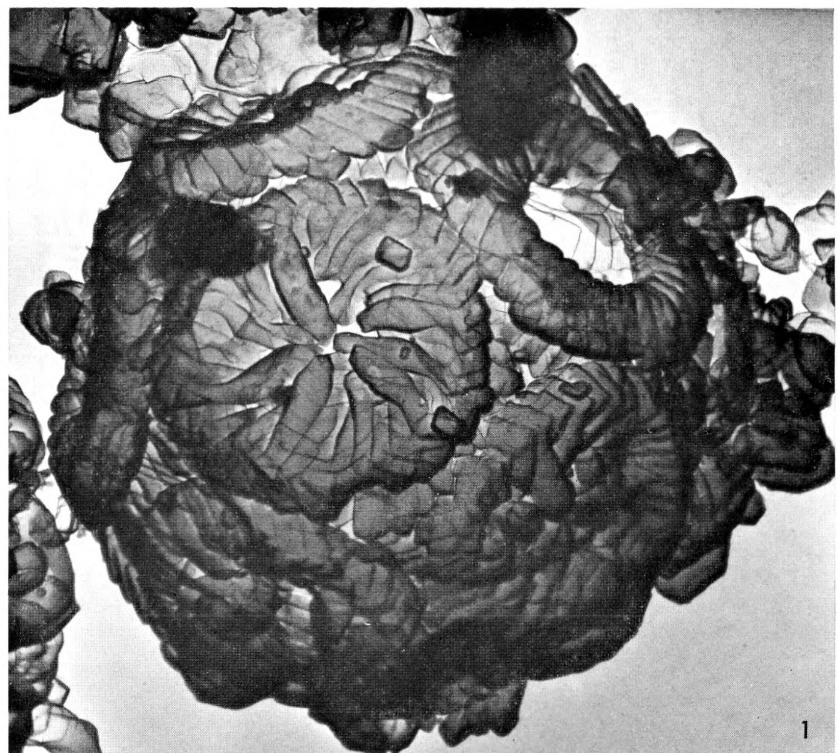
TAFEL XXVI

*Markalius circumradiatus* (STOVER) n. comb.

- Fig. 1. Coccospaere. Elektronenmikroskopphotographie 58/10 aus dem unteren Maastrichtien von Mon, A 11.  
Fig. 2. Distale Ansicht eines Exemplars mit unbedecktem Zentralteil. Elektronenmikroskopphotographie 58/2, aus dem unteren Maastrichtien von Mon, A 11.  
Fig. 3. Distale Ansicht eines Exemplars mit bedecktem Zentralteil. Elektronenmikroskopphotographie 40/13 aus dem unteren Maastrichtien von Mon, A 10.  
Fig. 4, 5. Dasselbe Exemplar wie Fig. 3, im Lichtmikroskop, DM 68, 69. Fig. 5 zwischen gekreuzten Nicols.  
Fig. 6, 7. Distale Ansicht im Lichtmikroskop, DM 74, 75, aus dem unteren Maastrichtien von Mon, A 10.  
Fig. 7 zwischen gekreuzten Nicols.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ , die Lichtmikroskopaufnahmen 1800  $\times$ .

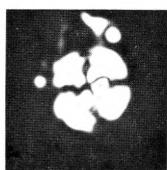
TAFEL XXVI



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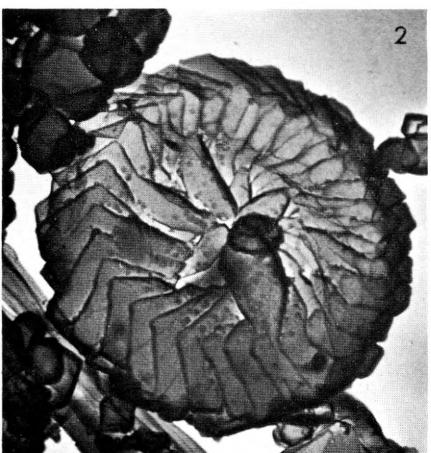
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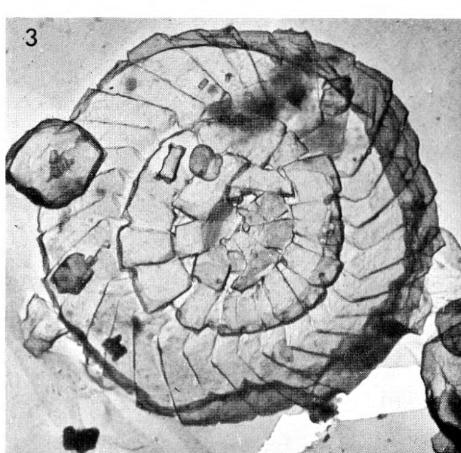
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TAFEL XXVII

*Biscutum constans* (GORKA) BLACK.

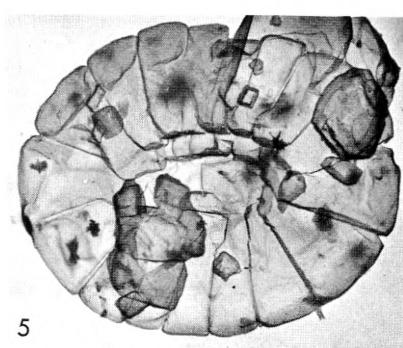
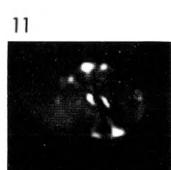
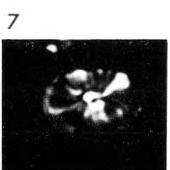
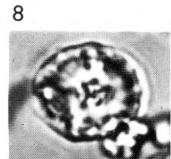
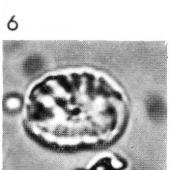
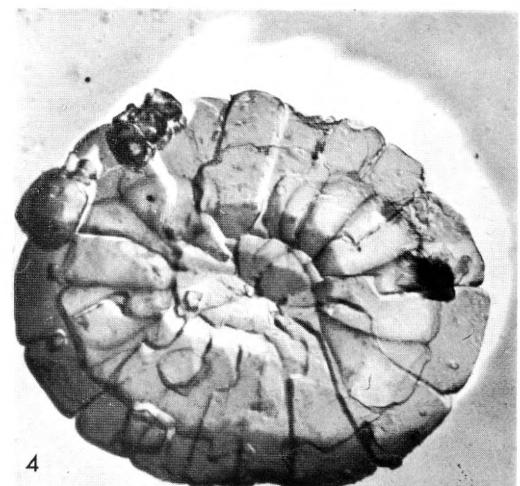
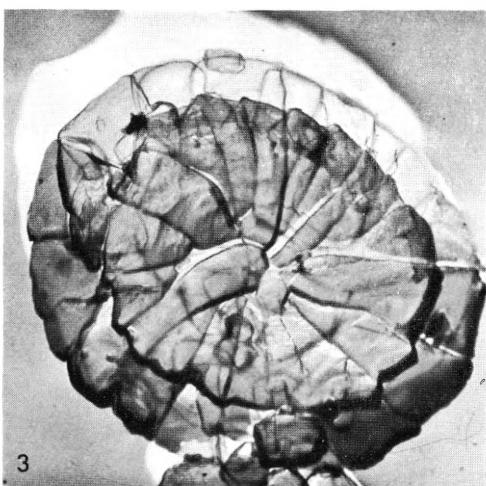
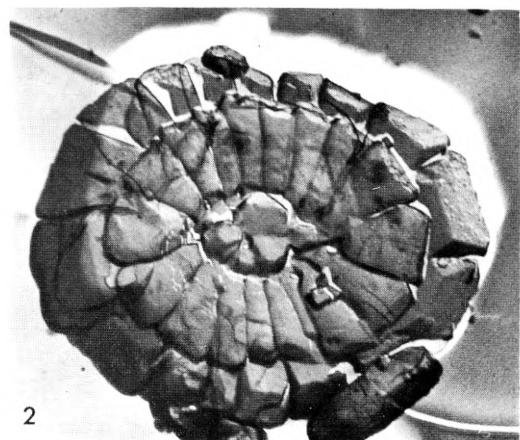
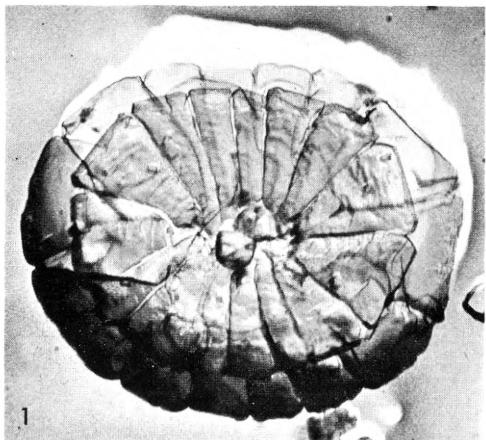
Fig. 1–3. Basale Ansichten. Elektronenmikroskopphotographien 35/13, 32/31 und 35/3 aus dem unteren Maastrichtien von Mon, A 11, A 15, A 11.

Fig. 4, 5. Distale Ansichten. Fig. 4 zeigt in „Transparenz“ auch die basale Randscheibe. Elektronenmikroskopphotographien 32/30 und 54/22 aus dem unteren Maastrichtien von Mon, A 15 und B 22.

Fig. 6, 7. Dasselbe Exemplar wie Fig. 1, im Lichtmikroskop, DH 36, 37. Fig. 7 zwischen gekreuzten Nicols. Fig. 8, 9. Dasselbe Exemplar wie Fig. 3, im Lichtmikroskop, DH 34, 35. Fig. 9 zwischen gekreuzten Nicols. Fig. 10, 11. Dasselbe Exemplar wie Fig. 4, im Lichtmikroskop, DK 16, 17. Fig. 11 zwischen gekreuzten Nicols.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ , alle Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL XXVII

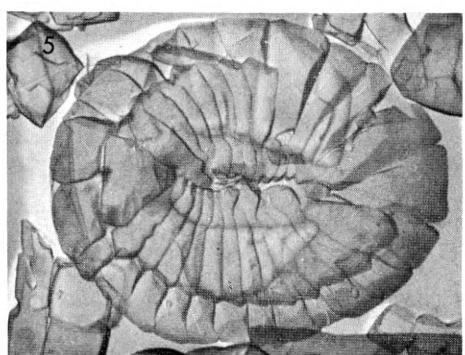
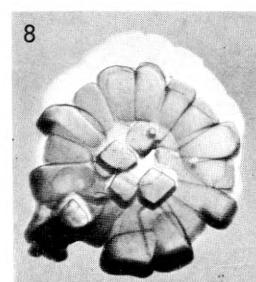
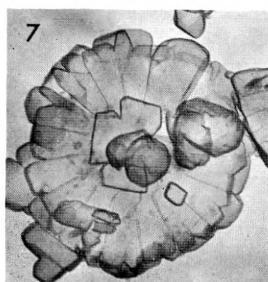
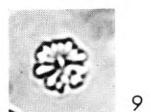
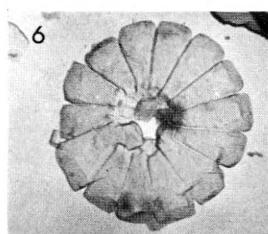
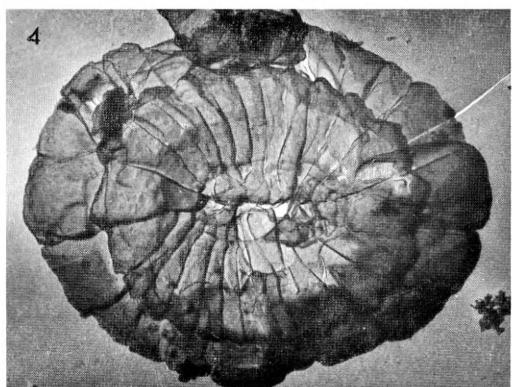
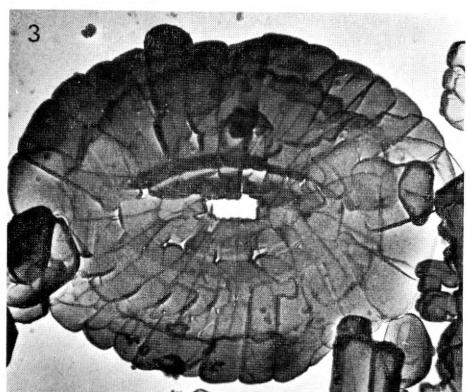
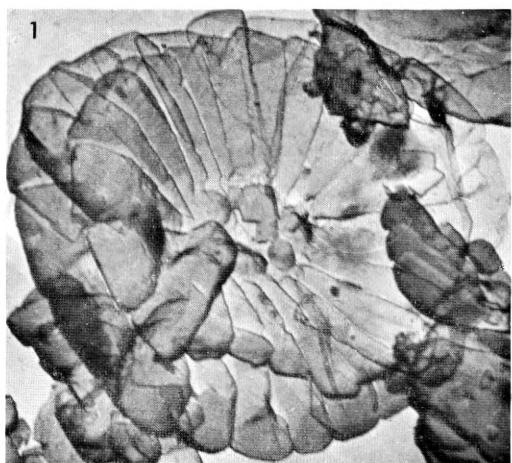
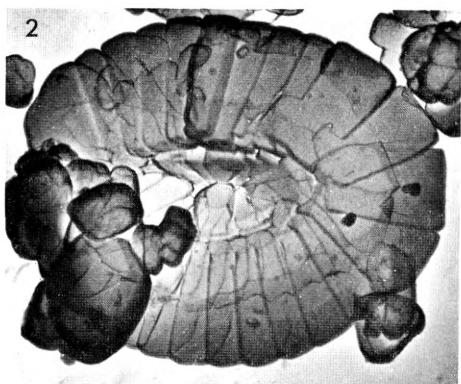


#### TAFEL XXVIII

- Fig. 1. *Biscutum castrorum* BLACK. Schräge, basale Ansicht. Elektronenmikroskopphotographie 39/10 aus dem unteren Maastrichtien von Mon, A 22.
- Fig. 2, 3. *Biscutum castrorum* BLACK. Distale Ansicht, wobei die basale Randscheibe dank der „Transparenz“ teilweise sichtbar ist. Elektronenmikroskopphotographien 59/27 und 60/10 aus dem unteren Maastrichtien von Mon, B 3 und A 18.
- Fig. 4, 5. *Biscutum castrorum* BLACK. Basale Ansicht. Elektronenmikroskopphotographien 55/31 und 23/26 aus dem unteren Maastrichtien von Mon, A 18, A 27.
- Fig. 6–8. *Discorhabdus ignotus* (GORKA) n. comb. Elektronenmikroskopphotographien 54/14, 8/33 und 33/18 aus dem unteren Maastrichtien von Mon, B 22, A 17, A 15.
- Fig. 9. Dasselbe Exemplar wie Fig. 8, im Lichtmikroskop, DI 68.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500 ×, die Lichtmikroskopaufnahme 1800 ×.

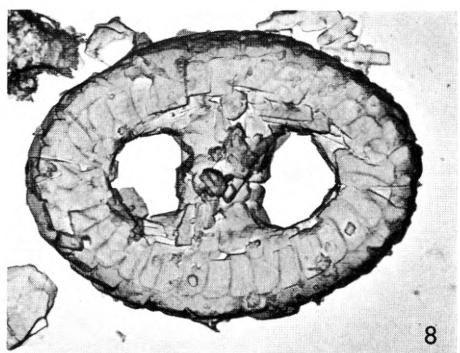
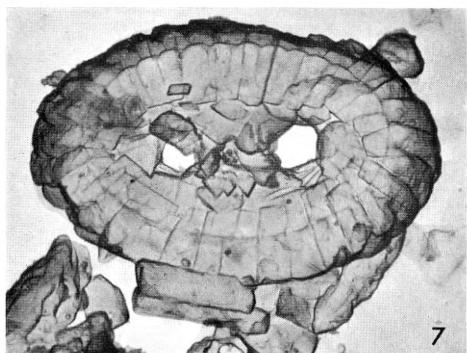
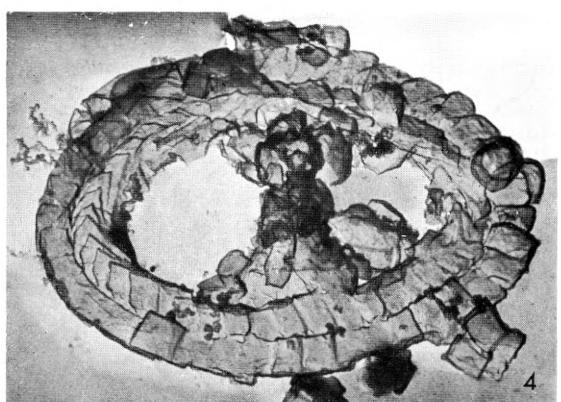
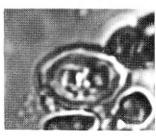
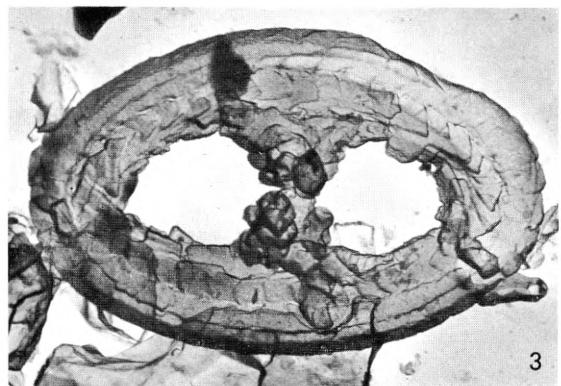
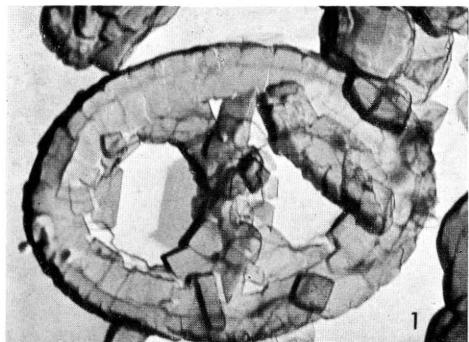
TAFEL XXVIII



TAFEL XXIX

- Fig. 1. *Zygodiscus ponticulus* DEFLANDRE. Elektronenmikroskopphotographie 35/18, aus dem unteren Maastrichtien von Mon, A 11.
- Fig. 2. Dasselbe Exemplar wie Fig. 1, im Lichtmikroskop, DH 64.
- Fig. 3, 4. *Zygodiscus acanthus* (REINHARDT) REINHARDT. Elektronenmikroskopphotographien 55/16 und 40/20 aus dem unteren Maastrichtien von Mon, A 10.
- Fig. 5, 6. Dasselbe Exemplar wie Fig. 4, im Lichtmikroskop, DM 66, 67. Fig. 6 zwischen gekreuzten Nicols.
- Fig. 7, 8. *Zygodiscus spiralis* BRAMLETTE & MARTINI. Elektronenmikroskopphotographien 62/29 und 62/23 aus dem oberen Maastrichtien von Kjolby Gård.
- Fig. 9, 10. *Zygodiscus spiralis* BRAMLETTE & MARTINI. im Lichtmikroskop, DG 8, 9 aus dem unteren Maastrichtien von Mon, A 4.
- Fig. 11–13. *Zygodiscus spiralis* BRAMLETTE & MARTINI im Lichtmikroskop, DO 37–39, aus dem Maastrichtien von Gora Pulawska, Polen.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ , die Lichtmikroskopaufnahmen 1800  $\times$ .



TAFEL XXX

- Fig. 1. *Microrhabdulus attenuatus* (DEFLANDRE) DEFLANDRE. Elektronenmikroskopphotographie 9/28 aus dem unteren Maastrichtien von Mon, B 13.
- Fig. 2. *Microrhabdulus* sp. Elektronenmikroskopphotographie 35/19 aus dem unteren Maastrichtien von Mon, A 11.
- Fig. 3, 4. Dasselbe Exemplar wie Fig. 2, im Lichtmikroskop, DH 71, 72. Fig. 4 zwischen gekreuzten Nicols.
- Fig. 5, 6. *Microrhabdulus attenuatus* (DEFLANDRE) DEFLANDRE. Elektronenmikroskopaufnahmen 47/20 und 35/8 aus dem unteren Maastrichtien von Mon, A 10, A 11.
- Fig. 7, 8, 9. Dasselbe Exemplar wie Fig. 6 im Lichtmikroskop, DH 28, 29, 30. Fig. 8, 9 zwischen gekreuzten Nicols.
- Fig. 10, 11. *Microrhabdulus decoratus* DEFLANDRE. Elektronenmikroskopphotographien 59/1, 33/16 aus dem unteren Maastrichtien von Mon, B 3 und A 15.
- Fig. 12–15. *Lucianorhabdus cayeuxi* DEFLANDRE. Lichtmikroskopaufnahmen DP 76, 77 und DM 78, 79 aus dem unteren Maastrichtien von Mon, B 22, A 10.

Vergrosserung: Fig. 1 ca. 7000  $\times$ , Fig. 2 ca. 6000  $\times$ , Fig. 5 ca. 5000  $\times$ , Fig. 6 ca. 3700  $\times$ , Fig. 10, 11 ca. 7500  $\times$ . Die Lichtmikroskopaufnahmen 1800  $\times$ .

TAFEL XXX



14



15



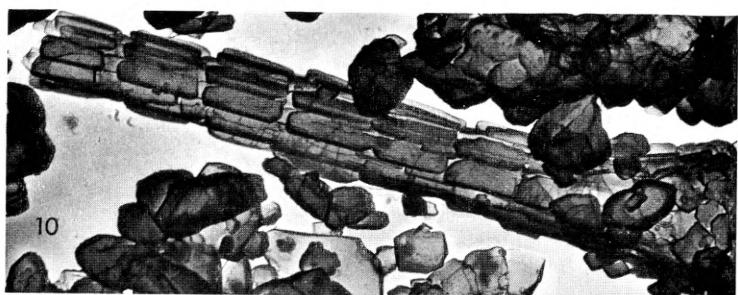
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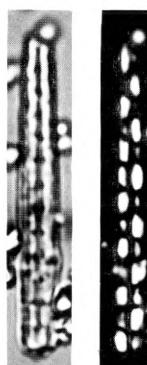
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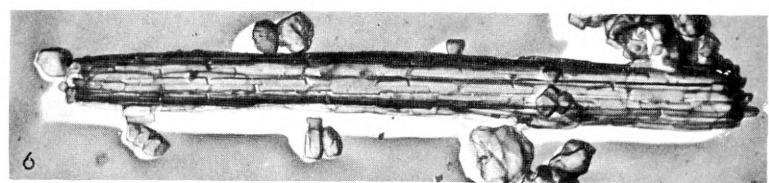
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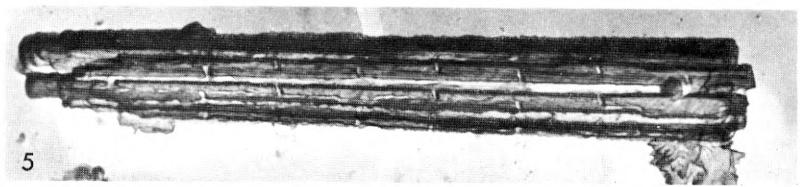
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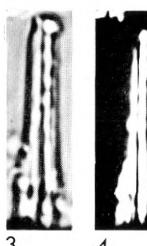
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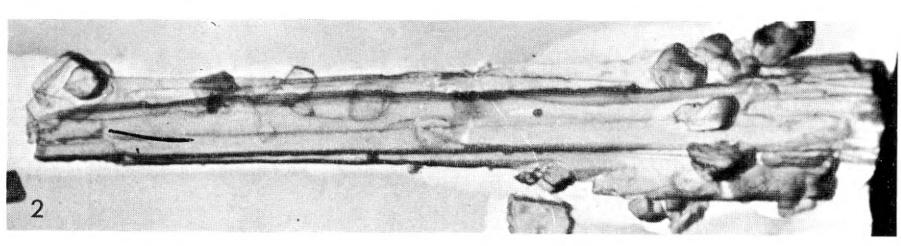
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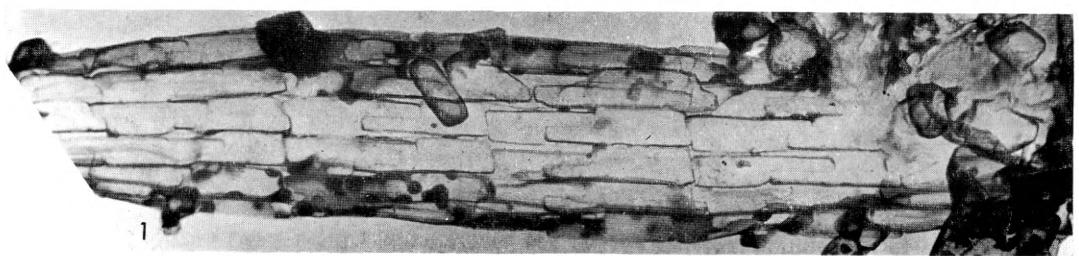
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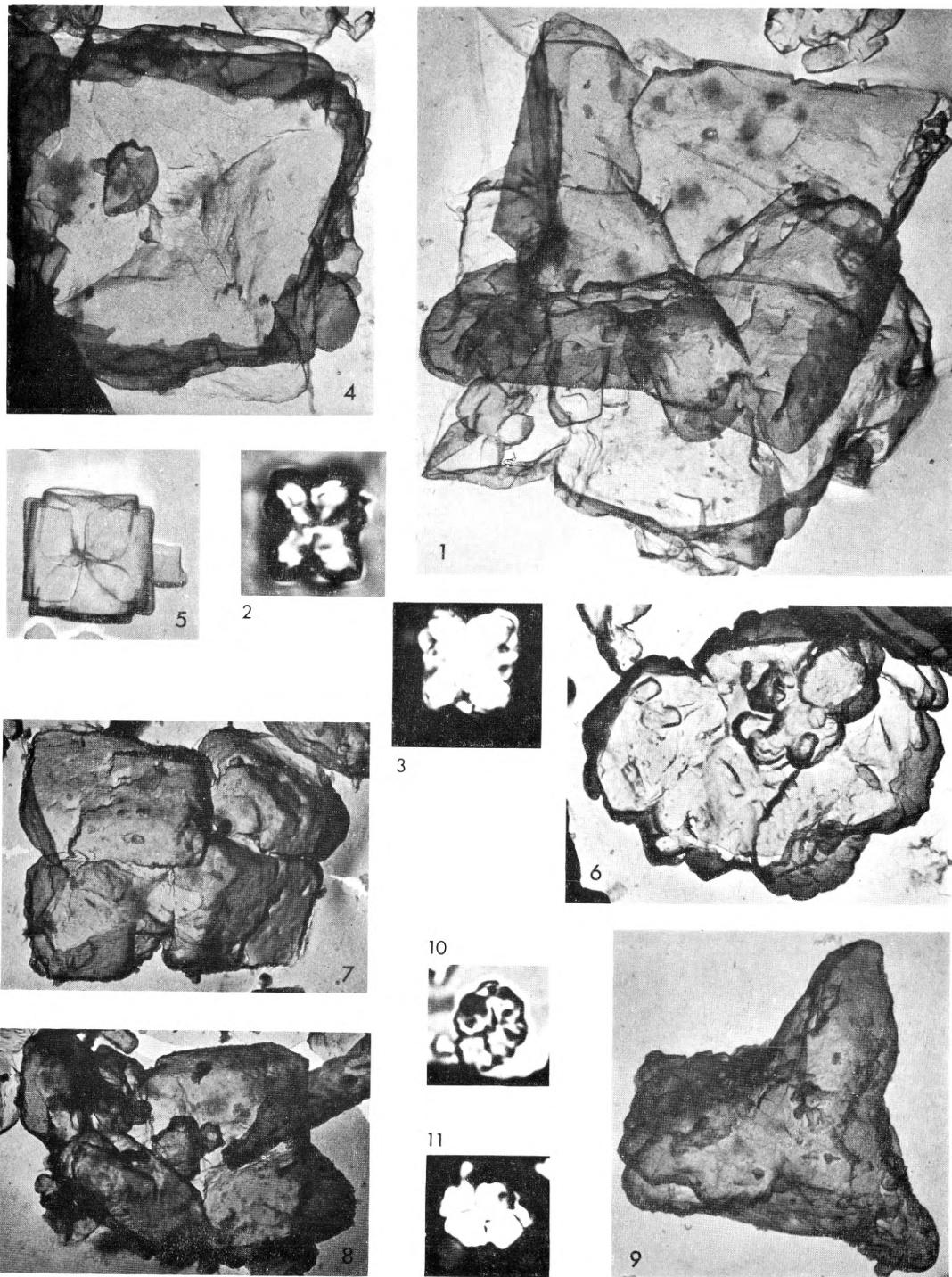
1

## TAFEL XXXI

- Fig. 1, 4, 5. *Micula staurophora* (GARDET) STRADNER. Exemplare verschiedener Grösse und unter verschiedenem Winkel. Elektronenmikroskopphotographien 40/10, 40/11 und 23/31 aus dem unteren Maastrichtien von Mon, A 10, A 10 und A 27.
- Fig. 2, 3. Dasselbe Exemplar wie Fig. 1, im Lichtmikroskop, DM 64, 65. Fig. 3 zwischen gekreuzten Nicols.
- Fig. 6. *Tetralithus obscurus* DEFLANDRE. Elektronenmikroskopphotographie 63/7 aus dem oberen Maastrichtien von Kjolby Gård.
- Fig. 7, 8. *Tetralithus obscurus* DEFLANDRE. Aussenseite und Innenseite. Elektronenmikroskopphotographien 60/16, 60/17 aus dem Maastrichtien von Grodno.
- Fig. 9. *Marthasterites inconspicuus* DEFLANDRE. Elektronenmikroskopphotographie 62/27 aus dem oberen Maastrichtien von Kjolby Gård.
- Fig. 10, 11. Dasselbe Exemplar wie Fig. 6, im Lichtmikroskop, DP 66, 67. Fig. 11 zwischen gekreuzten Nicols.

Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ , die Lichtmikroskopaufnahmen 1800  $\times$ .

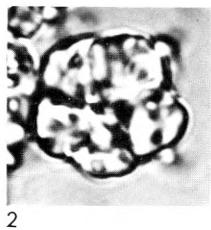
TAFEL XXXI



TAFEL XXXII

- Fig. 1. *Braarudosphaera bigelowi* (GRAN & BRAARUD) DEFLANDRE. Elektronenmikroskopphotographie 35/22 aus dem unteren Maastrichtien von Mon, A 11.
- Fig. 2, 3. Dasselbe Exemplar wie Fig. 1, im Lichtmikroskop, DH 40, 41. Fig. 3 zwischen gekreuzten Nicols.
- Fig. 4, 6. *Deflandrius* sp. Elektronenmikroskopphotographien 34/14 und 35/25 aus dem unteren Maastrichtien von Mon, A 11, A 10.
- Fig. 5. Dasselbe Exemplar wie Fig. 4, im Lichtmikroskop, DH 70.
- Fig. 7. Dasselbe Exemplar wie Fig. 6, im Lichtmikroskop, DG 72.
- Fig. 8. *Eiffellithus regularis* (GORKA) n. comb. Elektronenmikroskopphotographie 45/19 aus dem Maastrichtien von Mecmierz, Polen.
- Fig. 9. *Eiffellithus regularis* (GORKA) n. comb. Elektronenmikroskopphotographie 62/7 aus dem oberen Maastrichtien von Kjolby Gård.

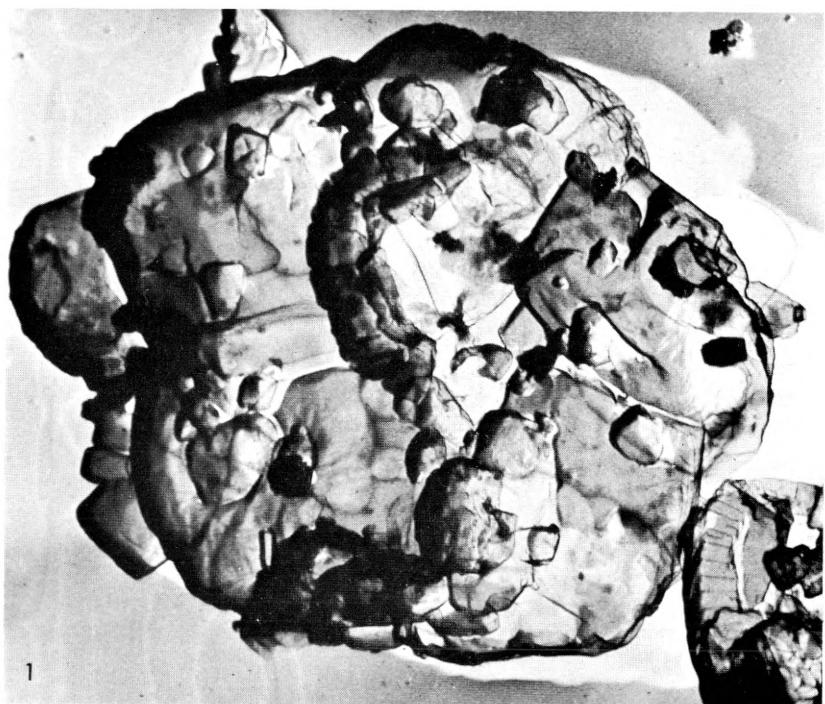
Vergrösserung: Alle Elektronenmikroskopphotographien ca. 7500  $\times$ , die Lichtmikroskopaufnahmen 1800  $\times$ .



2



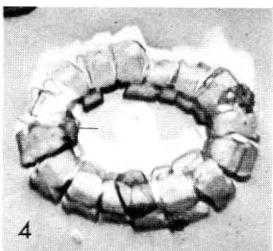
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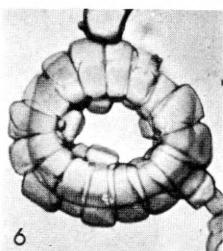
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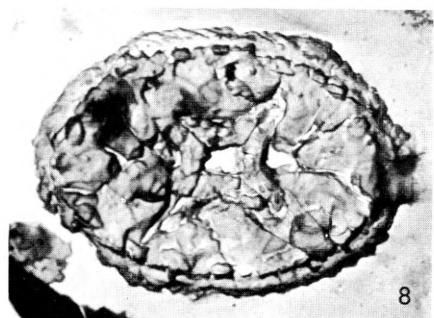
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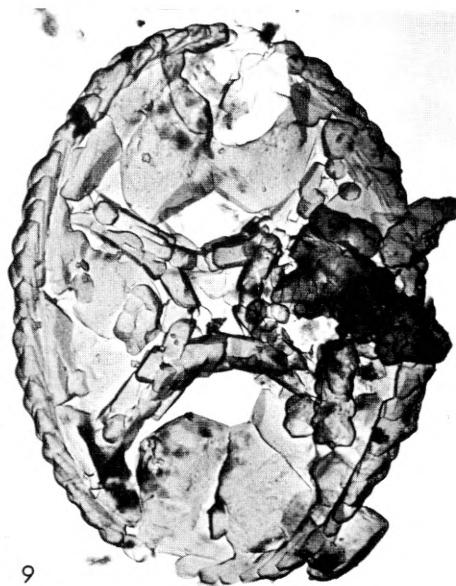
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8



9



Det Kongelige Danske Videnskabernes Selskab

Biologiske Skrifter

Biol. Skr. Dan. Vid. Selsk.

Bind 11 (kr. 162.-)

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MARIE HAMMER

# INVESTIGATIONS ON THE ORIBATID FAUNA OF NEW ZEALAND

With a Comparison between the Oribatid Fauna of  
New Zealand and that of the Andes Mountains, South America

## PART III

Det Kongelige Danske Videnskabernes Selskab  
Biologiske Skrifter 16, 2



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### Synopsis

The present paper is Part III of my investigations into the oribatid fauna of New Zealand. A hundred species are mentioned here, mainly within the genus *Oppia* and the group Galumnoidea. Through all the investigations (Parts I-III) the number of species of oribatids recorded from New Zealand has risen from 7 to 312. On the basis of these it has been tried to give an account of the origin of the oribatid fauna of New Zealand, as well as its connexion with the oribatid fauna of South America. 39 species have a wide distribution over large regions of the earth. They must be assumed to have existed before New Zealand became an isolated area. Their age can be estimated at about 100 million years. 17 species are common to New Zealand and South America. Some of these, within the genus *Trimalaconothrus*, show some special morphological characters which suggest Transantarctic relationships. The number of presumably endemic species constitute 82 per cent. This percentage is lower than the percentage of insects and must be due to the fact that a number of New Zealand oribatids arose before the connexion between New Zealand and South America was finally broken off.

## Preface

The present paper constitutes Part III of my Investigations on the Oribatid Fauna of New Zealand. A hundred species have been described or mentioned, mainly belonging to the genus *Oppia* in the widest sense of the term and to the group Galumnoidea. Furthermore, eight species have been described which have been found at a revision of the material and which belong in Parts I-II. I shall here take the opportunity of thanking the large number of colleagues with whom I have collaborated for many years, by naming species within "*Oppia*" after them. Prominent deceased research workers have also been commemorated in this way.

For permission to use material collected in birds' nests in New Zealand I am most obliged to Dr. J. L. GRESSITT, Bernice P. Bishop Museum, Honolulu, Hawaii. The Forest Research Institute, Whakarewarewa, Rotorua, New Zealand, has also placed a few species at my disposal, for which I offer the Institute my best thanks.

Furthermore, I offer my most cordial thanks to the Directors of the Carlsberg Foundation, who have continued granting me economic support during the working up of the material.

I owe an immense debt of gratitude to the Royal Danish Academy of Sciences and Letters, who has undertaken the printing of my many papers on the distribution of the oribatids, a debt which I shall never be able to pay, even with my warmest thanks.

I am also much obliged to the Rask-Ørsted Foundation for paying the translation.

I also most cordially thank Mr. NIELS HAISLUND, Cand. mag., who has translated part of the manuscript and revised the rest and always has assisted me in cases of doubt.

*Fredensborg, June 1967.*

MARIE HAMMER



## Introduction

The publication of Part III of the *Investigations on the Oribatid Fauna of New Zealand* for the time being concludes the great investigations of the distribution of the oribatids which I started in East Greenland in 1933. In the first publication proper, *Studies on the Oribatids and Collemboles* (1944) I showed that the microfauna of Greenland (oribatids and collemboles) mainly was of European origin, and that presumably it had to a great extent survived the Glacial Age in Greenland. Greenland was considered part of a European faunal area which at the continental shift had drifted towards the west.

My investigations in Arctic Canada corroborated that the microfauna of Greenland on the whole is of European origin, although a few more continental species have later immigrated from North America (HAMMER 1952–53).

The investigations into the oribatids of the Andes Mountains showed no relationship with Arctic or North European ones, but some genera, which besides from the Andes Mountains are also known from the Pacific area, directed my attention to that area. It seems increasingly convincing to me that the oribatids, which have very poor possibilities of spreading, by their pattern of distribution may make it probable that there was formerly a land connexion on the southern hemisphere, as they had done on the northern hemisphere in my first investigations. At first, it was impossible to carry through such investigations, as our knowledge of the oribatids (their taxonomy and distribution) when I started 35 years ago was extremely poor, and the information available was not reliable. When an oribatid found e.g. in Chile or another South American country had been recorded under a European name, but no description or drawing was available and the individual had been lost, the information about its presence in the country in question was worth nothing. In the case of each country I therefore had to start afresh with a description of the large number of species collected by me. Such investigations, which e.g. in the case of a group of insects, which usually are fairly well known in a systematic respect, might be made at a desk in comparatively short time, have, because of the huge work: the collecting, the sorting out, the preparation, the work of drawing, and the descriptions, including the descriptions of some 600–700 new species, taken about 35 years. This large number of new species, of course, only constitutes a small part of the existing number, but they are

sufficient to give an impression of the oribatid fauna of the countries in question so that comparisons are justifiable. For instance, it may be stated that New Zealand when the present investigations started, had seven described species. Now about 330 species are known. South America showed the same picture. Only after a number of years' work there was a basis of investigation. A comparison between the oribatid fauna of these two territories is now possible. The result of the investigations during this long period shows that the oribatid faunas of South America and New Zealand are closely related, which must mean that these areas once were connected by land. The comparison, however, suffers by our very defective knowledge of the oribatid fauna in the Pacific area (see below).

The recent oribatids of New Zealand have so far been mentioned only in the following papers: MONIEZ (1894), a species which, because of the brief description, it has not been possible to identify. MICHAEL (1908), 6 species, 4 of which have been found again at the present investigations. They have been mentioned in the introduction to Part I.

LAMB (1952), no new species.

WOOLLEY (1965), one species, which has been found again and is mentioned in Part I, p. 72.

RAMSAY (1966), two species: *Multoribates scheloribatoides* and *Zygoribatula magna*, the former seemingly identical with *Setobates minor* Ham. mentioned in Part II, p. 35 (1967). As Ramsay's species, which belongs to the species *Setobates*, has priority over *S. minor* Ham., this species must be termed *Setobates scheloribatoides* (Ramsay). *Zygoribatula magna* seems to be very similar to *Z. connexa* (Berl.), although a little larger. The latter is mentioned in Part II, p. 47. (In 1962 RAMSAY described 25 species from The Brothers in Cook Strait, 5 of which have been found in New Zealand and described in Part I, 2 in Part II. I have not found the other 18 species or been able to recognize them from the paratypes sent to me by RAMSAY. They had been prepared differently from my method, which made it impossible to distinguish the large number of details. RAMSAY's manuscript has not yet been published).

In HAMMER (1966) Part I 90 new species were described.

In HAMMER (1967) Part II 65 new species were described.

In the present work, Part III, 10 new genera have been set up and 89 new species have been described.

About 330 species are known from New Zealand, among them some species with a wide distribution over the earth.

Again I want expressly to state that I have never intended to give a detailed description of all species, which would have required several generations. The descriptions of the large number of species are so detailed that probably it will always be possible to recognize the species. My chief purpose has been to obtain a certain knowledge of the oribatid faunas of the areas investigated so that it would be possible for me to carry through a comparison between the oribatid faunas in South America and New Zealand.

### List and Descriptions of the Species Found

In order to keep in order the great material of "*Oppia*" *sensu lato* from New Zealand, more than 80 species, it is necessary to set this chaos which the genus "*Oppia*" represents, to rights. The point has almost been reached when any oribatid of a definite small size and with an appearance which "reminds" of "*Oppia*" is without further circumstances denoted by this name. In the *Investigations on the Oribatid Fauna of the Andes Mountains II. Peru* (1961) and *III. Chile* (1962) I set up some new genera under the genus *Oppia* in the widest sense of the name. In the present work I have taken a step further and set up a good number of new genera. *Oppia* proves to be an extraordinarily complicated genus, in which many characters must be taken into consideration. Important characters are the number of notogastral hairs, their position, the appearance of the pseudostigmatic organ, the structure of the pseudostigma, the presence or absence of lamellae, chitinous structures on the transition between the propodosoma and the hysterosoma; the number of hairs on the propodosoma, furthermore the shape of the hysterosoma, the breadth of its anterior margin, the number of genital hairs, of aggenital hairs, the situation of the fissure iad, the length of the legs, the shape of the segments, the length of the solenidia, etc. All these characters offer an infinitude of possible combinations. When several species show the same combination of a good number of the characters mentioned here, it seems a safe guess that these species constitute a genus, as distinct from the species which together form another well-defined combination of characters. On the basis of this view I have set up the *Oppia* genera listed below. In cases in which a single species is decidedly characteristic and different from other species, it has been set up as an independent genus, the diagnosis of which perhaps must later be changed or supplemented with more character. The genus *Lanceotoppia*, which in New Zealand is represented by numerous species, shows a large range variation, especially as regards the appearance of the pseudostigmatic organs. Perhaps some species must later be referred to subgenera or new genera. In spite of my efforts to divide "*Oppia*" into more genera, I have not been successful. It has not been possible for me to place a certain number of species in the system. These species still pass by the name of *Oppia* in spite of the fact that they do not belong to the genus *Oppia*, the type of which is *O. nitens* C. L. KOCH 1836.

In the key below the page and volume of the generic diagnoses from South America (S.A.) and New Zealand (N.Z.), respectively, are indicated on the extreme right.

		S.A. p. vol.	N.Z. p. vol.
1. 13 pairs of notogastral hairs.....	2		
10 pairs of notogastral hairs, by reduction 7-8 pairs .....	4		
2. Branched pseudostigmatic organs .....	3		
Not branched pseudostigmatic organs .....		<i>Polyoppia</i>	9/III
3. Iad obliquely to anal field .....		<i>Gittella</i>	63/II
Iad parallel to anal field .....		<i>Multioppia</i>	61/II
4. One pair of aggenital hairs.....	5		
Three pairs of aggenital hairs .....		<i>Tripiloppia</i>	10/III
5. Complicated chitinous structures between the propodosoma and the hysterosoma.....	6		
No chitinous structures .....	9		
6. Pseudostigmatic organs club-shaped, hairy .....		<i>Oppiella</i> Jacot 1937	33/III
Pseudostigmatic organs ball-shaped.....	7		
7. Rostrum tripartite .....	8		
Rostrum not tripartite, Hysterosoma with two broad an- terior tubercles and longitudinal ridges .....		<i>Quadropippia</i> Jacot 1939	33/III
8. Very complicated structures, 5 genital hairs.....		<i>Belloppia</i>	15/III
Only a broad bridge on the hysterosoma .....		<i>Miroppia</i>	18/III
9. Tibia I with a long distal process .....		<i>Paroppia</i>	19/III
Tibia I without a long distal process.....	10		
10. Small mites. Solenidia of Tibiae I-II, Tarsi I-II short and very broad .....		<i>Solenoppia</i>	20/III
Solenidia not short and broad .....	11		
11. Pseudostigmatic organs branched.....	20		
Pseudostigmatic organs not branched, club-shaped to faintly globular.....	12		
12. Pseudostigma with a lid, 4 genital hairs.....		<i>Operculoppia</i>	22/III
Pseudostigma without a lid, 4 genital hairs.....	13		
13. Pseudostigma with a narrow bridge, 6 genital hairs .....		<i>Membranoppia</i>	25/III
Pseudostigma without a narrow bridge, 6 genital hairs..	14		
14. Pseudostigmatic organs tiny balls, 6 genital hairs .....		<i>Globoppia</i>	44/III
Pseudostigmatic organs lanceolate, thread-shaped .....	15		
15. A hook behind Acetabulum II, pseudostigmatic organs thread-shaped .....		<i>Hamoppia</i>	28/III
No hook behind Acetabulum II .....	16		
16. All femora with broad lamina, 4 genital hairs .....		<i>Laminoppia</i>	30/III
No lamina on femora .....	17		
17. Interlamellar hairs absent .....		<i>Amerioppia</i>	54/II
Interlamellar hairs present .....	18		
18. Air-filled hairs posteriorly on the hysterosoma .....		<i>Aeroppia</i>	65/II
No air-filled hairs posteriorly on the hysterosoma .....	19		
19. Pseudostigmatic organs lanceolate .....		<i>Lanceloppia</i>	42/III
Pseudostigmatic organs club-shaped, broadest distally...		<i>Oppia</i> C. L. Koch 1936	
20. Lamellae present .....	21		
Lamellae absent .....		<i>Brachioppia</i>	51/II
21. Rostral hairs feathered proximally, bent and smooth distally		<i>Ramusella</i>	50/III
Rostral hairs normal.....		<i>Brachioppiella</i>	47/III

In what follows the genera are arranged in the same order as in the key.

*Polyoppia* n. gen.

This new genus like *Multioppia* has 13 pairs of notogastral hairs. Rostral, lamellar, and interlamellar hairs are present. No lamellae. Pseudostigmatic organs are rod-shaped to club-shaped. No bridge on the anterior margin of the hysterosoma. Five (? sic) pairs of genital hairs. One pair of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. Iad situated obliquely to the lateral side of the anal field. Femora short and broad.

*Polyoppia Baloghi* n. sp.; fig. 1.

Colour brown. Length about 0.83 mm.

The propodosoma is about half as long as the hysterosoma, rather narrow, conical in its anterior half. The mite is slender at the transition between the propodosoma and the hysterosoma. The rostral hairs, which are more than twice as long as their mutual distance, thin, parallel, and slightly uneven, reach by half their length beyond the tip of the rostrum. The lamellar hairs, which are approximately half as long as the rostral hairs and as long as their mutual distance, are thin and smooth. The interlamellar hairs are short and smooth. The expseudostigmatic hairs are as long as the lamellar hairs and smooth. The integument of the propodosoma is smooth except on the posterior half of the lateral sides, which are set with small tubercles. The pseudostigmatic organs, which in a curve are bent backwards and outwards, are almost equally thick throughout, though pointed at the tip. They are slightly serrate in their distal half and approximately as long as their mutual distance. Along the posterior border of the propodosoma four rounded tubercles can be seen, the two middle ones are directed backwards, the lateral ones, which are set behind the pseudostigmata, are directed laterally. Behind the latter similar tubercles on the anterior border of the hysterosoma can be seen. In the middle of the propodosoma and behind the lamellar hairs there is at a deeper level a "cup"-shaped figure.

The hysterosoma is broadest across the middle. There are 13 pairs of notogastral hairs. Ta is situated on the anterior border and is minute. The remainder are very long and smooth, all of them except ti reaching the base of the following one.

The ventral side is shown in fig. 1 a. The genital field is very small as compared with the anal field. There are 5(? 6) pairs of genital hairs, one pair of aggenital hairs, two pairs of anal hairs, and three pairs of adanal hairs. Ad3 is situated off the anterior border of the anal field, ad2 obliquely behind iad, which is short and set obliquely to the anal field. Ad1 is postanal. Many of the hairs of the ventral side are slightly curved.

The legs are remarkable by having femora, which are very broad for most of their length, the proximal part being short and thin. Some of the hairs of the legs are curly.

BALOGH (1966, p. 71, fig. 4) figures a mite *Multioppia problematica* n. sp., which in many characters is very similar to *P. Baloghi*. It is, however, much smaller (0.392 mm), the rostral hairs are barbed, the interlamellar hairs are absent. The pseudo-

stigmatic organs are short, rather broad clubs. It has 12 pairs of long notogastral hairs, and a tiny ta. *Polyoppia Baloghi* and *Multioppia problematica* may be congeneric in spite of the above-mentioned differences. Unfortunately BALOGH does not figure the ventral side and for that reason its position in the system cannot be decided. This species is named after Dr. J. BALOGH, Hungary.

Pauatahanui: Two specimens in dead moist leaves in forest soil (Cypresses).

*Tripiloppia* n. gen.

Oppiidae with three pairs of aggenital hairs (hence the generic name). Rostrum tripartite. Rostral and interlamellar hairs well developed, lamellar hairs minute. Exopseudostigmatic hairs long. Lamellae present. Pseudostigmatic organs branched. Usually a bridge on the anterior margin of the hysterosoma. 10 pairs of notogastral hairs, ta well developed. 4 pairs of genital hairs. The lyrifissure iad parallel to the lateral side of the anal field.

*Tripiloppia Aokii* n. sp.; fig. 2.

Colour light brown. Length about 0.34 mm.

The anterior half of the propodosoma is long and narrow, widening considerably off Leg I. The tip of the rostrum is tripartite, the medial part is much narrower than the lateral parts. The rostral hairs, which are parallel and set on the dorsal surface, are thin and smooth. They scarcely reach beyond the tip of the rostrum. The lamellae, which are set on the posterior third of the propodosoma, have almost the same appearance as those of *Oppiella nova* (Oudms.), consisting of two anterior forward directed parallel ridges and two posterior auriculate ridges. The former do not reach the pseudostigmata, but after a bend a little in front of the latter they run backwards along the outer side of the interlamellar hair. The auriculate ridges are S-shaped, the anterior curve surrounding the interlamellar hair, the posterior part ending in a small knob corresponding to a tooth on the anterior border of the hysterosoma. The lamellar hair is minute, set on the medial side of the lamella in a loop formed by the anterior tip of the lamella bending medially and backwards. The interlamellar hairs, which are strong and smooth, are about as long as their mutual distance. The exopseudostigmatic hair is as long as the interlamellar hair, smooth, and curved. Laterally to the lamellae some chitinous scales can be seen. On the lateral sides of the propodosoma there are similar scales or tubercles. The field within the auriculate ridges is a greyish colour, bordered anteriorly by an indistinct line. A little further anteriorly there is one or two indistinct lines and in the middle of the propodosoma a few similar short transverse lines. The pseudostigmatic organ has long slender branches issuing from a flat and rather broad stem. The numbers of branches, which are almost equally long, vary from 5 to 8. Those with 8 branches have a tendency to have shorter notogastral hairs.

The hysterosoma is oval apart from the straight anterior border. The latter has four teeth, which continue as narrow keels along the dorsum. The size of the teeth

varies a good deal. The lyrifissure ia can be seen behind the outer tooth. The hair ta, which is long and curved, is set on the medial keel. The remaining notogastral hairs are smooth, thin, slightly curved, and moderately long.

The ventral side is shown in fig. 2 a. Epimeres I are separated by a narrow sternal plate, Epimeres II are fused or separated by so faint a line that it can scarcely be seen. The fused Epimeres III-IV are separated from those on the opposite side by a very narrow line. The sejugal apodemata are connected by a broad band. The genital field is much smaller than the anal field. There are 4 pairs of genital setae, i.e. one pair on the anterior border, one at a short distance behind the first and two along the lateral border. There are three pairs of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. All hairs of the ventral side are short, smooth and hyaline, the hair pores are bright. The fissure iad is long and parallel to the lateral side of the anal field.

The legs are rather long (see fig. 4) with soft and mostly smooth hairs. The solenidion of Tibia II is short. The tip of the maxillae can often be seen in front of the rostrum. Mandibles of the chelicere type, slender. This species is named after Dr. JUN-ICHI AOKI, Japan.

Puketi: One specimen in thick moist moss on the ground in native forest.

Waitakere: One individual in slightly moist moss under *Manuka* shrub.

Rotorua: Many specimens in thick, slightly moist moss under *Manuka* shrub in the thermal area.

Lake Rotoiti: One specimen in very thick moist moss on the ground; three specimens in wet moss and liverworts on a vertical slope above a brook, both localities in *Nothofagus* forest.

Fox Glacier: One individual in moist to wet moss or liverworts on a thick trunk covered by mosses in native forest.

### *Tripiloppia Trägårdhi* n. sp.; fig. 3.

Colour light brown. Length about 0.49 mm.

As the following species in most characters resemble the type species only the differences will be mentioned. The lamellae are not so distinct as in the preceding species. They are strongly curved. The anterior part of the lamellae incline a little, then they bend laterally in a big curve and finally they turn backwards, reaching the pseudostigmata on the outer side of the latter. In their whole length they are tongued on their lateral border. The anterior part is apparently covered by a thin more or less hyaline plate, which almost invisibly continues backwards laterally to the auriculate ridge. The latter consists of a strong posterior lobe, which is set opposite a rounded tooth on the anterior border of the hysterosoma. Its anterior part almost disappears on the medial side of the interlamellar hair. The lamellar hair, which is short and smooth, is set at a short distance behind the tip of the lamella. The interlamellar hair is short and thick. The pseudostigmatic organs have thin, delicate

branches in a number of 5 to 6. The tip of each branch is hook-shaped. At a short distance behind the hook a short, secondary branch can be seen.

The anterior border of the hysterosoma is narrow and straight with rounded corners. There are only two teeth or rather round knobs which are set on either end of a bridge, the lateral sides of which continue backwards for a short distance. The hair ta is set behind the tooth. The fissure ia is long and very distinct. The notogastral hairs, 10 pairs, are rather short and smooth.

The ventral side agrees with that of the type species. This species is named after the late DR. IVAR TRÄGÅRDH, Sweden.

Keri-Keri: 8 individuals in moss on a steep slope above a brook in deep shadow; one specimen in moss on a mouldering trunk in the same locality.

*Tripiloppia Forsslundi* n. sp.; fig. 4.

Colour light brown. Length about 0.55 mm.

The tip of the rostrum looks very peculiar as if covered by two round, hyaline lobes carrying the short, smooth rostral hairs. In fact I am unable to tell how the rostrum is built. The anterior part of the lamellae are parallel, smooth on the lateral side, and thus different from the lamellae of *T. Trägårdhi*. They continue almost invisibly backwards along the lateral side of the auriculate ridges. The latter have a strong posterior lobe and forwards directed ridges, which reach the posterior part of the proper lamellae. Within the auriculate ridges there is a greyish field. The lamellar hairs, which are set almost in the middle of the parallel lamellae, are very short and smooth. The interlamellar hairs are rather long and thick. The branches of the pseudostigmatic organ are unequally long, the two distal ones being rather short, though varying in length, number three not much more than half as long as the proximal one, which is approximately as long as the stem between the proximal branch and the pseudostigma.

The hysterosoma differs from that of the two preceding species by the absence of teeth on its anterior border. The latter forms a faint arch within which the hairs ta are set. There are 10 pairs of thin and smooth notogastral hairs, ta being considerably longer and stronger than the remaining hairs.

The ventral side agrees with that of *T. Aokii*, fig. 2 a. This species is named after DR. KARL-HERMAN FORSSLUND, Sweden.

Keri-Keri: 4 specimens in a river valley (STAGAARD coll.).

*Tripiloppia Tarras-Wahlbergi* n. sp.; fig. 5.

Colour light brown. Length about 0.49–0.50 mm.

The lamellae are almost parallel in most of their length, faintly S-shaped. Their anterior end medially turns almost so as to encircle the tiny lamellar hair. Their posterior end reaches beyond the base of the interlamellar hair. A membranous plate issuing from the posterior end of the lamella seems to cover the medial part of the pseudostigma. The auriculate ridges have a distinct posterior lobe and a more faintly

developed anterior part, which in a curve reaches the lamella. The interlamellar hairs are stronger than all other hairs. The pseudostigmatic organs have 5–6 slender, delicate branches, the distal ones being the shorter.

The hysterosoma has on its anterior border a low arch, which in a lateral view stands out like a keel. The hair ta is rather long and much stronger than the remaining notogastral hairs, which are tiny. The ventral side agrees with that of the preceding species. This species is named after Dr. NILS TARRAS-WAHLBERG, Sweden.

Pu Pu Springs: Two specimens in almost dry mosses under *Manuka* shrub.

*Tripiloppia Dalenii* n. sp.; fig. 6.

Colour brown. Length about 0.63 mm.

The rostral hairs reach beyond the tip of the rostrum and are longer than those of the preceding species. The tip of the rostrum, when seen in a slightly oblique lateral view, looks like the sketch, fig. 6 a. The lamellae incline, tapering distally. The lamellar hairs are set on the lateral side of the lamellae near the tip. Posteriorly the lamellae disappear off the interlamellar hair. Of the auriculate ridges only the posterior lobe is present. Extremely faint lines indicate the anterior part of the auriculate ridges. The interlamellar hairs are very long. The pseudostigmatic organ has 4–5 rather short branches, the proximal one always being short (see details fig. 6 b).

The anterior border of the hysterosoma forms a broad low arch, immediately behind which the long hairs ta are placed. The remaining hairs are not much more than one third as long as ta, hyaline and difficult to see.

In this species Epimeres II in some individuals are separated posteriorly by a short ridge issuing from the band which connects the sejugal apodemata. This species is named after Dr. PER DALENIUS, Sweden.

Fox Glacier: Three specimens in mouldering leaves among dead trunks in native forest; two individuals in moss on a tree in the same locality.

*Oppiella nova* (Oudms.) 1902; fig. 7.

Colour greyish to light brown. Length varying from 0.22 to 0.30 mm.

*Oppiella nova* is the commonest oribatid in New Zealand and has been found everywhere both in more open land and in native forest. It is most abundant in thick moist mosses.

*Oppiella dubia* Ham. 1962; fig. 8.

Colour light brown. Length varying from 0.30 to 0.34 mm.

Keri-Keri: Many individuals in moss and grass under *Eucalyptus* trees, a few in grass and *Hieracium* by the roadside; one specimen in dead, moist *Selaginella* vegetation on forest soil.

Waitakere: A few individuals in moss and a little grass in native forest.

Rotorua: Five specimens in moss and liverworts on the bank of Lake Tarawera, under trees.

Waitomo: One specimen in thin moss and liverworts on a slope behind the hotel.

New Plymouth: Several specimens in moss and grass on a lawn under tall trees.

*Oppiella suramericana* (Ham.) 1958; fig. 9.

Colour light brown. Length about 0.24 mm.

*O. suramericana* has been found almost everywhere, thus in the following localities: Keri-Keri, Waitakere, Rotorua, Pauatahanui, Pu Pu Springs, Lake Rotoiti, Christchurch, Hokitika, Fox Glacier, and Milford. It is most abundant in Pu Pu Springs, where numerous individuals were found in soaking wet ?Leucobryum, grass, and water cress at the edge of the swamp with the well, under Manuka shrub.

*Oppiella fallax* var. *obsoleta* (Paoli) 1908; fig. 10.

Colour pale ochre to light brown. Length about 0.31–0.32 mm.

Keri-Keri: One specimen in a thin layer of moss and liverworts on an overgrown road, under trees.

*Oppiella Bulanovaae* n. sp.; fig. 11.

Colour greyish to yellowish. Length about 0.24 mm.

The tip of the rostrum is tripartite, the middle part being broad anteriorly. The rostral hairs are thin and hyaline. They reach by half their length beyond the tip of the rostrum. The lamellae are narrow, curved ridges, which reach the pseudostigmata. At their anterior end the tiny lamellar hair is set. In front of the posterior part of the lamella another curved ridge, which is stronger and shorter than the lamella, can be seen. The auriculate ridges halfway encircle the interlamellar hairs, which are longer than their mutual distance. The exopseudostigmatic hair is moderately long. The pseudostigmatic organs are very long and branched. There are 5–8 anterior branches and fewer posterior ones issuing from rather a flat stem, the middle branches being the longest. On the pseudostigma there are both a posterior lobe and a lateral crest or lobe.

The hysterosoma is only a little longer than broad. On its anterior border the tiny hair ta is situated. The remaining notogastral hairs are very thin, hyaline, and long. R3 and r1 are absent.

The ventral side is shown in fig. 11 a. All the hairs of the ventral side are very long. 1c is set on a longitudinal ridge. There are 5 pairs of genital hairs, the position of which, viz. one on the anterior border, two in a transverse row and two near the posterior border, is not common. The aggenital hair and ad3 are located rather close together. Ad2 is situated off the anterior anal hair, i.e. in front of iad, which is parallel to the lateral side of the anal field. All the legs are long and slender, Femur IV being especially long. The solenidia of Tibia I and Tibia IV, and of Genus I–II are long

and thin; they are short and broad in Tibia II and Genu III. This species is named after Dr. ELISAVETA BULANOVA-ZACHVATKINA, U.S.S.R.

Rotorua: Several specimens in luxuriant ?*Leucobryum* under *Manuka* shrub in the thermal area.

*Quadroppia quadricarinata* (Mich.) 1885; fig. 12.

Colour pale ochre. Length about 0.17 mm.

Found at Keri-Keri, New Plymouth, Pauatahanui, Pu Pu Springs, Nelson district, and Lake Rotoiti.

*Quadroppia circumita* (Ham.) 1961; fig. 13.

*Q. circumita* may be only a variety of *Q. quadricarinata*. The forms mainly differ in the shape of the chitinous ridges on the anterior part of the propodosoma and the long curved ridge on the dorsum of the hysterosoma. In *Q. circumita* this issues from the lateral part of the anterior knob, in *Q. quadricarinata* from a more laterally situated ridge.

Keri-Keri: One specimen in moss and liverworts on an overgrown road under trees.

Milford: One specimen in thick moss, white clover, and grass by the roadside.

*Belloppia* n. gen.

Small beautiful Oppiidae with a complicated lamellar and chitinous structure at the transition between the propodosoma and the hysterosoma. Rostrum tripartite. Rostral, lamellar, and interlamellar hairs usually present. Pseudostigmatic organs club-shaped. 10 pairs of notogastral hairs. 5 pairs of genital hairs, one pair of agenital hairs. The fissure iad is parallel to the anal field.

*Belloppia Wallworki* n. sp.; fig. 14.

Colour pale ochre. Length about 0.22–0.23 mm.

The propodosoma is rather narrow, conical. The tip of the rostrum is tripartite with deep incisions, which are rounded at the bottom. The middle is pointed at the tip. The rostral hairs, which are smooth, project by half their length beyond the tip of the rostrum. The lamellae are situated in the posterior two fifths of the propodosoma. They are narrow, slightly S-shaped and almost parallel ridges, which posteriorly reach the pseudostigmata. The lamellar hair is minute and is set within a loop formed by the end of the lamella bending medially. Behind the lamella there is a V-shaped ridge in which the interlamellar hair is set. The posterior end of this ridge is a well chitinized lobe, which fits into an incision on the lateral edge of a chitinous bridge, that covers the transition between the propodosoma and the hysterosoma. The interlamellar hairs are thicker and longer than the lamellar hairs and smooth. The exopseudostigmatic hair is proportionately long. The pseudostigma has on its

posterior border a lobe opposite a strong, lateral tooth on the anterior border of the hysterosoma. It has moreover a short ridge directed medially. The pseudostigmatic organ is a longish club, fig. 14 a, which is broadest across the middle. In a dorsal view it is ball-shaped. It is apparently set with tiny hairs or scales. In front of the pseudostigma there is a semicircular ridge.

The hysterosoma is oval. In the middle of the anterior border there is a narrow arch, which anteriorly projects beyond the lobe of the V-shaped ridges. Its anterior border is rounded apart from the incision for the above-mentioned lobe. Its lateral margins continue as distinct keels across the dorsum as far as the hair ta, indistinctly beyond ta. On either side of the arch there is a very strong tooth set behind the pseudostigma. It also continues as a faint keel over the dorsal surface. Behind the arch an indistinct structure with two parallel lines can be seen. Anteriorly the lines give way, forming a ring round two distinct bright holes. The notogastral hairs, 10 pairs, are short, thin, and smooth.

The ventral side is shown in fig. 14 b. A well chitinized narrow sternal ridge separates Epimeres I. Farther backwards the sternal plate is faintly chitinized, forming a broad plate between Apodemata II and between the sejugal apodemata. The genital field, which is smaller than the anal field, has five pairs of hairs, viz. one on the anterior border, one immediately behind the first, one at a short distance behind the second and a little more laterally, and two near the posterior border. The aggenital hairs are set on a line with ad3 and halfway between the genital and the anal field. Ad2 is located approximately off an1 and ad1 behind the anal field. All legs are slender with soft, short, smooth hairs. The solenidion of Tibia II is short. Mouth parts have not been studied. This species is named after Dr. JOHN WALLWORK, England.

Lake Rotoiti: Three specimens in moist to wet *?Leucobryum* on a slope, probably a spring locality; many in thick moist moss on a dead trunk; one specimen in dripping wet moss and liverworts in oozing water from a brook; many individuals in moss and liverworts on a vertical slope above a brook in shadow, all localities in *Nothofagus* forest.

*Belloppia Evansi* n. sp.; fig. 15.

Colour light brown to ochre. Length about 0.20 mm.

The lamellae in this beautiful little mite consist of a well chitinized lower part attached to the dorsal surface and an upper part, which is a more or less hyaline, vertical blade. The lamellae are parallel in most of their length. Posteriorly they widen before they reach the pseudostigmata. Their medial border is straight and smooth, whereas their lateral border is furnished with deep incisions, which can be seen as round holes through the upper vertical part. The latter are broadest or highest immediately before the lamellae bend towards the pseudostigmata. Another and smaller vertical blade can be seen in continuation of the first further posteriorly on a narrow longitudinal ridge, which runs to an arch on the anterior border of the hysterosoma. Lamellar hairs have not been observed. Their pore may be set at a short distance

behind the tip of the lamellae. The interlamellar hair is set laterally to the second vertical blade. It is short and smooth. The pseudostigmatic organ is club-shaped, fig. 15 a.

In the middle of the anterior border of the hysterosoma there is an arch with a straight anterior border, sharp lateral edges, and almost parallel sides. The whole structure is more or less hyaline and it is difficult to see whether the sharp lateral edges fit into the curve behind the second vertical blade or they form one straight line with the anterior border of the structure. The lateral part of the lateral sides are apparently also vertical. The lateral sides are more strongly chitinized. They continue as keels over the dorsal surface running at the same time laterally. Behind the straight anterior border a small rounded arch can be seen and on either side of the latter the rounded, well chitinized shoulders. The hysterosoma is much narrower anteriorly than posteriorly. The hair ta is located in the middle of the retroverse keels. The notogastral hairs are short and smooth.

The ventral side agrees with that of the preceding species in all essential characters. Ad3 is, however, placed a little further posteriorly than ag; ag and ad3 more laterally and closer together than in *B. Wallworki*. This species is named after Dr. G. OWEN EVANS, England.

**Keri-Keri:** One specimen in thin moss on wet soil near a brook in a deep cleft with trees; one individual in moss on the ground in deep shadow.

*Belloppia Shealsi* n. sp.; fig. 16.

Colour pale ochre. Length about 0.19 mm.

The lamellae in this very small species incline strongly and only their distal third are parallel. They are almost equally broad throughout though tapering distally. The tiny lamellar hair is situated at some distance behind the tip of the lamella. Between the lamellae there are two short S-shaped ridges, in the anterior curve of which the interlamellar hair is situated. It is longer and thicker than the lamellar hair and smooth. The pseudostigmatic organ is club-shaped, in a dorsal view ball-shaped. The posterior end of the S-shaped ridge reaches the anterior border of an arch set on the anterior margin of the hysterosoma. The anterior border of this arch is apparently straight, but in front of it a rounded arch set at a deeper level can be seen. The sides of the arch continue backwards over the dorsal surface of the hysterosoma as slightly diverging keels on which the hair ta is situated. On either side of the arch the slightly protruding shoulders can be seen. The notogastral hairs are smooth and rather short.

Ag and ad3 from the two sides are set in a broad curve, the distance ag-ad3 being shorter than the distance ag-ag. This species is named after Dr. J. G. SHEALS, England.

**Puketi:** Four specimens in thick moist to wet moss on the ground in native forest.

**Waitakere:** One individual in moist moss on the ground under *Manuka* shrub.

Pauatahanui: One specimen in thick moist moss under a tree-fern in native forest.

Milford: Numerous in thick moist moss on dead branches in a tree-fern forest.

*Miroppia* n. gen.

A peculiar *Oppia* (*mirus* 'peculiar') with arched hysterosoma covering the insertion of Legs III-IV. Rostrum tripartite. True costulae absent, replaced by chitinous folds. Lamellar hairs absent. Interlamellar hairs very long. Pseudostigmatic organs spherical. Anterior part of the hysterosoma a broad arch on either side of which the extremely long hair  $\alpha$  is situated. 8 pairs of notogastral hairs. Sternal plate broad, faintly chitinized. The lateral hairs of the epimeres set more medially than usual. 5 pairs of genital hairs. One pair of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. Iad parallel to the anal field. All legs rather long. One claw, which is extremely pointed, sickle-shaped.

*Miroppia zealandica* n. sp.; fig. 17.

Colour light brown. Length about 0.33 mm.

The tip of the rostrum is divided into three parts the middle one of which apparently is broader than the lateral ones. The rostral hairs, which are set on the dorsal surface behind the two incisions, are thin, ?smooth, and they reach by most of their length beyond the tip of the rostrum. Lamellar hairs are absent. There are no lamellae, but a few curved folds issuing from the anterior border of the pseudostigmata run forwards for a short distance. Between these folds there is a greyish field, which ends posteriorly in two faint edges medially to the interlamellar hairs, fig. 17 a. Near the edge a light spot can be seen. The interlamellar hairs, which are smooth and very thin towards the tip, are about twice as long as their mutual distance. The exopseudostigmatic hair is rather long. The pseudostigmatic organ has a ball-shaped head on a very short stem. On the posterior border of the pseudostigma there is a small tubercle. The sides of the propodosoma behind Leg I have strong chitinous keels, and Tectop. I projects like a broad crest.

The hysterosoma is arched and not much longer than broad. It is broadest across the middle, slightly tapering towards either end. The anterior margin forms a broad arch, the sides of which continue as short keels on the dorsal surface of the hysterosoma. The latero-anterior borders of the hysterosoma are broad shoulders. There are 8 pairs of notogastral hairs, of which the anterior one,  $\alpha$ , which is set on the side of the arch, differs from the rest by being extremely long, as long as the interlamellar hair. It is smooth and very thin. The remaining hairs, which are situated as shown in fig. 17, are thin, smooth, and rather short. P1 and r3 are missing.

Fig. 17 b shows the ventral side. There is a broad, faintly chitinized, sternal plate between Epimeres I-II. Between the fused Epimeres III-IV from the two sides the sternal ridge is scarcely discernible. The sejugal apodemata are dark brown and broad. The hair 1 c is displaced rather medially, the same is the case with 4 c. The

genital field, which is proportionately big, is anteriorly surrounded by a ridge, which laterally to the anterior margin is divided into two ridges running more or less parallel to Acetabulum IV. There are five pairs of long, smooth genital hairs. The aggenital hairs are exceptionally long. Also the anal and the adanal hairs are long, all are smooth. Ad3 is preanal, ad2 is located off iad, which is parallel to the anal field. Ad1 is postanal. There is no sculpture to be seen anywhere. The legs are long and thin with soft, smooth hairs. Fig. 17 c shows Leg I. The genu and the tibia have a very long solenidion. The claw, which is situated on a short stalk, is sickle-shaped and extremely thin towards the tip, figs. 17 d–e. Near its base there is a pointed ventral tooth. Tibia II has a proportionately short solenidion, Genu II a very long one. Tibiae III–IV both have a similar long solenidion as Tibia I.

Lake Rotoiti: Two specimens in wet moss and liverworts on a vertical slope above a small brook in *Nothofagus* forest.

*Paroppia* n. gen.

This genus deviates from other Oppiidae by the shape of Tibia I being drawn out into a long process on the end of which Solenidion I is placed. The tip of the rostrum with a broad hyaline "lip". Lamellae absent. Lamellar and interlamellar hairs present. Pseudostigmatic organ sickle-shaped, serrate. A lateral keel issuing from the pseudostigma ends in a tubercle. No bridge between propodosoma and hysterosoma. 10 pairs of notogastral hairs. Ta on the anterior border. Ventral side with a broad sternal plate. The curved ridge in front of the genital field ends laterally in front of Acetabulum IV. Four pairs of genital hairs, one pair of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. Iad parallel to the anal field. The legs with short swollen joints.

*Paroppia Lebruni* n. sp.; fig. 18.

Colour yellowish to white. Length about 0.27 mm.

The tip of the rostrum appears swollen due to a broad hyaline lip. The rostral hairs, which are placed rather close together, reach by about one third of their length beyond the tip of the rostrum. They are slightly barbed. The lamellar hairs are located in the middle of the propodosoma. They are thin and short, about as long as their mutual distance. The interlamellar hairs are about as long as the lamellar hairs. The exopseudostigmatic hairs are tiny. Between the interlamellar hairs there are eight small light spots in two rows. The pseudostigmatic organs, which are as long as their mutual distance, are sickle-shaped, the distal third coarsely serrate, especially on the posterior border. Issuing from the side of the pseudostigma there is a short ridge with a furrow. The ridge ends in a retroverse tubercle, which corresponds to a small tubercle or tooth on the anterior border of the hysterosoma. Round this ridge the integument is covered with small tubercles.

The hysterosoma is a little longer than broad. Its posterior end is rounded, its anterior end arched. The arch is rather pointed with sloping lateral sides. Laterally

to the arch there are on either side two teeth, one opposite the tubercle on the ridge, the other corresponding to the posterior part of the side of the propodosoma, which ends in a free tip. The hair ta is missing, but its hair pore can be seen behind the medial tooth on the anterior border of the hysterosoma. The notogastral hairs are strong, stiff, and rough. The lyrifissure im is located near r3.

The ventral side is shown in fig. 18 a. The sternal plate, which is faintly chitinized, is expanded between Epimeres II, the hairs 2 a from the two sides separated by a correspondingly long distance. The sejugal apodemata are connected by a broad plate. The curved ridge following the anterior border of the genital field is faint. It reaches the side of the hysteroroma in front of Acetabulum IV. The genital plate has four long hairs, viz. one on the anterior border, the second behind the first, but more laterally, and two in their usual position in the latero-posterior corner. The distance between ag and ad3 is only half as long as the distance ag-ag. Ad2 is located off the middle of the side of the anal field and off iad, which is parallel to the anal field. Ad1 is postanal. The legs are rather short and most of the joints are swollen distally. Fig. 18 b shows Tibia and Tarsus I. Solenidion I of Tibia I is set on the end of the process, Solenidion II further proximally at the base of the process. The Solenidia of Tarsus I are different, one being short and broad, the other longer, curved, and thin. Near the base of the claw, there is a retroversely curved hair. This species is named after Dr. PH. LEBRUN, Belgium.

Lake Rotoiti: A few specimens in moist moss on the ground; one in wet moss and liverworts on a vertical slope above a small brook, both localities in *Nothofagus* forest.

Fox Glacier: Many individuals in dead leaves between logs in native forest.

Milford: One specimen in thick, moist moss on the ground in *Nothofagus* forest.

#### *Solenoppia* n. gen.

A very small *Oppia* with broad and short solenidia of Tarsi I-II, Tibiae I-III, and Genu III. Faint lamellar ridges. Lamellar and interlamellar hairs present. Short ridges between the interlamellar hairs. Pseudostigmatic organs hairy clubs. 10 pairs of notogastral hairs. Four pairs of genital hairs, one pair of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. Iad situated obliquely off the anterior margin of the anal field. Legs short with swollen joints as in *Suctobelba*.

#### *Solenoppia Grandjeani* n. sp.; fig. 19.

Colour pale ochre. Length about 0.18 mm.

The rostrum is very broad. The rostral hairs, which are situated on the dorsal surface on a dark band, are short, curved, and ? barbed. The dorsal side of the rostrum and the space between the lamellae are wrinkled. The lamellae are distinct only distally, where they, together with a slightly curved translamella, form a semi-circular ridge. Their posterior end runs partly towards the pseudostigma, partly to-

wards the interlamellar hairs, in front of which a reticulate or wrinkled pattern can be seen. The lamellar and the interlamellar hairs are very short and thin. Between the interlamellar ridges there are two short J-shaped ridges, which open medially. Their anterior end encircles a light spot, their posterior end reaches the anterior border of the hysterosoma. The expseudostigmatic hairs are tiny. The pseudostigmatic organs are broad clubs with three hairs on their distal ends and about 4–5? short hairs on their lateral borders, fig. 19 a. Due to their minute size the exact appearance of the organs is difficult to tell.

The hysterosoma is considerably longer than broad. It is broadest posteriorly. Its anterior dark border projects, forming an arch with sloping sides. On the latter a short tooth can be seen behind the pseudostigma. There are 10 pairs of notogastral hairs, which are set as shown in fig. 19. The hair  $\tau_1$  is missing, but its hair pore can be seen medially to the pseudostigma. The hairs are more or less erect, ?smooth, and fairly strong.  $T_1$  is set farther anteriorly than  $t_1$ .

Fig. 19 b shows the ventral side. The sternal plate is broadest between Epimeres I, and narrowest between Epimeres II. The genital field is small as compared with the anal field. There are four pairs of genital hairs, viz. two in a longitudinal row behind the anterior border and two at the latero-posterior border. The genital field is surrounded on all sides by a broad dark band.  $Ad_3$  is preanal,  $ad_2$  is set at a short distance behind  $iad$ , which is set obliquely off the anterior border of the anal field. The latter is also surrounded by a dark frame.  $Ad_1$  is postanal.  $Tectop. IV$  ends in a blunt tooth.

All legs are short and the joints are swollen, figs. 19 c–d. Fig. 19 c shows Leg I, fig. 19 d Leg II. As I have been unable to dissect the mite and to lay bare the legs, the legs are drawn *in situ* in a lateral view and consequently not all the hairs could be studied. Figs. 19 c–d, however, show the extremely broad solenidia of Tarsi and Tibiae I–II. In Tarsus I only one of the solenidia is broad, the other of ordinary appearance, in Tarsus II both solenidia are broad. In Tibia I only the distal solenidion is broad. A similar broad and short solenidion is found also in Genu III and Tibia III, but not in Leg IV. This species is named after Dr. FRANCOIS GRANDJEAN, France.

Waitakere: One specimen in liverworts and small ferns on a log in native forest.

Pauatahanui: One specimen in moist liverworts on wet clay on a vertical slope by the roadside in a forest; four individuals in thick moss, grass, and small plants at the foot of a tree-fern in native forest.

*Solenoppia Travéi* n. sp.; fig. 20.

Colour pale ochre. Length about 0.23 mm.

*S. Travéi* is very similar to *S. Grandjeani*. It is, however, bigger. The lamellar ridges form an irregular oval, which posteriorly ends in two V-shaped ridges. The pseudostigmatic organs of the two species are apparently alike, fig. 20 a. The anterior border of the hysterosoma is more pointed than in the preceding species and forms a

semicircular ridge at either end of which the hair ta can be seen. The notogastral hairs have a position different from that of *S. Grandjeani*. Thus te and ti from the two sides are situated on a transverse line.

On the ventral side iad is situated a little further posteriorly, i.e. behind the anterior border of the anal field. The broad solenidia of Tarsi I-II, Tibiae I-III, and Genu III are perhaps not quite so broad as in the preceding species. This species is named after Dr. J. TRAVÉ, France.

Lake Rotoiti: Four individuals in moist to wet *?Leucobryum* on a slope (?spring locality); one specimen in wet liverworts and moss on a vertical slope above a small brook, both localities in *Nothofagus* forest.

Fox Glacier: One specimen in thick moist moss in native forest on Lake Matheson.

Milford: Three individuals in luxuriant moss on dead branches in tree-fern forest; one specimen in wet moss on a stone in *Nothofagus* forest.

*Solenoppia Taberlyi* n. sp.; fig. 21.

Colour whitish to very pale ochre. Length about 0.17 mm.

This tiny mite has a broad, regular, lamellar arch, which posteriorly reaches the pseudostigmata. Lamellar hairs have not been observed. Between the interlamellar hairs there is a faint W-shaped figure, the tip reaching the anterior border of the hysterosoma. Within the W-shaped figure there are two light spots and in front of these there are on either side two smaller ones in an oblique row. The pseudostigmatic organ is a pointed club on the posterior border of which there are 6 fairly long radiating branches, fig. 21 a. Exopseudostigmatic hairs have not been observed.

The hysterosoma is an oval apart from the anterior border, which is slightly angular, being slightly pointed behind the W-shaped figure, and having a small edge behind the pseudostigmata. The hair ta is missing. The notogastral hairs are apparently shorter than those of the two preceding species, perhaps due to their more erect position. Te and ti from the two sides are situated in a line.

On the ventral side the fissure iad is set obliquely off the anterior border of the anal field. It is long and very distinct. This species is named after Dr. GEORGES TABERLY, France.

Keri-Keri: Two specimens in moss on a slope above a small brook, shaded by tall trees.

*Operculoppia* n. gen.

The generic name refers to a lid (*operculum*), which covers the opening of the pseudostigma. The rostral hairs are situated laterally. Lamellae are more or less indistinct. Interlamellar and exopseudostigmatic hairs tiny or absent. Tutorium present only on the sides. Posterior part of the sides of the propodosoma straight. Pseudostigmatic organs club-shaped, not branched. 10 pairs of notogastral hairs, ta tiny. Four

pairs of genital hairs. The hair 1 a far anteriorly. Legs with short, lumpy joints. All solenidia rather short. Tarsi usually with two distal tips.

*Operculoppia Kunsti* n. sp.; fig. 22.

Colour brown. Length about 0.60 mm.

Unfortunately the only specimen found is a little crushed, so its exact size and shape perhaps are not quite correct.

The rostral hairs are set rather laterally. They are barbed, bent medially, and they meet in front of the tip of the rostrum. The lamellar hairs, which are set in a greyish, densely punctate middle field, are thin, barbed, and shorter than their mutual distance. Lamellae are not present, but a dark shade or frame surrounds the middle field. Interlamellar and exopseudostigmatic hairs are absent. The light spots in the posterior part of the propodosoma are very distinct and crowded. In front of them there is a light curved line with a dark border. The opening of the pseudostigma is covered by a lid situated on the top of a tall hyaline cylinder, fig. 22 a. There is no posterior lobe on the pseudostigma. The pseudostigmatic organ has a disk-shaped head on a comparatively long and thin stalk. The posterior part of the sides of the propodosoma, when seen in a dorsal view, is straight, ending in a posterior blunt tooth. This part of the propodosoma is covered with very small granules. A tutorium is not present on the dorsal surface, only laterally.

The hysterosoma is circular. The anterior border is slightly arched in the middle. Ta is scarcely discernible. The notogastral hairs are short, stiff, and barbed. The integument is extremely finely punctate. Part of the ventral side is shown in fig. 22 b. The hair 1 a is set far anteriorly. Behind the sejugal apodemata there are two small crests (the hair 3 b, which in the following species, *O. Jelevae*, is set behind this crest, cannot be seen). There are four pairs of genital hairs. The lyrifissure iad is located obliquely to the anal field. When preserved, the legs are highly bent (see figs. 22 and 23). The joints are short and broad. All solenidia are rather short, the ordinary hairs, i.e. a medial hair on Genu I and Tibia I are very long. The tarsi have two small distal tips, see figs. 23 c, 24 b. This species is named after Dr. MIROSLAV KUNST, Czechoslovakia.

Waitakere: One specimen in liverworts and *Leucobryum* on a log in native forest.

*Operculoppia Jelevae* n. sp.; fig. 23.

Colour brown. Length varying from 0.61 to 0.65 mm.

A rather lumpy species with highly arched propodosoma, the rostrum being at a much lower level than i.a. the lamellar hairs. The rostral hairs, which are situated on the sides, are bent medially and reach by half their length beyond the tip of the rostrum. They are distinctly barbed. In a dorsal view a middle field bordered by dark parallel lamellae and an anterior translamellar ridge cover most of the propodosoma. The middle field is finely punctate. The lamellar hairs, which are located at a short

distance behind the transverse ridge, are about two thirds as long as their mutual distance. They are barbed and bent medially. Interlamellar hairs are absent, but their long pores, which are broadest laterally, can be seen. Between the latter there are crowded, light spots, at least eight, the posterior ones of which lie close together, whereas there is some distance between the anterior ones. Exopseudostigmatic hairs are absent. The pseudostigmatic organ is lanceolate. It seems very short because it is bent backwards, upwards, and forwards. When laid bare it is long and slender, the head pointed, fig. 23 a. Whereas the anterior part of the propodosoma is broad, dome-shaped, the posterior part has parallel sides. There are no tubercles on the sides of the propodosoma.

The hysterosoma is a little longer than broad. It is rounded at either end. The anterior border is a broad, dark rim. The hair ta is scarcely discernible. The notogastral hairs are moderately long, curved, barbed, and very thin towards the tip. The fissure im is set immediately laterally to r3. The integument is finely punctate.

The ventral side is shown in fig. 23 b. The hairs 1 a and 1 b are rather close together, 1 a unusually far anteriorly. 3 b is set on the posterior border of the seugal apodema protected by a small dark crest. There are four pairs of genital hairs, the two posterior ones of which are close together. Ad3 is set at a level a little in front of the anal field. Iad is placed obliquely to the anal field. The anal hairs are set unusually far laterally.

The legs are rather short. The femora are edged and swollen distally, fig. 23 c. The hairs of the legs are barbed and rather long. All the tarsi have two distal short tips. All solenidia are short. Tibia IV has a medial, distal, brush-shaped hair, Tarsus IV two medial, shovel-shaped hairs.

Some specimens differ from the type specimen by being slightly bigger, more distinctly punctate both in the middle field and on the hysterosoma, by having stronger lamellar hairs, and ta a little longer. This species is named after Dr. MARA JELEVA, Bulgaria.

**Keri-Keri:** Several individuals in a cleft with water (STAGAARD coll.); a few specimens in thin moss on the ground near a brook in shadow.

**Waitakere:** Two specimens in moss and grass under bushes in a garden.

**Fox Glacier:** Three specimens in thick moss and dead leaves in native forest; a few individuals in grass and low plants by the roadside in a mixed *Nothofagus* forest.

**Milford:** One specimen in thick moss on the ground in *Nothofagus* forest; several individuals in dead *Nothofagus* leaves.

*Operculoppia crassiseta* n. sp.; fig. 24.

Colour brown. Length about 0.82 mm.

The rostral hairs, which are situated on the dorsal surface, but rather laterally, are barbed, curved, and they almost meet in front of the tip of the rostrum. The lamellar hairs, which are set at a short distance behind the anterior part of the tall

lamellar arch, are parallel, thick, stiff, straight, and densely barbed. They are approximately one and a half times longer than their mutual distance. The lamellae are parallel, and the arch is as long as two thirds of the propodosoma. The interlamellar hairs, which are situated laterally in a short transverse pore, are very short. A hyaline lid covers the opening of the pseudostigma. The pseudostigmatic organ is lanceolate, the distal third being directed forwards. The tip is set with tiny bristles. Exopseudostigmatic hairs have not been observed. The distance between the light spots, which are located between the interlamellar hairs, is longer than the width of the spots.

The hysterosoma is an oval, the anterior end perhaps being slightly narrower than the posterior end and projecting as far as the posterior border of the pseudostigmata. There are two pores on the anterior border, but I am unable to tell whether they represent ta or ia. The notogastral hairs are short, stiff, and smooth.

The ventral side is shown in fig. 24 a. There are four pairs of genital hairs. Ad3 are preanal and are situated rather laterally. Iad is situated obliquely to the anal field; ad2 is located obliquely behind iad, i.e. further laterally, ad1 is postanal. Tectop. IV ends in a sharp tooth. The femora have distally a thick, rough or barbed hair, which is equally thick throughout. All the solenidia are rather short. The claw is extremely strong, fig. 24 b. Ventrally on Tarsus II there are two short and thick hairs, a similar one on Tibia II. At the base of the claw two short conical tips can be seen.

Arthur's Pass: One specimen in *Nestor notabilis* nest (C. MITCHELL, Bish. Mus. Honolulu coll.).

#### *Membranoppia* n. gen.

Characteristic by having a narrow membrane, which lies across the pseudostigma like a narrow bridge. The notogastral hairs te, ti, ms, r3, and r2 are located behind each other. Very long solenidion on Tibiae I and IV and on Genus I-II. Lamellae present only in their anterior part. Rostral hairs inserted laterally. Lamellar and interlamellar hairs present. Pseudostigmatic organs club-shaped. The genital field with six pairs of hairs. One pair of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. Iad set obliquely to the anal field.

#### *Membranoppia Krivoltzkyi* n. sp.; fig. 25.

Colour pale ochre to light brown. Length about 0.245 mm.

The rostral hairs, which are inserted far laterally, reach by half their length beyond the tip of the rostrum. In the middle of the propodosoma there is a lamellar arch, the posterior part of which is faintly developed only. The translamella is almost straight. The lamellar hairs, which are set on the lamellae and a little behind the translamella, are a little shorter than their mutual distance. The interlamellar hairs are scarcely discernible. Across the pseudostigma there is a thin membrane issuing from the posterior border of the propodosoma. It is broadest posteriorly and across the pseudostigma it is like a narrow bridge. The pseudostigmatic organs are short, broad clubs, fig. 25 a. Exopseudostigmatic hairs are absent. Between the pseudo-

stigmata there are four light spots and in front of these, there is a faint transverse line, which separates the posterior part of the middle field from the anterior part.

The anterior end of the hysterosoma is a little narrower than the posterior end. The anterior border is darker than the surroundings, broad, and well chitinized. Two small pores for ta can be seen on it. The notogastral hairs are smooth, rather thin, and short. The hair pores are distinct. Te is set far anteriorly, ti behind it. Together with ms, r3, and r2 they form a longitudinal row. Laterally to r3 there is a distinct gland.

The ventral side is shown in fig. 25 b. The sternal plate and the apodemata are dark along all sides and have a bright furrow through them. There are six pairs of genital hairs, which are set almost in a longitudinal row. Ad3 is situated off the anterior border of the anal field. The lyrifissure iad is located obliquely to the anal field, rather far anteriorly. The legs are not very long. The solenidia of Tibiae I, IV and of Genus I-II are extremely long. That of Tibia II is proportionately long and thin. This species is named after Dr. D. KRIVOLUZKY, U.S.S.R.

Lake Rotoiti: Four individuals in thick *?Leucobryum* in *Nothofagus* forest.

Milford: Three specimens in thick moss on dead branches in tree-fern forest.

*Membranoppia Sitnikovae* n. sp.; fig. 26.

Colour light brown. Length about 0.38 mm.

*M. Sitnikovae* shows a great similarity to *M. Krivoluzkyi*. The rostral hairs are set far laterally. The lamellar hairs, which are set on the end of short lamellar ridges, which do not reach the pseudostigmata, are strong and about one and a half times longer than their mutual distance. A shade of a translamella can be seen. The inter-lamellar hairs are scarcely discernible. Between the latter there are four light spots. The posterior part of the middle field is more greyish than the anterior part. A faint line indicates the two parts. Across the pseudostigma there is, as in the preceding species, a narrow membranous bridge coming from the posterior part of the propodosoma. On the posterior margin of the pseudostigma there is a lobe. The exopseudostigmatic hair is moderately long. The pseudostigmatic organ is a longish club, fig. 26 a.

The hysterosoma is slightly arched anteriorly, broader posteriorly. Its anterior margin is very broad and dark brown. The hair ta is missing. Ti is located behind te, which is situated rather close to the anterior margin of the propodosoma.

The ventral side agrees with that of the preceding species. The solenidia of Tibiae I and IV are very long, those of Tibiae II-III somewhat shorter. Distally on Tibia IV there is a very long, stiff hair. This species is named after Dr. L. SITNIKOVA, U.S.S.R.

Rotorua: Two specimens in moss on a vertical slope grown with ferns, near Mirror Lake.

New Plymouth: One specimen in moist to wet *Selaginella* in native forest.

Fox Glacier: A few specimens in dead leaves in native forest.

Milford: Three individuals in wet moss in *Nothofagus* forest.

*Membranoppia Karppineni* n. sp.; fig. 27.

Colour pale light brown. Length about 0.26 mm.

This species, which has most characters in common with *M. Krivolutzkyi* can be distinguished by the absence of a translamellar ridge, the short and narrow lamellar ridges, but especially by the shape of the pseudostigmatic organ, which is a slender club set with minute hairs on the distal border, which make it appear fringed (cp. fig. 25 a with fig. 27 a, which shows different views of the pseudostigmatic organ). The solenidia of Tibia II is shorter and broader than in *M. Krivolutzkyi*. This species is named after Dr. E. Karppinen, Finland.

Nelson district: Many individuals in moist moss by the roadside in *Nothofagus* forest at Upper Takaka.

*Globoppia* sp.; fig. 28.

Colour brown. Length about 0.68 mm.

As the length of the notogastral hairs within the *Globoppia* species is very variable and the hairs ti and ms in the only specimen found are missing, this species will not be established as a new species.

It is a typical *Globoppia* with a tiny globular pseudostigmatic organ, barbed lamellar hairs, short interlamellar hairs, and a well developed exopseudostigmatic hair. The hysterosoma is globular and ta is tiny. The notogastral hairs, which are of different length, are barbed.

There are six pairs of genital hairs. The aggenital hairs are located midway between the genital and the anal field. Ad 3 is placed off an 1, ad 2 off an 2. The fissure iad is set obliquely to the anal field a little in front of ad 2. All the legs are long and slender. The solenidia are rather long. That of Tibia II is short and broad. Coxa III with five short teeth.

Christchurch: One specimen in a thin layer of moss on a slope by the roadside, in shadow.

*Globoppia nidicola* n. sp.; fig. 29.

Colour brown. Length about 0.57 mm.

The rostral hairs, which are longer than their mutual distance, are thin, slightly barbed, and they reach by almost half their length beyond the tip of the rostrum. The lamellar hairs, which are situated in the middle of the propodosoma, are thin, slightly barbed, and as long as the rostral hairs. Their mutual distance is the same as that of the rostral hairs. The interlamellar hairs are very small. The exopseudostigmatic hairs are moderately long. The pseudostigmatic organ is a tiny ball on a short, thin stalk. The light spots between the interlamellar hairs are indistinct. There are apparently three close together on either half. On the posterior border of the pseudostigma there is a tubercle opposite a brown curved ridge behind the pseudostigma.

The hysterosoma is circular. Ta is distinct. The remaining hairs are very thin,

slightly barbed, and of different length, te, ti, ms, r3, and r2 being equally long and much longer than those on the posterior border.

There are six pairs of genital hairs. Ad3 is placed off the anterior border of the anal field at a distance almost as long as the width of the latter. Ad2 is set behind iad, which is located obliquely to the anal field. The hairs ad1 are situated on either side of a short triangular ridge behind the anal field. All legs are long and slender. Coxa III has only one tiny tooth on its anterior border.

Greymouth: One specimen in *Puffinus griseus* nest (C. MITCHELL, Bishop Mus. coll.).

*Hamoppia* n. gen.

Immediately behind the proximal part of Femora II there is a small hook (*hamus*). Lamellae indistinct. Pseudostigmatic organs lanceolate. Pseudostigma with a very big posterior lobe situated opposite a small rounded tubercle below the anterior margin of the hysterosoma. 10 pairs of notogastral hairs, ta tiny. Six pairs of genital hairs, one pair of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. Iad set obliquely to the anal field.

*Hamoppia Lionsi* n. sp.; fig. 30.

Colour light brown to brown, the propodosoma being considerably darker than the hysterosoma. Length about 0.46 mm.

The propodosoma is rather long; the rostrum is pointed. On the dorsal surface of the rostrum there is a V-shaped light spot. The rostral hairs, which are set on the dorsal surface, are long, curved, and unilaterally barbed. They reach by one third of their length beyond the tip of the rostrum. The lamellae form a long regular arch, which is a little broader anteriorly. The part which is set between the lamellar hairs is faintly developed. The lamellae are strongest immediately behind the lamellar hairs. These are thin and as long as their mutual distance. The interlamellar hairs, which are situated very close to the posterior part of the lamellae, are scarcely discernible. The light spots between the interlamellar hairs are very indistinct. The expseudostigmatic hairs are very thin. On the posterior margin of the pseudostigma a broad, brown lobe can be seen. It corresponds to a dark brown, round knob hidden by the anterior border of the hysterosoma, and it can be seen through the latter laterally to the hair ta. The pseudostigmatic organs are slender, lanceolate, and set with minute bristles along their posterior border. They are a little shorter than their mutual distance. Laterally to the pseudostigma a number of short teeth can be seen, in front of which there is a long hook with its tip directed upwards. It is situated behind Leg II. A similar hook can be seen at the base of Leg I. Laterally to the expseudostigmatic hairs the integument is covered with very small dark granules. The middle field within the lamellae is densely punctate.

The hysterosoma, which is longer than broad, is broadest across the middle. The anterior margin is only faintly chitinized. The hair ta is tiny. It can be seen

behind the pseudostigma. The notogastral hairs are rather long, very thin towards the tip, and slightly barbed. Te and ti from the two sides are set on a transverse line. The fissure im is set at a good distance in front of r3. The integument is densely punctate.

The ventral side is shown in fig. 30 a. It does not show any characteristic features. The sternal plate is well developed. Between Apodemata II there is a broad plate with two bright holes. There are six genital hairs on each plate, one pair of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. The lyrifissure iad is situated obliquely to the anal field. The legs are slender and rather long. The solenidion of Tibia II is rather long and it is thin at the tip. This species is named after Dr. J.-C. LIONS, France.

*Lake Rotoiti*: One specimen in thick moist *?Leucobryum* near a spring in *Nothofagus* forest.

*Hamoppia Thamdrupi* n. sp.; fig. 31.

Colour light brown. Length about 0.50 mm.

Behind the tip of the rostrum there is a V-shaped fissure. The rostral hairs, which are slightly barbed, reach by more than half their length beyond the tip of the rostrum. They are situated rather close together. The middle field of the propodosoma is bordered laterally by curved greyish faint chitinizations. They are distinct only in the middle. The lamellar hairs, which are placed unusually close together, are thin and about twice as long as their mutual distance. In front of them several transverse wrinkles can be seen. The interlamellar hairs, which are situated off the anterior pair of the light spots, are very thin and rather short. The pseudostigmatic organs are long, lanceolate, slightly broader in their distal half, then tapering towards the tip. They are slightly serrate, especially along the posterior border. They are at least as long as their mutual distance. On the posterior margin of the pseudostigma there is a broad, brown lobe and opposite it a longish, brown tubercle, which is partly hidden by the anterior border of the hysterosoma. The exopseudostigmatic hair is tiny. The chitinous tubercles laterally to the pseudostigmata are very small. The integument of the middle field is finely punctate.

The hysterosoma is a little longer than broad. The hair ta is very short and located over the brown tubercle opposite the lobe on the pseudostigma. The notogastral hairs are long, flexible, and very thin towards the tip. They are slightly barbed. The integument of the hysterosoma is extremely finely punctate.

The ventral side agrees with that of *H. Lionsi*, fig. 30 a. There are six pairs of genital hairs; the aggenital hairs, the adanal hairs, and the fissure iad are set like those of *H. Lionsi*. Behind Leg II there is a tiny hook. There is none behind Leg I. Several of the joints of the legs have yellow light spots arranged symmetrically on corresponding legs. This species is named after Dr. H. M. THAMDRUP, Denmark.

*Waitakere*: One specimen in moss and grass in native forest.

*Laminoppia* n. gen.

All femora with broad laminae. The lamellae form a long arch. Pseudostigmatic organs rod-shaped. The hysterosoma is circular, with a well chitinized broad anterior margin. 10 pairs of notogastral hairs, ta not different from the remaining hairs. Four pairs of genital hairs, one pair of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. Iad set obliquely to the anal field.

*Laminoppia Blocki* n. sp.; fig. 32.

Colour brown. Length about 0.35 mm.

The propodosoma is short, broad, and highly arched, the rostrum being at a much lower level than the lamellae. The rostral hairs, which are situated on the sides, are very thin and rather short. They just reach beyond the tip of the rostrum. The lamellae and the translamella form an even arch with parallel sides. It reaches across two thirds of the length of the propodosoma. The lamellar hairs, which are situated at a short distance behind the anterior margin of the arch, are very short and thin. Interlamellar and exopseudostigmatic hairs have not been observed. The pseudostigma has on its posterior border a broad lobe corresponding to a blunt tooth below the anterior border of the hysterosoma, fig. 32 a. The pseudostigmatic organs are equally thick throughout, the end set with minute bristles. They are probably almost as long as their mutual distance. The integument is smooth, i.e. without small chitinous tubercles laterally.

The hysterosoma is circular. The anterior margin is very broad and dark. The hair ta is developed like the remaining 9 pairs of notogastral hairs, all of them being small and thin. The lyrifissure im is situated laterally to r3.

The ventral side is shown in fig. 32 b. It is characteristic of this species that the hairs 1 b, 3 b, and 4 b are displaced further medially than usually found within Oppiidae. There are four pairs of genital hairs, one pair of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. The aggenital hair is found much nearer to the anal field than to the genital field. Ad3 is situated approximately off the anterior margin of the anal field, ad2 close behind iad, which is located obliquely to the anal field. On the posterior part of the anal plates there is a curved ridge, the posterior part of which more or less follows the posterior margin of the anal field, whereas the anterior ends turn forwards and medially.

The legs are rather short and provided with chitinous crests and laminas. Figs. 32 c-d show Genu, Tibia and Tarsus I and Leg IV, respectively. All the femora have broad laminae or keels, in Femora I-II they are distal, in Femora IV there is a keel along the whole ventral side, figs. 32 d. Also the coxae and the tibiae are furnished with keels although much narrower (see the figures). The tarsi end in two short tips, one on either side of the claw. This species is named after Dr. W. BLOCK, England.

Lake Rotoiti: A few specimens in mouldering *Nothofagus* leaves.

Milford. One specimen in wet moss in *Nothofagus* forest.

*Amerioppia longiclava* Ham. 1962; fig. 33.

Colour light brown. Length about 0.30 mm.

Waitakere: A few individuals in slightly moist moss and grass under bushes in a garden; several in moss and grass in the wood.

Rotorua: Several specimens in dry moss on the ground; numerous in many samples from moist dead leaves and moss, all in the thermal area; a single one at Lake Tarawera in moist moss and liverworts on a slope to the lake.

Pu Pu Springs: Numerous in almost dry moss under *Manuka* shrub.

Nelson: Two specimens in thin, moist moss on the ground in deep shadow at the water reservoir of the town.

Lake Rotoiti: Four specimens in thick moss and bone-dry lichens and *Lycopodium* in open *Manuka* shrub a few hundred feet above lake level.

Dunedin: Two specimens in moist penguin dung mixed with grass in a penguin's nest.

*Amerioppia Woolleyi* n. sp.; fig. 34.

Colour brown. Length about 0.34 mm.

The species within the genus *Amerioppia* can be distinguished almost exclusively by their size, the shape of the pseudostigmatic organs, the length and the position of the notogastral hairs. The pseudostigmatic organ is in *A. Woolleyi* a slender club, fig. 34 a, which is broadest distally. It is set with minute scales in transverse rows. The hair ta has not been observed. The notogastral hairs, 10 pairs, are of different length, te, ti, ms, r3, and r2 being considerably longer than those on the posterior border, and a little longer than r1. They are slightly barbed. R3 and ms from the two sides are situated almost in a transverse row. The distance ms-ms is at least twice as long as the distance ms-r3. The distance r2-r1 is more than twice as long as r1-r1.

*A. Woolleyi* differs from almost all species of *Amerioppia* described so far by having pseudostigmatic organs, which are broadest distally; most species have lanceolate pseudostigmatic organs. *A. chilensis* Ham. 1962 (0.32 mm) in many ways reminds of *A. Woolleyi*, having club-shaped pseudostigmatic organs; the notogastral hairs are, however, much shorter, and it is a little smaller in size. *A. hexapilis* Ham. 1961 (0.45 mm), which also has club-shaped pseudostigmatic organs, has six long notogastral hairs, viz. te, ti, and ms from the two sides, and the notogastral hairs are much stronger; it is moreover considerably bigger. This species is named after Dr. T. Woolley, U.S.A.

Puketi: One specimen in thin dry moss and small plants scraped from the bark of a tree in native forest.

Waitakere: One specimen in moist moss and liverworts on the ground in native forest.

Rotorua: A few individuals in moist moss and dead leaves; several in thick moist *Leucobryum*, both localities in the thermal area.

New Plymouth: A single individual in thin moss on a trunk in native forest.  
 Pauatahanui: One specimen in moist dead leaves in ?cypress forest.  
 Hokitika: One individual in luxurious green moss under trees on a river bank.  
 Fox Glacier: A few individuals in luxurious moss on a log in native forest.

*Lancetoppia Sellnicki* n. sp.; fig. 35.

Colour brown. Length about 0.60–0.62 mm.

The rostral hairs, which are a little longer than their mutual distance, are slightly serrate. The lamellar hairs, which are situated on two dark chitinous scales, are about one and a half times longer than their mutual distance. Lamellae are absent, but in this species and perhaps in most *Lancetoppia* species a shadow of a transverse ridge between the lamellar hairs can be seen and likewise a dark shadow in the usual position of the lamellae. In front of the transverse ridge this species has two other transverse ridges. The interlamellar hairs are short. The exopseudostigmatic hair is tiny. The pseudostigmatic organs, which are bent backwards and outwards in a curve, are about equally thick throughout, pointed at the tip and slightly rough. Very characteristic of this species are numerous small dark chitinous tubercles laterally and in front of a smooth middle field located between the lamellar and the interlamellar hairs. Similar tubercles along the sides both in front of and behind Leg 1 can be seen. They give the outlines a serrate appearance.

The hysterosoma is as broad as it is long. On its anterior border there are two indistinct tubercles opposite a lobe on the posterior border of the pseudostigmata. The hair ta is distinct. Te, ti, ms, and r<sub>2</sub> are equally long, r<sub>3</sub> slightly shorter. They are almost smooth. Te and ti from the two sides are situated on a transverse line. This species is named after Dr. M. SELLNICK, Germany.

Puketi: Several specimens in dead Kauri leaves and wet mosses on the ground in native forest.

Keri-Keri: Two specimens in thin moss on the ground close to a brook in a cleft, in deep shadow.

*Lancetoppia Strenzkei* n. sp.; fig. 36.

Colour light brown. Length about 0.47–0.49 mm.

*L. Strenzkei* differs from the preceding species, besides by its lighter colour and its smaller size, first and foremost by its very long pseudostigmatic organ, which is swollen in the middle, fig. 36 a. The chitinous scale at the base of the lamellar hair is less distinct and the many small tubercles laterally to and in front of the lamellar hairs are smaller and lighter. There are no tubercles on the anterior border of the hysterosoma opposite the lobe on the pseudostigmata, rather slight incurvations, but not always present and perhaps only an occasional appearance.

Fig. 36 b shows the ventral side, which agrees with that of *L. hexapili* Ham. (1962, p. 42, fig. 31 a), except that the fissure iad is longer. Thus a short iad, as mentioned in the generic diagnosis, cannot any longer be a generic character. The

agenital hair is situated rather far posteriorly, closer to the anal field than to the genital field. This species is named after the late Dr. K. STRENZKE, Germany.

Keri-Keri: Several individuals in thick mosses, grass, and small ferns on the ground close to a brook in a deep cleft, in shadow.

Waitomo: A few specimens in dead leaves in shadow by the roadside.

Lake Rotoiti: A few individuals in thick dry mosses, lichens, and *Lycopodium* in mixed *Manuka-Nothofagus* forest a few hundred feet above lake level.

*Lancetoppia Willmanni* n. sp.; fig. 37.

Colour light brown to yellowish. Length about 0.53–0.57 mm.

Easily recognizable by the shape of the hysterosoma, which is longer than broad, by the very long and strong lamellar hairs, which reach the tip of the rostrum, and the long retrorse interlamellar hairs. The latter are approximately as long as their mutual distance. In front of the base of the lamellar hairs a transverse ridge can be seen, though it is not always equally distinct. There are no small tubercles in the surroundings of the lamellar hairs as in the two preceding species, only on the posterior part of the sides. The pseudostigmatic organs, which are slightly thicker in the middle, are distinctly barbed. The exopseudostigmatic hairs are moderately long.

On the anterior border of the hysterosoma there is behind the pseudostigmata a low rounded tubercle. The anterior chitinized border of the hysterosoma is broader, rounded, i.e. not so straight as that of the two preceding species. The hair ta is missing. The notogastral hairs are distinctly barbed.

On the ventral side, which in most characters agrees with that of *L. Strenzkei*, ad3 is set in front of the anal field and very laterally, ad2 off iad. The aggenital hairs are directed forwards and are set closer to the anal field than to the genital field. This species is named after Dr. C. WILLMANN, Germany.

Christchurch: Three specimens in moist *Polytrichum* and low plants on a vertical slope near oozing water.

Fox Glacier: One specimen in thick moist moss at the foot of a giant tree in native forest; several individuals in moss and dead leaves in the same locality.

Milford: Three individuals in dead leaves in *Nothofagus* forest.

*Lancetoppia van der Hammeni* n. sp.; fig. 38.

Colour brown. Length about 0.62 mm.

This species is rather similar to *L. Willmanni*, but can be distinguished from the latter among other characters by its very long lamellar hairs, which in a dorsal view reach beyond the tip of the rostrum, crossing off the base of the rostral hairs. The lamellar hairs are strong and barbed. Two faint parallel longitudinal lines can be seen running between the lamellar and the interlamellar hairs. The posterior third of the middle field thus formed is cut off by a transverse line. The middle field, which

is rather narrow, not much broader than the distance between the lamellar hairs, is punctate. In front of the lamellar hairs there is a faint transverse band. The interlamellar hairs are a little longer than their mutual distance and in the preparation always retroverse. The exopseudostigmatic hairs are tiny. The chitinous ring, which dorsally covers Acetabulum I ends in a free posterior tip. In a dorsal view a strong lateral tooth immediately in front of Leg II can be seen. The tooth lateral to the pseudostigma is likewise strong. Small tubercles are present only on the posterior part of the sides. The pseudostigmatic organs, which in a dorsal view are proportionately short, are almost equally thick throughout and slightly rough, fig. 38 a.

The hysterosoma is longer than broad. Its anterior margin is rounded. The hair ta has not been observed. The notogastral hairs are long and slightly barbed. On the anterior border of the hysterosoma there are two low tubercles set behind the pseudostigmata.

The aggenital hairs are directed forwards and located midway between the genital and the anal field. Ad3 is preanal and is set far laterally, ad2 off or behind iad. The hairs of the legs are strong and barbed. This species is named after Dr. L. VAN DER HAMMEN, Holland.

*Keri-Keri*: Found in small number in several samples collected in mosses, ferns, and low plants forming a green carpet on the ground close to a brook in a deep cleft with tall trees, always in deep shadow; also in grass, moss, and dead leaves on the slope of the cleft.

*Lancetoppia Märkeli* n. sp.; fig. 39.

Colour light brown. Length about 0.33 mm.

The rostrum is broad and the distance between the rostral hairs is long. The lamellar hairs, which are situated on the end of faint ridges, are very thin and not half as long as their mutual distance. In front of the lamellar hairs a short transverse ridge can be seen. The interlamellar hairs are very small. Exopseudostigmatic hairs cannot be seen. The pseudostigmatic organs, which are longer than their mutual distance, are thickest a short distance behind the tip. They are slightly rough.

On the anterior border of the hysterosoma and behind the posterior lobe on the pseudostigmata, there are two low brown rounded tubercles, which are more distinct than those in *L. Willmanni*. The anterior border of the hysterosoma is rounded, narrow in the middle. The hair ta is missing. The femora are very broad for most of their length.

Ad3 is situated off the anterior border of the anal field, ad2 behind iad. This species is named after Dr. K. MÄRKEL, Germany.

*Waitakere*: One specimen in moss and dead leaves in native forest.

*Lake Rotoiti*: One specimen in mouldering *Nothofagus* leaves.

*Fox Glacier*: One specimen in grass and low plants by the roadside in mixed forest between the glacier and the coast.

*Lancetoppia Becki* n. sp.; fig. 40.

Colour light brown. Length about 0.36 mm.

The lamellar hairs are rather thin and longer than their mutual distance. A transverse ridge can be seen in front of their base. There are several longitudinal rows of small tubercles between the lamellar hairs and the pseudostigmata. There are also some tubercles in front of the base of the lamellar hairs and laterally to the pseudostigmata. The interlamellar hairs and the exopseudostigmatic hairs are very small. Between the interlamellar hairs there are two short parallel retroverse scales. The pseudostigmatic organs, which are slightly rough, are broadest in the middle.

The anterior margin of the hysterosoma is a dark brown band. The hair ta is tiny. The notogastral hairs are long and slightly barbed.

Ad3 is situated off the anterior border of the anal field, ad2 behind iad. This species is named after Dr. L. BECK, Germany.

Puketi: One specimen in dead moist to wet leaves and moss under a Kauri tree.

*Lancetoppia Knüllei* n. sp.; fig. 41.

Colour pale ochre to yellowish-white. Length about 0.31 mm.

The rostral hairs are long and their mutual distance big, approximately as long as the hairs. The lamellar hairs are thin and about half as long as their mutual distance. Laterally to their base a faint oblique ridge can be seen. In front of the lamellar hairs there is a faint transverse line and two longitudinal lines directed obliquely backwards. The interlamellar hairs are scarcely discernible. The same holds good of the exopseudostigmatic hairs. The pseudostigmatic organs are very long, longer than their mutual distance. They are thickest a short distance behind the tip. They are slightly rough.

Behind the pseudostigmata there are on the anterior border of the hysterosoma two distinct brown tubercles, between which the anterior border is narrow and straight. The hysterosoma is not much longer than broad. The hair ta is missing. In a dorsal view only six pairs of notogastral hairs can be seen. In a ventral view the tiny hairs p1-p3 can be seen. The notogastral hairs are slightly barbed. Ad3 is preanal. This species is named after Dr. W. KNÜLLE, Germany.

Fox Glacier: One specimen in luxurious liverworts on the forest soil in native forest.

*Lancetoppia Poppi* n. sp.; fig. 42.

Colour brown. Length about 0.53 mm.

The rostral hairs reach only a little beyond the tip of the rostrum. They are approximately as long as their mutual distance. The lamellar hairs, which almost reach the base of the rostral hairs, are a little longer than their mutual distance. In front of their base a faint ridge can be seen. A shadow of a ridge runs obliquely

backwards from the lamellar hairs. Interlamellar and expseudostigmatic hairs are missing. The pseudostigmatic organs are rather club-shaped than lanceolate, being broadest near the tip. Their distal two fifths, i.e. the head, is set with minute hairs. The integument is covered with small tubercles on the sides of the propodosoma.

On the anterior border of the propodosoma there are no tubercles corresponding to the lobe on the posterior border of the pseudostigmata. The hair ta is very small. The distance r2-r2 is unusually long. Ad3 is situated off the anterior margin of the anal field. This species is named after Dr. E. POPP, Germany.

**Pauatahanui:** One specimen in wet moss and liverworts in a depression grown with low *Scirpus* by a brook in native tree-fern forest.

*Lancetoppia Schusteri* n. sp.; fig. 43.

Colour light brown. Length about 0.46 mm.

The rostrum is slightly pointed. The rostral hairs are rather strong, barbed, and longer than their mutual distance. The faint lamellae or shadows of lamellae surround a middle field, the shape of which is very characteristic of this species, being broadest in the middle and bordered anteriorly by a curved band or ridge, which at either end reaches the base of the lamellar hairs. The integument of the middle field is more greyish than the surroundings, probably due to a fine punctation. The lamellar hairs, which are longer than their mutual distance and cross in front of the curved ridge, are slightly barbed. The interlamellar hairs, which are set in the posterior corner of the middle field, are as long as their mutual distance. The expseudostigmatic hairs are moderately long. The pseudostigmatic organs are very long, smooth flagellants, which are directed backwards and after a strong bend outwards. On the posterior border of the pseudostigmata there is a rounded lobe. Faint wrinkles can be seen laterally to the middle field, especially anteriorly. Farther backwards the integument is furnished with small dark tubercles. The tooth laterally to the pseudostigma is very strong.

The hysterosoma is only a little longer than broad. Its anterior margin is rounded. The hair ta is missing. The notogastral hairs are long and slightly barbed. Tectop. IV is very short and ends in a strong tooth.

Fig. 43 a shows the ventral side. A characteristic feature is the broad sternal plate between Apodemata II with two light holes. Otherwise the ventral side agrees with that of other *Lancetoppia* species. Ad3 is placed off the anterior margin of the anal field, ad2 a short distance behind iad. Ad1 are set behind the anal field at either end of a short curved ridge. Between the dorsal and the ventral shield there is an oblong bladder, but it may be due to the preparation. The legs are long and slender. Tibiae and Tarsi III-IV are especially thin. This species is named after Dr. R. SCHUSTER, Austria.

**Keri-Keri:** One specimen in low ferns and mosses on wet soil close to a brook in a deep cleft with tall trees; three individuals in moss and needles under a dead fir tree; one specimen in wet *Selaginella* under trees.

Waitakere: Four specimens in moist moss and liverworts on the ground in native forest.

Waitomo: One specimen in dead leaves under trees in deep shadow by the roadside.

Pauatahanui: One specimen in moist moss and liverworts on the forest (?cypress) soil.

Hokitika: One individual in luxuriant moss and liverworts under trees on the river bank.

*Lancetoppia Ramsayi* n. sp.; fig. 44.

Colour light brown. Length about 0.38 mm.

The faint transverse band, which is situated in front of the lamellar hairs, is located on a level with the anterior end of the tutorium. This band forms the anterior margin of a quadrangle, which reaches the anterior border of the hysterosoma. The lamellar hairs, which are set at a short distance behind the transverse band at the end of faint oblique lamellar shadows, are thin and as long as their mutual distance. The interlamellar hairs are minute. Exopseudostigmatic hairs have not been observed. The pseudostigmatic organs like those of *L. Poppi* (fig. 42) are thickest distally, and the head is set with a few minute hairs. Fig. 44 a shows the tip of the organ seen in different views. The lateral sides of the propodosoma are covered with small tubercles.

The hysterosoma is a little longer than broad. Its anterior margin, which is dark and heavily chitinized, is rounded. The hair ta is tiny. The notogastral hairs are moderately long and very thin. Ti and ms are directed medially.

Ad3 is situated off the anterior margin of the anal field, ad2 a short distance behind iad. This species is named after Dr. G. RAMSAY, New Zealand.

Keri-Keri: A few individuals on a rotten bridge and a few in a cleft with water (STAGAARD coll.).

Waitakere: One specimen in moist liverworts and mosses on a trunk in native forest.

Christchurch: Several individuals in a thin layer of moss at a vertical roadside, in shadow; two specimens in moist *Polytrichum* and small plants on a slope near oozing water.

Fox Glacier: Several individuals in thick mosses on a big tree in native forest.

Milford: Many specimens in thick moss, grass, and white clover by the roadside.

*Lancetoppia Luxtoni* n. sp.; fig. 45.

Colour pale ochre to light brown. Length about 0.30 mm.

The dark shadows or bands which surround the middle field, are more distinct than in the preceding species. The transverse band is located on a level farther post-

eriorly than the anterior end of the tutorium (cp. *L. Ramsayi*, fig. 44). Immediately in front of the transverse band a light line can be seen. The lamellar hairs are thin and shorter than their mutual distance. The interlamellar hairs are very thin, too. Between the latter there are four light spots and in front of them a faint transverse, light line. Exopseudostigmatic hairs have not been observed. The pseudostigmatic organs are spindle-shaped, when laid bare they are much thinner than in fig. 45. They are no longer than their mutual distance. The sides of the propodosoma are almost smooth with few and very small tubercles.

The hysterosoma is considerably longer than broad. Its anterior border is rounded, brown and well chitinized. Ta is missing. The notogastral hairs are thin and moderately long. Ti is located almost behind te, a position characteristic of this species. The lyrifissure im is found at a very short distance in front of r3. This species is named after Dr. M. LUXTON, New Zealand.

Keri-Keri: A few individuals in thick wet mosses on the ground by a brook in a deep cleft with dense trees and shrubs; a few in moss on a mouldering trunk; a few in *Selaginella* vegetation and in dead leaves and debris.

Waitomo: One specimen in moss, liverworts, and dead leaves in a tree-fern forest between huge rocks.

Fox Glacier: Several individuals in thick moss on Lake Matheson in native forest.

*Lancetoppia Moritzi* n. sp.; fig. 46.

Colour pale ochre to greyish. Length about 0.28 mm.

The rostrum is narrow. The rostral hairs, which are situated on the dorsal surface reach by half their length beyond the tip of the rostrum. They are slightly barbed. The translamellar ridge, which can be seen in the middle of the propodosoma, is narrow and very distinct. Where it joins the lamellae there is a tiny sideways directed tip. The lamellae incline a little. They are as broad as the translamellar ridge, but faintly developed proximally. The lamellar hairs, which are set at a short distance behind the translamellar ridge, are very thin and about half as long as their mutual distance. The interlamellar hairs are short, the exopseudostigmatic hairs tiny. On the posterior border of the pseudostigmata there is a very small lobe corresponding to a small edge behind the pseudostigmata and hidden by the anterior border of the hysterosoma. The pseudostigmatic organs have on rather a long stalk a club-shaped broad head, which is directed medially. Between the interlamellar hairs eight light spots in two oblique rows can be seen.

The hysterosoma, which is longer than broad, is almost truncate at the posterior end, the anterior end narrow and slightly arched. Ta is missing, but its pore can be seen immediately behind the pseudostigmata. The notogastral hairs are thin and short. The fissure im is located in front of r3.

The ventral side is shown in fig. 46 a. It does not show any special characters, except that the aggenital hairs and ad3 are situated at the same mutual distance.

The legs are short with swollen joints. The solenidion of Tibia II is short. Tibiae I-II have medially an unusually long feathered hair. Taken as a whole the hairs of the legs are long and distinctly feathered. This species is named after Dr. M. MORITZ, D.D.R.

Lake Rotoiti: Four specimens in wet moss and liverworts on a vertical slope above a small brook in *Nothofagus* forest.

*Lancetoppia Woodringi* n. sp.; fig. 47.

Colour light brown. Length about 0.40 mm.

The rostral hairs are situated rather close together. They are barbed and three to four times longer than their mutual distance. The lamellar hairs are thin, slightly barbed, and about as long as their mutual distance. In front of them there is a faint transverse ridge the ends of which join very faint longitudinal lines or rather shades running to the pseudostigmata. The middle field within these lines is greyish due to a dense punctuation. In its posterior part there are four light spots in two rows separated by a long distance. The interlamellar hairs are thin and probably half as long as their mutual distance, but due to their erect position their exact length is difficult to tell. The exopseudostigmatic hair is very thin and moderately long. The pseudostigma has a posterior lobe corresponding to a blunt tooth on the anterior border of the hysterosoma. The pseudostigmatic organs are almost as long as their mutual distance. They are equally thick throughout, blunt at the tip, which is set with extremely small scales. On the latero-posterior sides of the propodosoma there are small, round tubercles.

The hysterosoma is longer than broad. Its anterior border is slightly arched and narrowest in the middle. The hair ta is missing. The notogastral hairs are thin, curved, and slightly barbed. The fissure im can be seen laterally to r3, but further anteriorly. The integument is densely punctate.

The ventral side agrees with that of other *Lancetoppia* species. Ad3 is situated off the anterior margin of the anal field. The fissure iad is set obliquely to the anal field. Tectop. IV ends in a blunt tooth. The legs are long and slender. The solenidion of Tibia II is short and thick. This species is named after Dr. J. WOODRING, U.S.A.

Puketi: One specimen in a thin layer of moss and small plants scraped from the trunk of a big tree in native forest.

*Lancetoppia Menkei* n. sp.; fig. 48.

Colour light brown, darker than *L. Luxtoni*. Length about 0.33 mm.

This species, which is a little darker and a little bigger than *L. Luxtoni*, has many characters in common with the latter.

In front of the lamellar hairs there is rather a strong ridge. The lamellae are narrow and usually more distinct than the longitudinal folds or bands found in most *Lancetoppia* species. The lamellae converge more than in *L. Luxtoni*, fig. 45. The lamellar hairs are as long as their mutual distance. The interlamellar hairs are tiny.

Exopseudostigmatic hairs have not been observed. Between the interlamellar hairs there are four light spots in front of which a very faint line can be seen. The pseudostigmatic organs are bent medially. They are almost equally broad throughout, lanceolate, very pointed at the tip. On the posterior border of the pseudostigmata there is a broad lobe. Very small tubercles can be seen posteriorly on the sides of the propodosoma.

The hysterosoma is a little longer than broad. Its anterior margin is rounded, well chitinized and brown. The hair ta is missing. The notogastral hairs are set almost as in *L. Luxtoni* with ti behind te, and te and r3 directed outwards. The hairs are equally long. The fissure im is situated in dark surroundings and located behind r3, in *L. Luxtoni* always in front of r3. This species is named after Dr. H. MENKE, Germany.

*Lake Rotoiti*: One individual in moist moss on the ground in *Nothofagus* forest.

*Christchurch*: One specimen in wet liverworts, moss, and grass on a slope with oozing water.

*Fox Glacier*: One specimen in thick moss at the foot of a giant tree in native forest; a few in dead leaves in the same locality; one in more open forest in moss, plants, and grass by the roadside.

*Lancetoppia Mahunkai* n. sp.; fig. 49.

Colour light brown. Length about 0.43 mm.

A very characteristic species, which perhaps should not be placed within the genus *Lancetoppia* due to its long hairy, filamentous pseudostigmatic organs, but as these within this genus vary from broad clubs to long and very thin lanceolate organs, I shall until more is known about the taxonomy of the *Oppia* group, establish it within the genus *Lancetoppia*.

The lamellar hairs, which are about twice as long as their mutual distance, are slightly barbed. In front of them there is a faint transverse ridge on a level with the anterior end of the tutorium. The interlamellar hairs are tiny. Also the exopseudostigmatic hairs are extremely small. The pseudostigmatic organs, which are as long as the width of the propodosoma where it is broadest, are slightly bent at two places and therefore appear undulating. They are for most of their length set with small scales and they are almost equally thick throughout, though slightly tapering from the distal bend towards the tip. On the posterior border of the pseudostigmata there is a small lobe.

The hysterosoma is no longer than broad. Its anterior margin is straight in the middle. Ta is missing. The notogastral hairs are very thin and slightly barbed. The ventral side agrees with that of other *Lancetoppia* species. Ad3 is found off the anterior border of the anal field. All the legs are long and slender. Some of the hairs of the legs are very long. Femora I-II and Tibia I with a strong keel. This species is named after Dr. S. MAHUNKA, Hungary.

New Plymouth: One specimen in *Selaginella* vegetation and dead leaves under tree-ferns in native forest.

*Lancetoppia Schweizeri* n. sp.; fig. 50.

Colour light brown. Length about 0.40 mm.

The lamellar hairs, which are as long as their mutual distance, are very thin. The interlamellar and the expseudostigmatic hairs are short. In front of the lamellar hairs there is a curved ridge, which posteriorly reaches beyond the base of the lamellar hairs, becoming more and more indistinct. This ridge is situated further posteriorly than the end of the tutorium. The pseudostigmatic organs are rather club-shaped than lanceolate, though pointed at the tip. The head is almost one third as long as the whole organ (see fig. 50 a). Fig. 50 a shows the anterior part of the mite in a lateral view. Behind the small lobe on the posterior border of the pseudostigma a dark fold can be seen, and under the fold there is a small tubercle.

The hysterosoma is only a little longer than broad. Its anterior margin is straight. The hair ta is tiny. The hairs te, ti, and ms are longer than the rest. They are all very thin and slightly barbed.

The ventral side agrees with that of other *Lancetoppia* species in all essential characters. In the sternal plate between Apodemata II two holes can be seen (see fig. 43 a). Tectop. IV ends in an extremely pointed tooth. The legs are moderately long; Leg IV reaches a little beyond the posterior end of the hysterosoma. This species is named after the late Dr. J. SCHWEIZER, Switzerland.

Lake Rotoiti: Several individuals in thick, moist moss on the ground in *Nothofagus* forest.

Fox Glacier: One specimen in thick moss at the foot of a giant tree in native forest.

Milford: A few specimens in thick moss on dead trunks and branches in *Nothofagus* forest; two specimens in luxuriant moss under ferns, in shadow.

*Lancetoppia Csiszarae* n. sp.; fig. 51.

Colour light brown. Length about 0.28 mm.

This small mite can among other characters be distinguished by its small size, by its very short and thin lamellar hairs, which are about half as long as their mutual distance, and by its spindle-shaped to lanceolate pseudostigmatic organs. There is no transverse band in front of the lamellar hairs, only a very faint line and the longitudinal bands are just as indistinct as the transverse one apart from a short part behind the base of the lamellar hairs. This part is dark and curved and not equally distinct in the two specimens found. The interlamellar and the expseudostigmatic hairs are tiny. The pseudostigmatic organ is spindle-shaped to lanceolate, broadest near the tip, which is pointed. The organs are about as long as their mutual distance. Behind the pseudostigma there is on the anterior border of the hysterosoma a short tooth on a brown, rounded tubercle.

The hysterosoma is circular apart from the anterior border, which is straight and fairly broad. Ta is missing. Te and ti from the two sides are situated almost on a transverse line. The hairs are thin and slightly barbed. Tectop. IV ends in a blunt tooth. The fissure iad is situated approximately off the anterior margin of the anal field, i.e. rather far anteriorly, and it is dark. This species is named after Mrs. J. CSISZAR, Hungary.

Keri-Keri: Two specimens in mouldering leaves and debris on a slope above a brook under tall trees and shrub.

*Lancetoppia Vaneki* n. sp.; fig. 52.

Colour brown. Length about 0.80 mm.

The propodosoma is narrow as compared with the hysterosoma. The latter is almost circular. The rostral hairs are thin, slightly barbed, and twice as long as their mutual distance. The lamellar hairs, which are situated in the middle of the propodosoma, are very thin and about as long as their mutual distance. In front of them a faint line can be seen, and issuing from the base of the lamellar hair there is a shade of a ridge running posteriorly. The interlamellar hairs are short, but distinct. The expseudostigmatic hairs are well developed. The pseudostigmatic organs, which when stretched out are as long as their mutual distance, are about equally thick throughout, though slightly tapering at the tip, and rough. Two more or less hyaline scales are located behind the interlamellar hairs. They are directed backward and their posterior border is rounded.

The hysterosoma is as broad as it is long. Its anterior margin is dark and the tiny hairs ta are scarcely discernible. The notogastral hairs are very long and strong, and all of them reach beyond the base of the following one, some of them by more than half their length. They are slightly barbed. Ti is set unusually far anteriorly, te almost directly behind ti. The distance r1-r1 is unusually short and about the same as p1-p1.

The ventral side agrees with that of other *Lancetoppia* species. The fissure iad is located obliquely to the lateral border of the anal field off ad 3, which is set approximately off the anterior margin of the anal field. The solenidion of Tibia II is short. Tibiae I-II have a short longitudinal ventral ?crest off the solenidion. This species is named after Dr. J. VANEK, Czechoslovakia.

New Plymouth: Two specimens in mouldering leaves, debris, and ferns on swampy ground in native forest.

*Lancetoppia Seydi* n. sp.; fig. 53.

Colour light brown. Length about 0.33 mm.

The most characteristic feature of this species is the extremely pointed rostrum, which ends in a small tip. The rostral hairs do not differ from those of other *Lancetoppia* species. In front of the lamellar hairs there is a faint transverse ridge set on a

level with the anterior end of the tutorium. A shade of a longitudinal ridge running obliquely backwards from the base of the lamellar hair is present as is the case in most *Lancetoppia* species. The lamellar hairs are thin and about as long as their mutual distance. The interlamellar hairs are tiny. The expseudostigmatic hairs are short. The pseudostigmatic organs are lanceolate, broadest in the distal fourth and pointed at the tip. They are set with minute hairs. On the posterior border of the pseudostigma there is a small tubercle and opposite it a small knob on the anterior border of the hysterosoma can be seen.

The hysterosoma is almost as broad as long. The hair ta is absent. The notogastral hairs are very thin and slightly barbed. Te and ti from the two sides are situated on a transverse line.

The lyrifissure iad is located obliquely to the lateral side of the anal field, off an1. Ad3 is set laterally to iad off the anterior margin of the anal field. This species is named after Dr. E. SEYD, England.

Keri-Keri: One specimen in a thin layer of moist moss on the ground near a brook in a deep cleft with shrubs and tall trees.

*Lancetoppia Jacoti* n. sp.; fig. 54.

Colour from dark brown to almost light brown varying according to size. Length varying from 0.65 mm to 0.80, the biggest specimens being the darker.

The rostral hairs, which are parallel and almost twice as long as their mutual distance, are distinctly barbed. They reach by half their length beyond the tip of the rostrum. The lamellar hairs, which are situated almost in the middle of the propodosoma, reach beyond the base of the rostral hairs, sometimes they reach the tip of the rostrum. They are unilaterally barbed. In front of them a faint transverse shade can be seen. The interlamellar hairs seem very short due to their erect position, but in a lateral view their exact length can be seen, fig. 54 a. The expseudostigmatic hair is moderately long. The pseudostigma has a small posterior lobe, but there does not seem to be any corresponding tooth on the anterior border of the hysterosoma. The pseudostigmatic organ in a dorsal view is very short, being bent and thus shortened. The short lanceolate head is set with minute bristles. In a lateral view it appears rather long, fig. 54 a. The head is merged into the stalk and is not much thicker. The latero-posterior part of the propodosoma is covered with numerous small tubercles. Small tubercles can be seen also in front of the lamellar hairs.

The hysterosoma is longer than broad. Ta is short but distinct. The remaining notogastral hairs are long, slightly curved, very thin towards the tip, and faintly barbed. Those on the posterior border are shorter.

The ventral side is typical of *Lancetoppia*, see fig. 36 b. The hair 2a is set a little more laterally than in fig. 36 b and the aggenital hair is longer. The adanal hairs and iad are located as in fig. 36 b.

The bigger specimens are dark brown and often their notogastral hairs are a little shorter. They have been found together with the smaller specimens, i.e. at

Keri-Keri and Waitakere, but not at Rotorua, and Lake Rotoiti. This species is named after the late Dr. A. P. JACOT, U.S.A.

**Keri-Keri:** Two individuals in a thin layer of moss on wet soil; one in lichens and moss on a mouldering branch; two specimens in moss and needles under a fir tree.

**Waitakere:** One specimen in moss and liverworts on the ground; a few in moss and small ferns on a log, both localities in native forest.

**Rotorua:** Several individuals in moss, liverworts, and tiny ferns; many in luxurious *?Leucobryum*, both localities under *Manuka* shrub in the thermal area.

**Lake Rotoiti:** One individual in dead *Nothofagus* leaves.

*Lancetoppia Berlesei* n. sp.; fig. 55.

Colour brown. Length about 0.81 mm.

The rostral hairs, which are situated on the sides and far anteriorly, are slightly barbed. The lamellar hairs are located at a short distance behind a faint transverse band. They are thin, slightly barbed, and almost twice as long as their mutual distance, i.e. so long that in a dorsal view they reach the tip of the rostrum. The interlamellar hairs are tiny. They are situated very close to the light spots. The exopseudostigmatic hair is a little longer than the interlamellar hair. The pseudostigmatic organs, which are bent first backwards, then forwards, are considerably shorter than their mutual distance; the distal half is slightly broader than the stalk, lanceolate, and set with tiny bristles. The integument of the middle field is densely punctate, and appears finely striped.

The hair  $\tau_1$  is distinct. The remaining notogastral hairs are fairly long and slightly barbed.  $\tau_1$  is located almost behind  $t_1$ ,  $m_2$  behind  $\tau_1$  (the latter has been lost on both sides).

The ventral plate is densely and distinctly punctate.  $Ad_3$  is situated off the anterior border of the anal field,  $ad_2$  obliquely behind  $iad$ , which is almost parallel to the anal field.  $Ad_1$  is postanal. The aggenital and the adanal hairs are rather long. All the legs are long and slender. Femora I-II are, however, rather thick clubs. Coxa III has on its anterior border four strong teeth. This species is named after the late Dr. A. BERLESE, Italy.

**Keri-Keri:** One specimen in a thin layer of moss on the ground near a brook in a deep cleft with tall trees.

*Lancetoppia Banksi* n. sp.; fig. 56.

Colour dark brown to mahogany red. Length about 0.80 mm.

The rostral hairs are situated rather laterally and far anteriorly. They are strong and slightly barbed. The lamellar hairs, which are situated in the middle of the propodosoma, are very long and reach the tip of the rostrum. They are slightly uneven, almost smooth. The interlamellar hairs are tiny and are found off the anterior border

of the light spots. Exopseudostigmatic hairs are missing. The pseudostigmatic organs, which are short and bent, have a short lanceolate to club-shaped head set with tiny bristles. There is no lobe on the posterior border of the pseudostigma. Behind the latter a dark spot can be seen at a deeper level.

The hysterosoma is almost circular. Its anterior margin is faintly chitinized, i.e. paler than the latero-anterior border. Ta is distinct. The notogastral hairs are fairly long and slightly barbed. Ti is set almost behind te; ms, which is missing on both sides on the only specimen found, is located behind ti.

Ad3 is placed off the anterior border of the anal field, ad2 behind iad, which is set obliquely to the anal field. Ad1 is postanal. This species is named after the late Dr. N. BANKS, U.S.A.

Bay of Islands: One specimen at a stub in a pine wood (STAGAARD coll.).

*Lancetoppia Ewingi* n. sp.; fig. 57.

Colour brown. Length about 0.80 mm.

Behind the tip of the rostrum there is a V-shaped fissure. The rostral hairs, which are situated on the dorsal surface and rather close together, are slightly barbed. They reach by half their length beyond the tip of the rostrum. The lamellar hairs are situated rather close together at a short distance behind a broad transverse ridge. A dark shade runs from their base obliquely backwards. The lamellar hairs are barbed, rather strong, and so long that when crossed they reach the tip of the rostrum. The interlamellar hairs, which are situated close to a chitinized band between the pseudostigmata, are strong and as long as their mutual distance. The exopseudostigmatic hair is well developed. The pseudostigmatic organs are as long as their mutual distance, lanceolate, though slightly broader in the middle. They are set with small prominent scales or bristles. On the posterior border of the pseudostigma there is a very long tubercle, which reaches the anterior border of the hysterosoma and fits into an incision in the latter. The integument of the middle field is densely punctate. The chitinous tubercles on the lateral sides of the propodosoma are very small.

The hysterosoma is slightly arched, and its anterior border is narrowest in the middle. Ta is absent. The notogastral hairs are long, stiff, strong, and slightly barbed. Te and ti from the two sides are set almost on a transverse line, ti a little further anteriorly. The same holds good of r3 and ms. The integument is densely punctate.

The aggenital hairs and the adanal hairs are fairly long. Ad3 is situated at a level a little in front of the anterior border of the anal field at a distance from the latter as the length of the anal plate. Ad2 is set obliquely behind iad, which is located obliquely to the anal field. The hairs ad1 are postanal and are situated one at either side of the triangular posterior end of the ventral plate. The legs are long and slender. Femora I-II have a short narrow club on a long thin stalk. The hairs of the legs are thick and barbed. This species is named after the late Dr. H. E. EWING, U.S.A.

Waitomo: One specimen in mouldering leaves under trees in a cleft.

?*Lancetoppia Thorii* n. sp.; fig. 58.

Colour mahogany red. Length about 0.81 mm.

The propodosoma is short and broad. The tip of the rostrum ends in a small snout. The rostral hairs, which are situated on the dorsal surface, are thin and almost smooth. The lamellar hairs, which are situated at rather a short mutual distance, are stiff, uneven, and more than twice as long as their mutual distance. They are equally thick throughout. The interlamellar and the exopseudostigmatic hairs are tiny. The interlamellar hairs are set rather close to the pseudostigmata. The pseudostigmatic organs are long, thin, and slightly thicker towards the tip, which is rounded. The base of the pseudostigmatic organ is surrounded by a hyaline membrane strengthened by radiating ribs. By this special character it differs from other *Lancetoppia* species and it is rather doubtful whether it belongs to *Lancetoppia*. The chitinous tubercles laterally to the pseudostigmata are very small.

The hysterosoma is circular. The hair ta is tiny. The remaining notogastral hairs are of different length, being longest anteriorly. Only te, ti, and ms are moderately long, the rest are short and thin.

The ventral side. There are six pairs of genital hairs. Ad3 is situated off an1, ad2 off an2, ad1 is postanal. The fissure iad is set obliquely to the anal field between ad3 and an1. All the legs are short. The hairs of Femora I-II are of different length and thickness. This species is named after the late Dr. S. THOR, Norway.

Keri-Keri: One specimen in a thin layer of moss on wet soil close to a brook, in deep shadow.

Waitakere: One specimen in moss and liverworts in native forest.

Waitomo: One specimen in mouldering leaves in a small cleft, in shadow.

Lake Rotoiti: Several individuals in mouldering *Nothofagus* leaves.

Fox Glacier: One specimen in moss on a stone in a rushing brook from Fox Glacier.

*Lancetoppia Bertheti* n. sp.; fig. 59.

Colour brown. Length about 0.80 mm.

The rostral hairs, which are set on the dorsal surface, are barbed and at least twice as long as their mutual distance. The lamellar hairs, which are set at a short distance behind a brown transverse ridge, are thin, barbed, and more than twice as long as their mutual distance. They cross and reach in a dorsal view the tip of the rostrum. The interlamellar hairs are set at a short distance in front of the dorso-sejugal band. They are very thin and about half as long as their mutual distance. The exopseudostigmatic hair is fairly long. The pseudostigmatic organs are almost as long as their mutual distance, lanceolate, slightly tapering towards the tip, which is set with minute scales, and a little rough. The dorso-sejugal band has two large, dark swellings on its posterior border.

The hysterosoma is circular, apart from the anterior border, which is straight in the middle and very narrow. Ta is tiny, but distinct. The notogastral hairs are long,

rather thick, stiff, and barbed. Te and ti from the two sides are situated almost on a line, the same holds good of r3 and ms.

The ventral side. The hairs are long and barbed, 3b especially long and curved. There are six pairs of long, stiff genital hairs. The aggenital hair is as long as the length of the genital plate. Ad3 is situated far laterally off the anterior border of the anal field, ad2 off an2. The fissure iad is located obliquely to the anal field off an1. The hairs ad1 are situated at the latero-posterior corner of the anal field at either end of a triangular ridge. Coxa III has on its anterior border about five short spines. Femora I-II are slender clubs with thick barbed hairs. This species is named after Dr. P. BERTHET, Belgium.

Keri-Keri: One specimen in a thick carpet of mosses and small ferns near a brook in a deep cleft with tall vegetation.

?*Lancetoppia rigidiseta* n. sp.; fig. 60.

Colour brown. Length about 0.78 mm.

The anterior part of the propodosoma is arched and the tip of the rostrum is at a much lower level than the lamellar hairs. The rostral hairs are set on the sides. They are barbed, bent medially, and they almost meet at some distance in front of the tip of the rostrum. The lamellar hairs, which are a little longer than their mutual distance and which in a dorsal view reach the base of the rostral hairs, are rather thin and ?smooth. The interlamellar hairs are tiny. Exopseudostigmatic hairs have not been observed. The pseudostigmatic organs are lanceolate and short. The distal half, which is set with tiny bristles, is bent forwards and outwards. The tooth lateral to the pseudostigma is very broad.

The hysterosoma is broadest across the middle. Ta is absent. The notogastral hairs are short, stiff, smooth, and hyaline (hence the specific name).

The ventral side is shown in fig. 60 a. It agrees with the general appearance of that of *Lancetoppia*. Tectop. IV ends in a broad, sharp tooth. The legs are long and slender. All the femora have distally a somewhat thicker, unilaterally serrate hair.

Arthur's Pass: One specimen in *Nestor notabilis* nest (C. MITCHELL, Bishop Mus. Honolulu coll.).

*Lancetoppia Pifflī* n. sp.; fig. 61.

Colour light brown. Length about 0.38 mm.

The rostral hairs are rather close together, lyrate, barbed, and about three times longer than their mutual distance. The lamellar hairs are very thin and about as long as their mutual distance. The interlamellar hairs are as long as the lamellar hairs and likewise very thin. They are situated close to the dorso-sejugal ridge. The exopseudostigmatic hair is only half as long as the interlamellar hair. The pseudostigmatic organs, which are longer than their mutual distance, have a long thin stalk,

which becomes only slightly broader in its distal third. The tip is pointed. The distal part is set with minute scales. On the posterior border of the pseudostigmata there is a broad, brown lobe, but there does not seem to be any tubercle opposite it.

The hysterosoma is a little longer than broad. Its anterior margin is arched in the middle. Ta is tiny and set at either end of the arch. The notogastral hairs are thin, moderately long, and slightly barbed. Te and ti from the two sides are set on a line. The ventral side is in every detail typical of *Lancetoppia*. This species is named after Dr. E. PIFFL, Austria.

Waitakere: One specimen in liverworts and small ferns on a log in native forest.

*Oppia Feideri* n. sp.; fig. 62.

Colour light brown. Length about 0.27 mm.

The anterior part of the propodosoma is a long cone. The rostrum is slightly pointed. The rostral hairs, which are set rather close together, are strong, barbed, and one and a half times longer than their mutual distance. They reach by only one third of their length beyond the tip of the rostrum. There are no lamellae. Faint shades surround a middle field, in the anterior part of which the lamellar hairs are placed. They are thin and less than half as long as their mutual distance. The posterior border of the middle field is a darker ridge, the ends of which form two small, more or less erect scales. The tiny interlamellar hairs are situated in front of the latter. Exopseudostigmatic hairs are absent. The pseudostigmatic organs, which always are retroverse and then bent medially are lanceolate and dark, probably due to minute hairs. They are serrate on their posterior border, fig. 62 a.

The hysterosoma is semicircular in its posterior half, whereas the anterior half is narrowing towards the anterior border. The middle of the latter forms a tongue-shaped arch, on either side of which there is a small tooth set opposite the lobe on the posterior border of the pseudostigmata. The hair ta is missing; its pore can be seen medially to the tooth. The notogastral hairs are very short and thin. The fissure im is located more medially than in most *Oppia* species.

Fig. 62 b shows the ventral side. In Epimeres II a faint band runs from the sternal ridge obliquely backwards and laterally. There are six pairs of genital hairs, set in the usual position with four in a longitudinal row and two near the posterior border. Ad3 is preanal. The fissure iad is located obliquely to the anal field. Ad2 is situated behind iad. All the hairs are short. All the epimeres are distinctly reticulate. Legs III-IV are inserted rather close together and Tectop. IV is set immediately behind Coxa III. It ends in a blunt tooth. All the legs are rather short with swollen joints. This species, which has many characters in common with *Lancetoppia*, is named after Dr. Z. FEIDER, Rumania.

Waitakere: Two specimens in liverworts and *Leucobryum* on a log in native forest.

Lake Rotoiti: One specimen in moist to wet ?*Leucobryum* on a slope (spring

locality?); a few in mosses on the ground and on a log; in wet moss and liverworts above a small brook, all in *Nothofagus* forest.

*Oppia Haarłovi* n. sp.; fig. 63.

Colour light brown. Length about 0.285 mm.

The rostrum has on either side of the tip, which is slightly pointed, a narrow hyaline border. On the dorsal surface it has a V-shaped fissure. The rostral hairs, which are set laterally, on the end of a dark ridge, are thin, slightly barbed. They reach by less than half their length beyond the tip of the rostrum. The lamellar hairs, which also are barbed and thin, are set at some distance behind a curved ridge, which is located at a level with the anterior end of the tutorium. There are no lamellae, but a middle field is indicated by a more greyish colour. The interlamellar hairs are tiny like the exopseudostigmatic hairs. The pseudostigmatic organ is a slender club, fig. 63 a, set with minute bristles distally. The organs are almost as long as their mutual distance. Behind the pseudostigmata there is a small dark knob. There are only very small tubercles on the latero-posterior sides of the propodosoma.

The hysterosoma is a little longer than broad. Its posterior half is semicircular, whereas the anterior end tapers towards an anterior fold into which it fits. Immediately behind this fold a small round gland at either side can be seen, and laterally to the gland the pore for ta, which is absent. The notogastral hairs are very thin, ?barbed, and curved. The distances ti-ti, ms-ms are equally long, the distance r2-r2 considerably longer.

The ventral side is shown in fig. 63 b. It is not characteristic in any way. There are six pairs of genital hairs. Ad3 is set laterally at a level a little in front of the anal field. The distance between the aggenital hairs is much shorter than that of ad3. The fissure iad is located obliquely to the anal field at a good distance in front of ad2. The legs are rather short, the hairs thin and barbed. This species is named after Dr. N. HAARŁOV, Denmark.

Waitomo: Two specimens in mouldering leaves in native forest.

*Oppia Perez-Inigoi* n. sp.; fig. 64.

Colour light brown. Length about 0.26 mm.

The rostral hairs are situated far laterally and a good distance behind the tip of the rostrum. They are very thin and almost as long as their mutual distance, but in spite of this they just reach beyond the tip of the rostrum. The lamellar hairs, which are set at the anterior end of short oblique ridges, are thin, slightly barbed, curved, and shorter than their mutual distance. Behind the oblique ridges there are on either side two other ridges, parallel to the former and indistinct. Interlamellar hairs are absent. The exopseudostigmatic hair is scarcely discernible. The four light spots, two small posterior ones and two bigger anterior ones are separated by a distance which is longer than the width of the anterior spots. The pseudostigma has a small posterior lobe.

The pseudostigmatic organs are longer than their mutual distance. The stalk is very thin, the head narrow, lanceolate, and set with minute bristles. There are only extremely small chitinous tubercles on the latero-posterior sides of the propodosoma.

The hysterosoma is almost circular. Its anterior border is narrow in the middle. In front of the anterior border two brown swollen ridges can be seen. Ta is absent. The other notogastral hairs are very short and thin. The fissure im is placed far from r3, almost halfway between ti and ms but further laterally.

The ventral side is shown in fig. 64 b. The sternal plate, which has dark contours, is broad between Epimeres I. The hair 1a is situated far anteriorly. There are six pairs of genital hairs. The fissure iad, which is long, is set obliquely to the anal field. The legs are slender and proportionately long. The solenidion of Tibia II is short and broad, whereas those of Tibiae I, IV, Genus I-II are extremely long. Tibia IV has a distal brush-shaped hair, Tarsus IV two shovel-shaped hairs on the medial side. Fig. 64 a shows Leg I with its extremely long solenidion of the tibia and the genu.

This species has many characters in common with species of *Membranoppia*, i.e. the rostral hairs' lateral position, the lamellae only developed anteriorly, the anterior notogastral hairs in two longitudinal rows, the sternal plate with dark contours, and the very long solenidia. It does not, however, have a membranous bridge across the pseudostigma, and the pseudostigmatic organs differ, too. This species is named after Dr. D. PÉREZ-IÑIGO, Spain.

Waitakere: Three individuals in moss and liverworts on the ground in native forest.

*Oppia Pletzeni* n. sp.; fig. 65.

Colour brown. Length about 0.5–0.6 mm, difficult to measure as the only specimen found is crushed.

This species is very characteristic. The rostral hairs, which are rather thick, lyrate, and barbed, are set rather close together and reach by most of their length beyond the tip of the rostrum. The lamellae, which incline, are slightly undulating, rather broad, and brown. Their anterior end is turned medially, forming the beginning of a translamella. The lamellar hairs are stiff, rough, and a little longer than their mutual distance. They are set on the rounded anterior end of the lamellae. The interlamellar hairs are a little shorter and thinner than the lamellar hairs, but also stiff and rough. The expseudostigmatic hairs are as long as the interlamellar hairs. On the posterior border of the pseudostigma there is a broad lobe corresponding to a round knob hidden by the anterior border of the hysterosoma. The pseudostigmatic organs are sickle-shaped, long, thin, and serrate on their posterior border. The organs are as long as their mutual distance. A very fine punctuation can be seen in the middle field and in front of the latter on the dorsal side of the rostrum. On the latero-posterior sides of the propodosoma the integument is covered with small chitinous tubercles.

The hysterosoma has a broad, rounded anterior border. The hair ta is missing.

Its pore can be seen behind the pseudostigma. The remaining hairs are curved, stiff, and unilaterally serrate; ms has been lost on both sides. The integument has a very fine and dense punctuation.

The ventral side is shown in fig. 65 a. There are six pairs of long and thin genital hairs. The aggenital hairs, the adanal hairs, and the anal hairs are rather long and serrate. The fissure iad is set obliquely to the anal field. The ventral plate is densely punctate. Tectop. IV ends in a long, pointed tooth. The legs, which are rather long and slender, have long, stiff, and serrate hairs, especially long on Coxa III. The solenidion of Tibia II is shorter than the ordinary hairs of the joint in question. The solenidia of all the tibiae and all the genus are likewise unusually short. Tibia IV has distally on its medial side a brush-shaped hair, Tarsus IV proximally two shovel-shaped hairs. This species is named after Dr. R. VAN PLETZEN, South Africa.

**Keri-Keri:** One specimen in mouldering leaves and debris on a slope above a brook in deep shadow.

*Oppia Turki* n.s.; fig. 66.

Colour light brown. Length about 0.31 mm.

The propodosoma is long as compared with the hysterosoma. Behind the tip of the rostrum there is a light spot with a short lobe on its posterior border. The rostral hairs, which are situated dorsally, reach by more than half their length beyond the tip of the rostrum. They are thin, barbed, and one and a half times longer than their mutual distance. The lamellar hairs, which are much thinner than the rostral hairs, are about two thirds as long as their mutual distance. They are set on the end of well developed lamellae. These are slightly curved, inclining. Their anterior ends are connected by a faint line or ridge, and in front of the latter an arched line can be seen, running to the end of the lamellae. The interlamellar hairs, which are set in the latero-posterior corner of the middle field, cut off from the latter by an oblique line, are very short. The expseudostigmatic hairs are rather long and thin. On the posterior border of the pseudostigma there is a broad lobe opposite a small tubercle hidden by the anterior border of the hysterosoma. The pseudostigmatic organs are lanceolate, very pointed at the tip.

The hysterosoma is circular. The middle of the anterior border is greyish as far as the pore for the hair ta. The latter is missing. The notogastral hairs are thin and slightly barbed. They are in the only specimen found arranged unsymmetrically, especially as regards ms.

Fig. 66 a shows the ventral side. Unfortunately I am unable to tell the number of the genital hairs as the plates are open. The fissure iad is located rather far anteriorly off an 1, ad 2 a short distance behind iad. Ad 3 is preanal. The legs are moderately long. The solenidion of Tibia II is short and thick. This species is named after Dr. F. TURK, England.

**Pauatahanui:** One specimen in moss and liverworts in cypress forest.

*Oppia Tuxeni* n. sp.; fig. 67.

Pale ochre to very light brown. Length about 0.23–0.28 mm.

The rostrum is broad. The rostral hairs, which are situated rather far from the lateral sides, are barbed and almost twice as long as their mutual distance. They reach by half their length beyond the tip of the rostrum. The lamellar hairs, which are situated behind a transverse ridge, are thin and a little longer than their mutual distance. The lamellae, which are distinct and narrow, proceed for a very short distance beyond the transverse ridge. Posteriorly the lamellae are divided into two parts, one running to the pseudostigma, the other to the posterior border of the propodosoma. The interlamellar hairs are longer than their mutual distance, thin, and smooth. The expseudostigmatic hair is fairly long and smooth. On the posterior border of the pseudostigma there is a small lobe, apparently corresponding to a small tooth hidden by the anterior border of the hysterosoma. The pseudostigmatic organ has a round head on rather a long, thin stalk.

The hysterosoma is a little narrower at the anterior end than at the posterior one. Ta is missing. The remaining notogastral hairs, which are equally long, are stiff and smooth. The pores are distinct. The hairs ti, ms, and r1, which are set directly behind each other, have the same mutual distance. The fissure im is located close to r3.

The ventral side is shown in fig. 67 a. There are six pairs of genital hairs. The distances ag-ag and ad3–ad3 are equally long. The fissure iad is set obliquely to the anal field. The legs are rather short. The solenidion of Tibia II is very short. Those of Tibia I and Genus I–II long and thin, but not so well developed as in *Membranoppia*. This species is named after Dr. S. L. TUXEN, Denmark.

Lake Rotoiti: Two specimens in thick moist *?Leucobryum* in *Nothofagus* forest.

*Oppia Covarrubiasi* n. sp.; fig. 68.

Colour brown. Length about 0.48–0.50 mm.

The anterior part of the propodosoma is long and narrow, the posterior part is much broader. The tip of the rostrum is narrow like a snout. The rostral hairs, which are situated rather close together, are lyrate, barbed, and twice as long as their mutual distance. They project by one third of their length beyond the tip of the rostrum. In front of the rostral hairs and covering the tip of the rostrum two membranous lobes can be seen, I am uncertain of their exact shape. Lamellae are missing. The lamellar hairs, which are set on the posterior third of the propodosoma, are thin, barbed, and shorter than their mutual distance. In front of them a very faint line can be seen. The interlamellar hairs, which are set close to the posterior border of the middle field, are tiny. The light spots between the interlamellar hairs are scarcely discernible. The expseudostigmatic hair is short. The pseudostigmata have a large posterior lobe and behind it a small tubercle can be seen. The pseudostigmatic organ is almost equally thick throughout, slightly broader at the tip, which is set with

minute hairs. On the latero-posterior sides of the propodosoma there are small tubercles.

The hysterosoma is as broad as it is long (in fig. 68 it is shown a little from the anterior end and the hysterosoma is for that reason slightly shortened). It is broadest in the anterior half. Ta is tiny. The notogastral hairs are short and barbed. Immediately behind the anterior border there is a large quadrangular field, lighter in colour than the surroundings and more greyish. It can be seen at a deeper level stretching forwards to the camerostome, tapering.

The ventral side is shown in fig. 68 a. It is heavily chitinized. There are six pairs of genital hair pores. The hairs could not be seen. Ad3 is set off the anterior border of the anal field. The fissure iad is located obliquely to the anal field. An1 is set rather far anteriorly. The legs are long and slender. Tibia IV has a distal brush-shaped hair, Tarsus IV two shovel-shaped hairs, as often present in long-legged *Oppia* species. This species is named after Dr. B. COVARRUBIAS, Chile.

Dunedin: One specimen in moist penguin dung mixed with grass in a penguin's nest.

*Oppia Newelli* n. sp.; fig. 69.

Colour light brown. Length about 0.45 mm.

The rostral hairs, which are situated rather close together, are barbed and twice as long as their mutual distance. Between the lamellar hairs there is a faint translamella. The translamella form together with the narrow lamellae and the posterior border of the propodosoma a rectangular field, on the anterior border of which the short and thin lamellar hairs are situated. The lamellae are broken. At about one third from their anterior end they turn medially for a short distance, then disappearing. The posterior part of the lamellae is separated from the anterior part by a short distance, and the two parts do not meet as the posterior half turns laterally, where the anterior part turns medially. The interlamellar hairs are about as long as their mutual distance. The exopseudostigmatic hair is as long as the interlamellar hair. On the posterior border of the pseudostigma there is a small tubercle and opposite it on the anterior border of the hysterosoma there is a small edge. The pseudostigmatic organs are as long as their mutual distance. They are thick, spindle-shaped, with about five prominent spines on either side in the distal half.

The hysterosoma is a regular oval apart from the straight anterior border. Ta is tiny. The remaining notogastral hairs are thin, barbed, and so long that they almost reach the base of the following one. Te and ti from the two sides are set more or less on a transverse line. The same holds good of r3 and ms.

Fig. 69 a shows the ventral side. It deviates definitely from every other *Oppia* by having a transverse band behind the genital field. The usual curved ridge following the anterior border of the genital field can just be guessed. The genital field is surrounded by a frame, from the posterior margin of which there is a slight connection to the transverse band. There are six pairs of genital hairs. Ad3 is placed off the

anterior border of the anal field, ad 2 off an 2. Between ad 1, which are postanal, there are four light spots. The fissure iad is located obliquely to the anal field. The legs are long and slender. The solenidion of Tibia II is short. Some of the hairs distally on Tibiae III-IV and Tarsi III-IV are spine-shaped. This species, which is named after Dr. I. M. NEWELL, U.S.A., probably constitutes a separate genus, which cannot be established until more species have been found.

Pauatahanui: One specimen in moss and liverworts on the forest soil; one in moss on dead branches, both biotopes in native forest.

*Oppia Oudemansi* n. sp.; fig. 70.

Colour light brown. Length about 0.38 mm.

The rostral hairs, which are situated on the dorsal surface, are barbed and they reach only a little beyond the tip of the rostrum. The lamellar hairs are barbed and as long as the rostral hairs. They are set at a short distance behind the anterior border of a long lamellar arch. The latter is formed more by folds than by ridges and it can be seen only in profile. The interlamellar hairs are tiny. The pseudostigmatic organs are lanceolate and finely serrate on their posterior border. The expseudostigmatic hair is missing. Laterally to the expseudostigmatic hair pore there are small tubercles.

The ventral side. There are four pairs of genital hairs. The aggenital hair is situated halfway between the genital and the anal field. It is moderately long and barbed. Ad 3 is situated far laterally off the anterior border of the anal field or a little farther anteriorly. Ad 2 is located behind iad, which is set obliquely to the anal field. Ad 1 is postanal. All the hairs are moderately long. The most characteristic feature of this species is a fairly big protuberance or spur ventrally on Femora I-II. It does not end in a tip, but it is cut off broadly and straight distally with a hair in its middle. The one on Femur II has a retroverse tip. The solenidion of Tibia II is rather short, but thin distally. This species is named after the late Dr. A. C. OUDEMANS, Holland.

New Plymouth: One specimen in mouldering leaves on a slope in native forest.

*Oppia Baderi* n. sp.; fig. 71.

Colour light brown. Length about 0.36 mm.

The rostrum is a little pointed. The rostral hairs, which are situated rather close together, are barbed and about three times longer than their mutual distance. There are no lamellae. The lamellar hairs, which are set on the posterior third of the propodosoma, are as long as their mutual distance and barbed. In front of them a faint curved ridge can be seen. Several very indistinct wrinkles run as more or less broken transverse bands across a good deal of the anterior part of the propodosoma. The middle field bordered anteriorly by the transverse ridge, laterally by a dark shade is greyish, probably due to a dense punctuation. In the middle field there are four very

bright spots. The interlamellar hair is tiny. Also the exopseudostigmatic hair is very small. On the posterior border of the pseudostigma there is a small lobe, and opposite it on the anterior border of the hysterosoma a very distinct rounded tubercle can be seen. The pseudostigmatic organ is a flat, pointed club with short radiating hairs on the posterior border.

The anterior half of the hysterosoma is as broad as the posterior one, but whereas the posterior border is broadly rounded, the anterior border projects in the middle, forming a small tongue-shaped arch, on either side of which the tiny hair ta is located. The notogastral hairs, which are barbed proximally, are extremely thin towards the tip. Te and ti from the two sides are set on a transverse line.

Fig. 71 a shows the ventral side, which is heavily chitinized. There are four pairs of genital hairs. Ad3 is preanal; ad2 is behind the fissure iad, which is located obliquely to the anal field. Between the hairs ad1 there is a small V-shaped ridge. The legs are moderately long. The hairs of the legs are strong and barbed. The solenidion of Tibia II is short. This species is named after Dr. C. BADER, Switzerland.

**Fox Glacier:** One specimen in moss, liverworts, grass, and low plants by the roadside in mixed *Nothofagus* forest.

*Oppia Mihelcici* n. sp.; fig. 72.

Colour light brown to brown. Length about 0.36 mm.

The rostrum is broad. The rostral hairs, which are set rather far laterally, reach by about one third of their length beyond the tip of the rostrum. They are distinctly barbed. The lamellae are slightly undulating and so long that they reach across two thirds of the length of the propodosoma. They incline a little. The lamellar hairs are curved, barbed, and longer than their mutual distance. In front of them there is an almost semicircular ridge, which forms the anterior border of the middle field between the lamellae. The lamellar hairs reach beyond this ridge and beyond a faint transverse band in front of the ridge. The interlamellar hairs are tiny. The exopseudostigmatic hairs are scarcely discernible. On the medial border of the pseudostigma a ? keel runs backwards, ending opposite a blunt tooth on the anterior border of the hysterosoma. The pseudostigmatic organs are long, almost filamentous, though tapering towards the tip, which is very thin. They are uneven on the posterior border.

The hysterosoma, which is only a little longer than broad, is rounded at either end. Its anterior border is well chitinized. Ta is missing, its pore can be seen behind the pseudostigma. The notogastral hairs, which are moderately long, are thin and slightly barbed.

The ventral side is shown in fig. 72 a. The sternal ridge is equally thick throughout. It is dark brown. The same is the case with Apodemata II, the sejugal apodemata, and the curved ridges lateral to the genital field. The hair 3 b is set more posteriorly than is usually the case; 4 a more medially. There are four pairs of genital hairs. Ad3 is preanal. The fissure iad is located obliquely to the anal field. The legs are rather short. The solenidion of Tibia II is very short and broad. Tibia II and Tarsus

II have respectively one and two strong, serrate, ventral hairs. This species is named after Dr. F. MIHELČIČ, Austria.

Keri-Keri: Four specimens in moss and grass near a brook in a deep cleft with tall vegetation; a few in moss, needles, and dead leaves under a fir tree.

New Plymouth: A few specimens in mouldering leaves under oak trees.

Pauatahanui: One specimen in thick moss, grass, and low plants under a tree-fern.

Christchurch: One specimen in *Polytrichum* and low plants on a vertical slope with oozing water.

*Oppia ? minus* Paoli 1908; fig. 73.

Colour pale ochre to light brown. Length about 0.205 mm.

The only specimen found agrees with the description and the figure of WILLMANN 1931, p. 132, fig. 149, but not with those of PAOLI 1908, Table III, fig. 11, which shows a short semilunar ridge in front of two short tips issuing from the anterior border of the hysterosoma. These tips are present also in *Oppia minutissima* Selln.. Fig. 73 a shows a sketch of the ventral side drawn from the dorsal side, thus not being quite correct. PAOLI does not show the ventral side, and therefore it is not possible to decide whether this species is *O. minus* Paoli. WILLMANN's species and the present one may be a different species.

Lake Rotoiti: One specimen in moist moss on a mouldering log in *Nothofagus* forest.

*Oppia minutissima* Selln. 1950; fig. 74.

Colour pale ochre. Length about 0.185 mm.

Rotorua: Many specimens in moist liverworts and moss on the bank of Lake Tarawera, under trees.

Christchurch: One specimen in a thin layer of moss on a vertical roadside in shadow.

*Oppia arcualis* Berl. 1913; fig. 75.

Colour light brown to brown. Length about 0.42 mm.

Keri-Keri: One specimen in a valley with a river (STAGAARD coll.); one individual in moss on a mouldering log; one in a thin layer of moss and liverworts on a grown-over road in deep shadow; several individuals in dead *Selaginella* vegetation under tall trees and shrub.

Waitakere: Three specimens in moss and small ferns on a log in native forest.

*Oppia Winkleri* n. sp.; fig. 76.

Colour light brown. Length about 0.38 mm.

This species has many characters in common with the preceding one and they probably constitute a separate genus. The tip of the rostrum is not cut so deeply

into three parts as in *O. arcualis*, and the parts are not so distinct. There is no lamellar arch on the propodosoma, scarcely a shade of it. The lamellar hairs are very thin. The interlamellar hairs are set laterally to the anterior light spots. The exopseudostigmatic hair is shorter than that of the preceding species. The pseudostigmatic organs have apparently almost the same appearance as those of *O. arcualis*, but only apparently. Fig. 76 a shows that the distal long thread merges into the swollen head, whereas the organ in *O. arcualis* is club-shaped with two long distal threads, the posterior one of which is twice as long as the anterior one, fig. 75 a. The long distal thread is in *O. Winkleri* as long as the remaining part of the organ. Besides this long thread there are two shorter proximal ones and several very short ones set on the distal thread. Behind the four light spots between the interlamellar hairs three indistinct spots in dark surroundings can be seen. They are present also in *O. arcualis*, but scarcely discernible.

The hysterosoma is a little longer than broad. Its anterior margin is rounded. Ta is well developed. The fissure ia can be seen immediately behind ta. The lyri-fissure im is located medially to r3, not in front of r3 as in *O. arcualis*. The notogastral hairs are moderately long. Te and ti from the two sides are set on a transverse line. This species is named after Dr. J. R. WINKLER, Czechoslovakia.

Keri-Keri: Three specimens in moist grass and *Hieracium* by the roadside.

Rotorua: Five individuals in a thin layer of moist moss and small ferns under *Manuka* shrub in the thermal area.

*Brachioppia Higginsi* n. sp.; fig. 77.

Colour pale orange to light brown. Length about 0.29 mm.

The propodosoma is very long as compared with that of most *Oppia* species. The rostrum is rounded. The rostral hairs, which are barbed, reach by only one third of their length beyond the tip of the rostrum. The lamellae are indicated only by faint shades. The lamellar hairs, which are set in a greyish middle field, are, when seen in a dorsal view, a little shorter than their mutual distance. Between the pseudostigmata there are six light spots, which appear bright in dark greyish surroundings. Along their lateral sides a grey band continues beyond the posterior border of the middle field. On the posterior border of the propodosoma they appear like small erect scales. The interlamellar hairs, which are set laterally to these dark bands off the posterior spots, are thin and short. The exopseudostigmatic hairs are tiny. The pseudostigmatic organs have on a slender flat club 6–7 radiating branches, the proximal ones of which are the longest, becoming evenly shorter towards the distal end. The organs are a little longer than their mutual distance. On the posterior border of the pseudostigma there is a small tubercle corresponding to a tiny tubercle on the anterior part of the hysterosoma.

The hysterosoma is longish. Its posterior end is broad, its anterior end tapers slightly, ending in a low, narrow arch on either side of which the pore for ta can be seen. The fissure ia is very distinct and is displaced far medially in front of te. The

anterior part of the hysterosoma is a yellowish-orange colour. The notogastral hairs are short and thin. The lyrifissure im is found immediately in front of r3.

The ventral side. There are five pairs of genital hairs, viz. three along the anterior border and two near the latero-posterior border. Ad3 is preanal. The fissure iad is set obliquely to the anal field, ad2 is off iad. Tibia II has a strong, serrate spine distally, Tibia IV and Tarsus IV a stiff, spine-shaped hair. This species is named after Dr. H. G. HIGGINS, U.S.A.

*Keri-Keri*: Three individuals in a green, moist to wet carpet of mosses and low ferns close to a brook in a deep cleft with shrubs and tall trees; several specimens in moss on the ground above a small brook in deep shadow.

*Pauatahanui*: One specimen in thick, moist moss, grass, and small plants at the foot of a tree-fern in native forest.

*Brachioppia Hartensteinii* n. sp.; fig. 78.

Colour very light brown. Length about 0.43 mm.

Like the preceding one this species is longish, about twice as long as broad. The rostral hairs, which are set rather far posteriorly, are barbed. There are no lamellae. The lamellar hairs, which are set at a short distance behind a very faint transverse line, are very thin and a little longer than their mutual distance. The interlamellar hairs are much stronger than the lamellar hairs and as long as the latter. The expseudostigmatic hairs are short and thin. The six light spots between the pseudostigmata are close together with a narrow distance only between the two anterior ones. The pseudostigma has a small posterior tubercle. The pseudostigmatic organ is a flat, slender club, which on its posterior border has four branches, the shortest one distally. The club gradually becomes narrower for each branch towards the tip. The integument is covered with small round tubercles laterally to the pseudostigmata.

The hysterosoma is longish, broadly rounded at the posterior end, at the anterior margin with a low arch. The latter is marked well off laterally by a posterior indentation at either end. The hair ta is set in front of the indentation. The remaining notogastral hairs are equally long and slightly barbed. This can be seen best in profile. Ti is set directly behind te and ms behind ti, all in a longitudinal row. P3 and r2 from the two sides are situated almost on a transverse line. The fissure im is situated close to the medial side of r3.

The ventral side. There are four or ? five pairs of genital hairs. The curved ridge surrounding the anterior border of the genital field is very prominent. Ad3 is preanal, ad2 is situated laterally to iad, which is located obliquely to the anal field. Ad1 is postanal. All the tibiae have a stiff, strong, distal spine. Tarsi III-IV with similar, though smaller spines. This species is named after Dr. R. HARTENSTEIN, U.S.A.

*Waitakere*: One specimen in moss and liverworts along a trail in dark native forest.

*Brachioppia Walkeri* n. sp.; fig. 79.

Colour very light brown. Length about 0.43 mm.

This species is longish like the preceding ones. The rostral hairs, which are set rather laterally, are densely barbed. On the dorsal surface of the rostrum there is a U-shaped fissure. Across the posterior part of the rostrum several transverse wrinkles can be seen. The middle field is bordered by faint grey bands or ridges. The lateral ones are more or less replaced by small dark tubercles. The lamellar hairs, which are as long as their mutual distance, are barbed. The interlamellar hairs are likewise barbed and at least as long as their mutual distance. Between the interlamellar hairs there are six light spots in two rows. The four posterior ones are placed close together, whereas the two anterior ones are separated by a distance twice the width of the spots. From these more laterally situated spots a dark membrane runs backwards, reaching beyond the posterior border of the middle field, then turning laterally, forming a round lobe (cp. *Br. Higginsi* fig. 77). The exopseudostigmatic hair is rather long. On the posterior margin of the pseudostigma there is a small tubercle opposite a blunt tooth on the anterior border of the hysterosoma. The pseudostigmatic organ has a narrow flat head with 3–5 radiating branches on its posterior border. The head is broadest off the proximal branch, which is the longer.

The hysterosoma is longish. The posterior end is broad, rounded. The anterior end tapers, forming a narrow arch, which projects beyond the posterior border of the pseudostigmata. On either side of the arch there is a strong, blunt tooth. Ta is scarcely discernible. Its pore is located on the latero-anterior edge of the arch. The fissure ia is distinct. The notogastral hairs, which are soft and flexible, are barbed proximally, very thin and smooth distally. The lyrifissure im is placed at some distance in front of r3.

The ventral side. There are five pairs of genital hairs, viz. two behind each other at the antero-medial border, one near the middle of the lateral border, and two in the latero-posterior corner. Ad3 is preanal. Ad2 is set behind iad, which is located obliquely to the anal field. Ad1 is postanal. Tibia II has a long, distal spine. Tibiae III–IV have each two long, distal spines, and Genu III one long, stiff spine. Tarsus III has several very long spines. This species is named after Dr. N. A. WALKER, U.S.A.

Keri-Keri: Five individuals in a thick, green carpet of mosses, ferns, etc., close to a small brook in a deep cleft with tall vegetation; many specimens in thick, moist moss on a log and on the ground, in the same locality.

Waitakere: Three specimens in moist moss on the ground in native forest.

?*Brachioppia Suciui* n. sp.; fig. 80.

Colour very light brown. Length about 0.29 mm.

The rostrum is long, rounded at the tip. The rostral hairs, which are set rather close together, are slightly barbed. They are set rather far posteriorly and reach by

only one third of their length beyond the tip of the rostrum. There are no true lamellae, but a faint rectangular frame surrounds the grey middle field. Posteriorly the frame does not quite reach the pseudostigmata. The lamellar hairs are set at some distance behind the transverse line. They are thin and shorter than their mutual distance. The interlamellar hairs are tiny. The exopseudostigmatic hairs are unusually long and strong. Between the interlamellar hairs there are six light spots. The pseudostigmatic organ is a long, flat club with eight to ten radiating branches on its posterior border, fig. 80 a. The branches become gradually longer towards the tip; the two distal ones are, however, rather short. On the posterior border of the pseudostigma there is a lobe, which apparently corresponds to a small knob hidden by the anterior border of the hysterosoma. Small dark tubercles can be seen on the posterior part of the lateral sides of the propodosoma.

The hysterosoma is circular. It has a very broad chitinized anterior border. The two small knobs just mentioned can be seen through it. Ta is minute. It is set farther laterally than usual, laterally to the knob. The notogastral hairs are short and thin. R3 and ms from the two sides are set on a transverse line. The lyrifissure im is located at a short distance in front of r3.

The ventral side is shown in fig. 80 b. The sternal plate is well chitinized and rather broad, especially between Apodemata II. The genital field is narrow. There are five pairs of genital hairs, viz. three in an oblique anterior row and two in the latero-posterior corner. Ad3 is preanal. Ad2 is located laterally to the fissure iad, which is parallel to the lateral side of the anal field. Ad1 is postanal. Tectop. IV ends in a tiny, pointed tooth. All the legs are slender. Femora I-II have a ventral keel. Tibiae and Tarsi III-IV have long, spine-shaped hairs. Due to the position of iad being parallel to the anal field this species does not belong to *Brachioppia*; it has been placed within this genus only for the time being until more species with the same characters have been found. It is named after Dr. I. SUCIU, Rumania.

Waitakere: Several specimens in moist moss and grass under bushes in a garden on the edge of native forest.

*Brachioppiella Rajskii* n. sp.; fig. 81.

Colour light brown. Length about 0.28 mm.

The rostral hairs, which reach by only half their length beyond the tip of the rostrum, are slightly barbed. The lamellae, which are well developed, are winding, being concave both anteriorly and posteriorly on the lateral side. There is no translamella, but a faint line indicates the anterior border of a grey middle field. The lamellar hairs, which are located off the middle of the anterior concave part, are thin and shorter than their mutual distance. The interlamellar hairs are very short. Behind them two retroverse small lobes can be seen, and between them there are four light spots, the two anterior ones being separated by a distance one and a half times longer than the width of the spots. The exopseudostigmatic hair is tiny. On the posterior

margin of the pseudostigma there is a tubercle corresponding to a blunt tooth on the anterior border of the hysterosoma. The pseudostigmatic organs have a long and narrow, flat head with three radiating branches on the posterior border. The head is a little thicker proximally to the proximal branch. The two proximal branches are the longest. The pseudostigmatic organs taper towards the tip. The latero-posterior sides of the propodosoma are covered with a greyish (?) secretion.

The hysterosoma is almost circular. Its anterior chitinized border is narrow in the middle, forming a faint arch at either side of which the pore for ta can be seen. The notogastral hairs are very short and thin. Te and ti from the two sides are set almost on a transverse line. The fissure im is located at some distance in front of r3.

The ventral side. There are five pairs of genital hairs. Ad3 is preanal and set rather far laterally. The fissure iad is set obliquely off the anterior part of the anal field, ad2 a short distance behind iad. Ad1 is postanal. The legs are slender; there are no long spines as often present in *Brachioppia*. Genu III has a curved, dorsal, distal spine. This species is named after Dr. A. RAJSKI, Poland.

Pauatahanui: A few specimens in dead leaves in ?cypress forest.

*Brachioppiella Rafalskii* n. sp.; fig. 82.

Colour light brown. Length about 0.28 mm.

The rostral hairs, which reach by about one third of their length beyond the tip of the rostrum, are faintly barbed. The lamellae are rather long, narrow, and slightly inclining. At their anterior end they are connected by a curved translamellar ridge, which is very faint. The lamellar hairs, which are found immediately behind the curved ridge, viz. in the middle of the propodosoma, are very thin and shorter than their mutual distance. The interlamellar hairs are at least as long as the lamellar hairs. Exopseudostigmatic hairs have not been observed. The latero-posterior corners of the middle field are cut off by oblique lines. Between the interlamellar hairs there are four indistinct light spots separated by a distance twice their width. The pseudostigma has on its posterior border a tubercle opposite a small tooth on the hysterosoma. The pseudostigmatic organ has a flat, club-shaped head with five radiating branches on its posterior border, the branches being approximately equally long.

The hysterosoma is a little truncate posteriorly and not much longer than broad. Its anterior chitinized margin is narrow. The hair ta is proportionately long. The remaining notogastral hairs are moderately long and slightly barbed.

The ventral side. There are six pairs of genital hairs, viz. four in a longitudinal row and two in the latero-posterior corner. Ad3 is preanal. The fissure iad is set obliquely to the anal field, ad2 is located behind iad. Ad1 is postanal. *B. Rafalskii* is closely related to *B. petrohuensis* Ham. 1962, p. 48, fig. 39, but differs by its longer and inclining lamellae. This species is named after Dr. J. RAFALSKI, Poland.

Lake Rotoiti: Three specimens in thick, moist *?Leucobryum* in *Nothofagus* forest.

*Ramusella Sengbuschi* n. sp.; fig. 83.

Colour pale ochre to light brown. Length about 0.24 mm.

*Ramusella* was established 1962, the type species being *R. puertomontensis* Ham. 1962 a, p. 50, fig. 42. The new species corresponds in all important characters to the type species.

The rostral hairs, which are set close together in a dark band, are densely feathered proximally, whereas the distal part is smooth and bent medially. The lamellar hairs, which are situated in a greyish middle field at a short distance behind a faint transverse ridge and removed from the narrow lamellar ridges, are thin and approximately as long as their mutual distance. The interlamellar hairs are perhaps as long as the lamellar hairs. They are more or less erect. The light spots are distinct. The three spots in each row are situated close together and the rows are separated by a distance, which is longer than the width of the spots. The exopseudostigmatic hair is short. The pseudostigmatic organs differ from those of the type species by being more branched. The flat, club-shaped head has on its posterior border 10–13 radiating branches of different lengths, viz. a few short proximal ones, some very long in the middle becoming evenly shorter distally, fig. 83 a.

The hysterosoma is a regular oval with a broad chitinized anterior border. The hair ta cannot be seen, but its pore behind the pseudostigma can. The remaining hairs are thin and slightly barbed, moderately long.

The ventral side agrees with that of the type species (HAMMER 1962 a, fig. 42 a). The fissure iad is parallel to the lateral border of the anal field and situated off ad2. Ad3 is preanal. The legs, which are comparatively short, have no spines, although Tibia IV has a long, stiff, ventral hair distally. Tectop. IV ends in a pointed tooth. This species is named after Dr. H. G. SENGBUSCH, U.S.A.

Keri-Keri: Three specimens in a little moist moss and grass under a hedge of *Eucalyptus* trees; two individuals in moist moss and grass on a lawn.

*Neoribates barbatus* n. sp.; fig. 84.

Colour mahogany red. Length about 0.95 mm.

The rostral hairs, which almost meet at some distance in front of the tip of the rostrum, are barbed, the secondary bristles being rather long and scattered. The lamellar hairs, which are set near the end of the narrow inclining lamellae, are parallel, rather thin, and furnished with prominent scattered secondary bristles. They reach by most of their length beyond the tip of the rostrum and far beyond the rostral hairs. The lamellae are connected by a faint line forming a broad arch across the propodosoma, fig. 84 a. The interlamellar hairs are longer than the lamellar hairs and, like these, thin and with scattered bristles. They are very thin towards the tip, as is the case also with the lamellar hairs. The pseudostigmatic organs are more or less lanceolate, thinnest at the tip, and along their whole length set with outstanding bristles, fig. 84 b.

Along the anterior border of the hysterosoma there is a long area porosa dorso-

*sejugalis*. The position of the sacculi is shown in fig. 84. The hair pores are very indistinct.

Fig. 84 c shows the ventral side. There are four pairs of genital hairs. Ad3 is preanal, situated close to the anterior border of the anal field. The fissure iad is parallel to the anal field, near the anterior border of the latter. Ad2 is located off the latero-posterior corner of the anal field, and ad1 is postanal.

Waitomo: Two species in moss, liverworts, and mouldering leaves.

Lake Rotoiti: Two individuals in thick *Sphagnum*; one in wet moss and liverworts on a vertical slope above a small brook, both biotopes in *Nothofagus* forest.

Fox Glacier: One specimen in thick moss at Lake Matheson in native forest.

Milford: Four specimens in liverworts on a rotten log under trees.

*Galumna scaber* n. sp.; fig. 85.

Colour brown. Length about 0.62 mm.

The rostrum is conical. The rostral hairs, which are set laterally, are apparently smooth. The lamellae project beyond the side of the propodosoma; their medial border continues on the dorsal surface. Fig. 85 a shows the lamella and the sublamella. Both the lamellar and the interlamellar hairs are very long and reach far beyond the tip of the rostrum. They are extremely thin towards the tip, which is curved, and smooth. Medially to the base of the interlamellar hairs there is a big pore. The pseudostigmatic organs are filamentous to lanceolate, being slightly thicker towards the tip, which is pointed. Within the thickened part a light line can be seen. Behind the interlamellar hairs a small round area porosa dorso-sejugalis can be seen.

The propodosoma and the hysterosoma are separated by a distinct line, the dorso-sejugal suture. The integument of the hysterosoma is rough (= *scaber*) being set with chitinous tubercles in more or less regular oblique lines. These are most distinct between Aa–Aa. Aa is oval and at least twice as long as A1. A2 is the smaller and A3 is as long as A1. The pteromorphae have dark radiating ribs with holes or pores surrounded by ribs.

Fig. 85 b shows the ventral side. The hairs are all distinct but very thin. The area porosa postanal is short and oval.

Fox Glacier: One specimen in thick moss on a log in native forest.

*Galumna rugosa* n. sp.; fig. 86.

Colour brown to mahogany red. Length about 0.66 mm.

The rostral hairs are moderately long, thin, and barbed. The lamellar hairs, which also are barbed, reach halfway to the tip of the rostrum. The lamellae project beyond the side of the propodosoma and the lamellar line is distinct in young individuals in a dorsal view. Fig. 86 a shows the lines S and L. Interlamellar hairs are absent. The integument of the propodosoma from the tip of the rostrum to the dorso-sejugal suture is densely furrowed, being furnished with undulating dark chitinous

ribs, which make the outlines rough. The pseudostigmatic organ is a slender rough club, which is set with tiny scales for most of its length.

The dorso-sejugal suture is distinct. Behind the interlamellar hair pore there is a small round area porosa dorso-sejugalis. The pteromorphae have dark radiating ribs, being thinner and denser towards the distal border. In young individuals similar undulating ribs as those on the propodosoma can be seen on the pteromorphae, the ribs often running across the pteromorphous ribs. The pore for ta looks like a dark key-hole, or like the figure 8. Aa is rounded and about twice as big as A2. A3 is a little bigger than A2, and A1 is only half as big as A3. All the hair pores are double and look like the figure 8.

Fig. 86 b shows the ventral side. The hair pores of the ventral side are not double. An area porosa postanalis has not been observed.

Keri-Keri: Two specimens in a thick carpet of mosses and small ferns near a brook in a deep cleft with shrubs and tall trees; one in lichens and moss on a dead trunk.

Bay of Islands: Several individuals in a forest hang; in a pine wood, and in a *Citrus* plantation (STAGAARD coll.).

Rotorua: Two individuals in wet *Scirpus* close to the warm water called Soda Spring at Lake Rotoehu, 23 miles north east of Rotorua.

*Galumna microfissum* n. sp.; fig. 87.

Colour mahogany red to black, the propodosoma, however, lighter. Length about 1.12–1.14 mm.

The rostrum, which is conical, is at a lower level than the posterior part of the propodosoma. The rostral hairs are short, thin, and smooth. The lamellar line is well developed and the lamellar hair is as short and thin as the rostral hair. Fig. 87 a shows the lamella and the sublamella. The interlamellar hairs have the same appearance as the lamellar and the rostral hairs. The dorso-sejugal suture is very indistinct. Area porosa dorso-sejugalis is oblong. The pseudostigmatic organ is a very thin thread, which becomes extremely thin towards the tip. It is smooth.

The pteromorphae are covered with short, dark ribs, in older individuals moreover with brown chitinous patches in the neighbourhood of the fissure (shown on the left pteromorpha). The fissure is very short and surrounded by a dark frame. The hair pore ta is very small. On the posterior border of the hysterosoma there are two low indentations. Aa is shaped like a broad funnel, being broad and rounded laterally and with a fairly long and narrow medial part. A1 and A2 are situated rather close together. A1 is round, A2 and A3 oblong. The last two are equally large.

Fig. 87 b shows the ventral side. There are five pairs of genital hairs. All the hairs of the ventral side are thin and moderately long. Ad3 is located behind iad. An area porosa postanalis has not been observed. The three claws are equally strong.

Keri-Keri: Two specimens in a thin layer of lichens and moss on a dead branch, and in moss on the ground.

Waiuku Forest: One specimen in the litter (STYLES coll.).

Rotorua: Numerous in moist mosses and small ferns on a slope under *Manuka* shrub in the thermal area.

New Plymouth: One individual in mouldering leaves under oak trees.

Lake Rotoiti: One specimen in dead mouldering *Nothofagus* leaves.

Milford: One specimen in thick moss, grass, and white clover by the roadside.

*Acrogalumna longiplumus* (Berl.) 1904; fig. 88.

Colour brown. Length about 0.77 mm.

The specimens from New Zealand differ a little from the figures in WILLMANN 1931, fig. 289, and in BALOGH 1965, fig. 3, Plate 23. The interlamellar hairs thus do not reach beyond the tip of the rostrum as shown by WILLMANN. Aa is triangular in the specimens from New Zealand, A2 and A3 oblong. BERLESE does not show the areae porosae. According to WILLMANN Aa is small and round, according to BALOGH Aa is a little longish, and bigger than shown by WILLMANN. The specimens from New Zealand agree with a few specimens collected in the mushroom *Oudemansiella radicata* near Fredensborg and in Grib wood in North Eastern Zealand. These Danish specimens have a triangular Aa, a longish A2 and A3, A2, however, a little shorter than A1. The pseudostigmatic organ is in the Danish specimens very thin and slightly thicker in the distal third, which is very slender, lanceolate. In the specimens from New Zealand the pseudostigmatic organ is rather thick and rough. This species thus seems to be very variable.

Fig. 88 a shows the propodosoma in a lateral view. The male has a group of bright pores on the posterior part of the hysterosoma.

Keri-Keri: Numerous in many samples collected in a thin layer of lichens and moss on a rotten branch on the ground; in moss and grass on a lawn, but also in moist to wet moss in a kind of bog.

Waitomo: One specimen in moss and *Medicago* by the roadside.

Nelson: One specimen in a thin layer of moss on a slope at the water-reservoir of the town.

*Allogalumna novazealandica* n. sp.; fig. 89.

Colour light brown. Length about 0.40–0.41 mm.

The rostral and the lamellar hairs are very short, thin, and smooth. Interlamellar hairs are missing. The area porosa dorso-sejugal is oblong. The dorso-sejugal suture is scarcely discernible. The colour of the propodosoma is a little more greyish than that of the hysterosoma. The lamellar line is absent. Fig. 89 a shows the sublamella and the hairs of the propodosoma. The pseudostigmatic organ, which is rather short, is straight and almost equally thick throughout, perhaps slightly thicker in the distal third, and smooth.

The pteromorphae are light in colour and have only very faint ribs. The pore for ta has a long, light furrow running medially in greyish-yellow surroundings. Aa is oval and very large, A1 is circular and only half as big as Aa. A2 is also circular and smaller than A1. A3 is oval and perhaps as big as A1. In front of Aa some light spots can be seen. In the middle of the posterior part of the hysterosoma there is a small pore.

Fig. 89 b shows the ventral side. Hairs have not been observed. The area porosa postanal is fairly big and oval.

Waitomo: Five specimens in mouldering leaves under trees in a cleft by the roadside.

*Allogalumna remota* n. sp.; fig. 90.

Colour brown. Length about 0.67 mm.

The rostrum is a little pointed, conical, and at a lower level than the middle of the propodosoma. The rostral hairs are rather long and slightly barbed. The lamellar hairs are as long as the rostral hairs and likewise barbed. The interlamellar hairs are perhaps a little shorter and directed straight forwards. Fig. 90 a shows the sublamella and the hairs of the propodosoma. The dorso-sejugal suture is scarcely discernible. At a short distance in front of the intermellar hairs a faint transverse line can be seen. The area porosa dorso-sejugal is missing, but in some specimens something like a pore can be seen laterally to the long gland behind the interlamellar hairs. The pseudostigmatic organ is a long, very thin thread set with secondary bristles.

The middle of the hysterosoma is a mahogany red colour, the anterior border of which is indicated by a broken line. The pteromorphae have broad, brown ribs separated by yellow, narrow furrows. Aa is removed (= remota) from its usual position near the base of the pteromorpha to the middle of the hysterosoma. Aa is rather small and round. A1 is also round and a little bigger. A2 is absent, and A3 as big as A1. The middle pore is as big as Aa.

Fig. 90 b shows the ventral side. The genital and the anal field are light brown in dark brown surroundings. Also the anterior part of the ventral side as far as the ventro-sejugal apodemata is light, though with a darker band between Apodemata II. The hairs are fine, geniculate at their base. The area porosa postanal is indistinct. All the legs have three claws of which the middle claw is the strongest.

Keri-Keri: Numerous in a thick carpet of mosses and low ferns near a brook on wet soil in a deep cleft with tall vegetation; in luxuriant moss on the ground; in lichens and moss on dead branches, etc.

Waitakere: Several specimens in many samples collected in moss, liverworts, and dead leaves in native forest; also in moss in the drier part of the forest under a *Manuka* shrub.

Rotorua: Three individuals in thin, almost dry moss on the ground under a *Manuka* shrub in the thermal area; numerous in moist moss and small plants under a *Manuka* shrub in the thermal area.

*Pergalumna reniformis* n. sp.; fig. 91.

Colour light brown. Length about 0.50–0.51 mm.

The rostrum is pointed. The rostral hairs, which are situated halfway between the tip of the rostrum and the projecting lamellar tip, are rather long and strong. The lamellar and the interlamellar hairs are much shorter and much thinner, both are smooth. Fig. 91 a shows the position of the lamellar hairs between the two lamellar lines. The lamellar line can be seen also in a dorsal view. The area porosa dorso-sejugal is narrow, oblong. The pseudostigmatic organs are lanceolate, the head being only slightly thicker than the stalk. The organs are set with minute bristles, which make them slightly rough, fig. 91 b. The dorso-sejugal suture is a distinct straight line. The glands behind the interlamellar hairs are branched.

The pteromorphae have only faint, light ribs on an ochre ground, but medially there is a large light field into which the proximal ribs reach. The fissure is short and indistinct. Aa is big, reniform with the concave side directed anteriorly. Aa from the two sides are not equally big in the only specimen found. A1 is round and less than half as big as Aa. A2 is round, too, but much smaller than A1. A3 is longish and as big as A1.

Fig. 91 c shows the ventral side. It is a light brown colour. There is a faint line between the ventro-sejugal apodemata. All the hairs are short and thin. The area porosa postanal is oblong.

Rotorua: One specimen in thin moss on the ground under a *Manuka* shrub in the thermal area.

*Pergalumna silvestris* n. sp.; fig. 92.

Colour light brown. Length about 0.43 mm.

The propodosoma is pointed and only slightly arched. The rostral hairs are absent or not discernible. The lamellar hairs, which are set close to the lamellar line, fig. 92 a, are extremely small. The same holds good of the interlamellar hairs. The lamellar line is developed in its whole length. At the lateral side of the propodosoma it projects like a small keel. The dorso-sejugal suture is indistinct. The area porosa dorso-sejugal is guttiform, being narrowest laterally. The gland behind the interlamellar hair is composed of small round tubercles. The pseudostigmatic organs have a long thin stalk, widening distally into a short, flat club, which is serrate at the tip or set with minute bristles.

The pteromorphae have rather a sharp carina at a short distance in front of the fissure and parallel with the latter. Aa is twice as long as it is broad. It is set at almost right angles to the pteromorphae. A1, A2, and A3 are approximately of the same size, all being small and round. The shape of Aa is variable, fig. 92 b.

Fig. 92 c shows the ventral side. The area porosa postanal is round.

Fox Glacier: Five individuals in thick moss at the foot of a giant tree in native forest; many specimens in thick moss and dead leaves also in native forest.

*Addenda*

At a revision of the material the following eight new species were found, which have been described below; *Zeasuctobelba arcuata* n. sp.; *Machuella pyriformis* n. sp.; *Scheloribates maoriensis* n. sp.; ?*Xylobates sicafer* n. sp., *Lauritzenia acutirostrum* n. sp., *L. rotundirostrum* n. sp., *Totobates capitus* n. sp., and *T. microseta* n. sp. In Table I, p. 74, which shows the occurrence of the species in New Zealand, they are arranged together with species of the same genera, or, in cases in which the genus has not previously been recorded, in their respective place in the series.

*Zeasuctobelba arcuata* n. sp.; fig. 93.

Colour light brown. Length about 0.27 mm.

This new species is number four belonging to the genus *Zeasuctobelba* of which three were described in Part I (figs. 74–76) of this work. *Z. quinquenodosa* and *Z. trinodosa* have both two tubercles or broad teeth in the middle of the anterior border of the hysterosoma. These are missing in *Z. nodosa* and in *Z. arcuata*. Instead of the tubercles *Z. arcuata* has a low broad arch and on either side of the latter there is a long tooth. A similar arch is not present in *Z. nodosa*.

The rostrum has on either side a forward directed, fairly long tooth. On the dorsal side of the rostrum there are two long, tongued ridges, which run from the tip of the rostrum to the tectopedial field. Between them there is a row of small chitinous tubercles, but I am unable to tell how many, and also whether the posterior ones, which are only dark shades, have the exact shape as shown in fig. 93. The lamellar knob is open posteriorly. The lamellar hairs, which are situated off the posterior border of the knob, are longer than the latter. The interlamellar hairs, which are short and thin, are set laterally to the anterior part of the interpseudostigmatic ridge. The pseudostigmatic organ is club-shaped, the head being rather narrow, rounded at the tip. On the posterior border of the pseudostigma there is a very broad lobe corresponding to the pointed lateral tooth on the anterior border of the hysterosoma.

The notogastral hairs are thin and moderately long.

Waitakere: One specimen together with a huge number of *Z. nodosa* in moss and liverworts along a trail in native forest.

*Machuella pyriformis* n. sp.; fig. 94.

Colour yellowish to grey. Length about 0.22 mm.

The rostral, the lamellar, and the interlamellar hairs agree with those of the two previously described species (HAMMER 1961 a, fig. 59; HAMMER 1961 b, fig. 3). In the posterior part of the propodosoma there is in this species a structure consisting of very faint lines forming an arch from the anterior border of which short lines run anteriorly. Similar faint lines run from the pseudostigmata obliquely to the interlamellar hairs. These are very thin. Also the expseudostigmatic hairs are extremely thin. Across the opening of the pseudostigma there is a narrow furrow bounded by narrow ridges, both of which end in a tooth laterally to the pseudostigma.

The shape of the hysterosoma differs from that of the two species previously described by being more pointed posteriorly, broadest in its anterior half. The anterior border is very narrow in the middle and straight, but only for a short distance. The very thin line which in the two other *Machuella* species runs from the anterior border of the hysterosoma to the hair te is much longer here, and there are two of them. The lateral one can be seen as far as r3, the medial one as far as ti. In front of the anterior border of the hysterosoma some faint lines can be seen in the shape of small triangles, but it is probably only due to a sheet of secretion.

A sketch of the ventral side is shown in fig. 94 a. I am unable to see how many hairs carry the middle layer of secretion and even to tell the length of the anterior ones. Details are extremely difficult to see, but I can see with certainty that there are eight hairs on a line immediately in front of the genital field.

Waitomo: One specimen in dead leaves in a cleft with tall trees.

*Scheloribates maoriensis* n. sp.; fig. 95.

Colour yellow. Length about 0.42 mm.

An easily recognisable species due to its yellow colour, the very long rostral, lamellar, and interlamellar hairs and the withdrawing pteromorphae. The pseudostigmatic organs are club-shaped, and the head is set with tiny bristles in longitudinal oblique rows, fig. 95 a. The sides of the pteromorphae are slightly striped and are a yellowish-grey colour. The notogastral hairs are tiny, slightly hook-shaped.

The hairs of the ventral side are fairly long. The anterior pair of the genital hairs are especially long and cross in front of the genital field. Ad3 is situated at a short distance in front of the anal field, off the latero-anterior corner. Iad is parallel to the anal field. Ad2 is located in front of the latero-posterior corner and ad1 is postanal. All tarsi have three claws, the middlemost of which is the strongest.

Rotorua: Numerous in thick green moss under *Manuka* shrubs in the thermal area.

?*Xylobates sicafer* n. sp.; fig. 96.

Colour light brown. Length about 0.55 mm.

The tip of the rostrum, which is rounded, projects a little in front of the sides of the rostrum. The rostral hairs, which are thin and barbed, are almost as long as their mutual distance. The lamellae, which are broadest in their middle, taper distally, ending, bending medially, in a faint translamellar line, which together with the lamellae forms a regular arch. Where the lamellae are broadest, a "window" at the medial border can be seen. The lamellar hairs are set at a short distance behind the tip of the lamellae. They are as long as their mutual distance, thin and slightly barbed. The interlamellar hairs, which are more or less erect, are perhaps as long as the lamellar hairs and barbed like these. The pseudostigmatic organs are long, thin threads, which are almost equally thick throughout. For most of their length they are set with short outstanding scales or branches.

The hysterosoma is a little longer than broad. Its anterior margin is a broad arch. The pteromorphae, which are movable, do not reach quite so far anteriorly as the anterior margin of the hysterosoma. The notogastral hairs, 10 pairs, are scarcely discernible, but their pore is bright. Aa is a little longer than the remaining areae porosae. From the posterior border of the hysterosoma two proportionately long hairs project. They represent ad1.

Part of the ventral side is shown in fig. 96 a. The sternal ridge is represented by oblique wrinkles. There are probably six pairs of genital hairs. They are extremely difficult to see and I am uncertain of the anterior one. Ad3 is set within the frame of the anal field on its anterior border. Ad2 and ad1 are set on a faint curved ridge behind the anal field. The fissure iad is parallel to the lateral side of the anal field.

The legs are unusual, having branched dagger-shaped hairs on several joints (dagger: sica). In fig. 96 these hairs are shown on Femora I-II. They are present also distally on Tarsi I-III. Femora II-III are broad and have a big distal tooth. All the tarsi have three claws, the middlemost of which is much stronger than the very thin lateral ones.

Due to the strong dagger-shaped hairs, which I do not know from *Xylobates*, I have put a question mark in front of the generic name.

Keri-Keri: Six specimens in luxuriant moss and grass on a lawn.

*Lauritzenia acutirostrum* n. sp.; fig. 97.

Colour light brown. Length about 0.43 mm.

The rostrum ends in a pointed tip. The rostral hairs, which are situated laterally in front of a free tip of the tutorium, are thin and barbed. They just reach beyond the tip of the rostrum. The lamellae seem to be rather complicated and the distal half immediately behind the lamellar hair has apparently a broad plate along the medial thickening. The lower part of the lamellae seems to continue to the dorsal surface of the rostrum. The lamellar hairs are thin, distally barbed, and reach beyond the tip of the rostrum. The interlamellar hairs are barbed and apparently shorter than the lamellar hairs, but as they are erect, their length is difficult to tell. Round the base of the interlamellar hairs there is a plate within which there is a small extra pore. Also the notogastral hairs are surrounded by a plate with a pore. This extra pore can be seen in *L. longipluma* Hammer (1958, fig. 102), too. The pseudostigmatic organ is a long thread, which is thinnest in the middle. The distal end is slightly thickened and the tip is rounded. Along its distal half it is set with tiny hairs on the posterior border.

The hysterosoma is longer than broad. Its anterior border is a broad regular arch. The pteromorphae are rather short, movable. The notogastral hairs are equally long. They are extremely thin, slightly curly and rather short. Sa is narrow and very long, S1 is much shorter, S2 broader than Sa and a little shorter, S3 is as narrow as Sa but shorter. S3 is surrounded by a dark plate. The integument is without any sculpture.

The ventral side agrees with that of *L. longipluma* Hammer (1958, fig. 102 a),

except that there are one or two genital hairs more, in all five or six pairs. Those on the anterior border are extremely difficult to see. The adanal hairs are situated as in *L. longipluma*. Iad is parallel to the side of the anal field. The tarsi have three claws the lateral ones of which are very thin.

Keri-Keri: One specimen in lichen and moss on a rotten branch under trees.

*Lauritzenia rotundirostrum* n. sp.; fig. 98.

Colour light brown to brown. Length about 0.70 mm.

The rostrum is rounded. The rostral hairs are set laterally in front of a short pointed free tip of the tutorium. They are stiff, unilaterally barbed, and rather short. They just reach beyond the tip of the rostrum. The lamellar hairs, which are densely barbed, are about one and a half times longer than their mutual distance, and they reach by half their length beyond the tip of the rostrum. The interlamellar hairs are broken, so nothing can be told about their length. The lamellae are built like those of the preceding species. The pseudostigmatic organs consist of a very slender stalk that ends in a tiny lanceolate head, which is pointed distally. The stalk is thinnest close to the head. It reaches beyond the pteromorphae.

The hysterosoma is rather broad. Its anterior border is a regular arch. The pteromorphae are short and movable. The notogastral hairs are of different lengths, ta being bent and much shorter than the remaining hairs, which are rather long, very thin, and smooth. At the hair base an extra pore can be seen. Sa is rather long, S1 short, S2 broad and short, and S3 rather narrow. The fissure im is indistinct with a bright hole close to it.

The ventral side. There are five (? six) pairs of genital hairs. The adanal hairs are located like those of the preceding species. The fissure iad is parallel to the anal field, off its anterior half. The integument is without any sculpture. The legs are rather slender. Femur II has a ventral keel, which ends in a distal tooth. The tarsi have three claws, the middle one of which is only twice as strong as the lateral ones.

Puketi: One specimen in a thin layer of moss and small plants scraped from the bark of a big tree.

*Totobates capita* n. sp.; fig. 99.

Colour yellow to light brown. Length about 0.31 mm.

This small species bears a close resemblance to *Totobates minimus* Hammer (1967, p. 56, fig. 75), but it can easily be distinguished from the latter by the following diagnosis. The rostral hairs and the lamellar hairs are very long and distinctly barbed. Also the interlamellar hairs are considerably longer than those of *T. minimus*, and they are slightly barbed. The pseudostigmatic organs are very characteristic because in all the *Totobates* species so far described, in this one alone the head and part of the stalk project beyond the anterior border of the hysterosoma. The head is moreover very big, round, with small round dots inside, and set with tiny bristles.

The hysterosoma has slightly withdrawn pteromorphae. The hysterosoma is

narrowest at the posterior end, broadest anteriorly and apart from the pteromorphae it is pear-shaped. The notogastral hairs are proportionately longer than in the previously described species (HAMMER 1967). Those on the posterior border are curved. The distance p1-p1 is no longer than the length of p1.

On the ventral side the hairs 1 a are set as on *T. antarcticus* Wallw. (HAMMER 1967, fig. 74 b), i.e. rather close together and with the same mutual distance as the hairs 2 a. The hairs 3 a are very close together. The aggenital hair is located as in *T. antarcticus*, i.e. at a short distance behind the genital field. Ad3 is a little farther anteriorly than in *T. antarcticus*.

Keri-Keri: Several individuals in thick moss and lichens on a log under trees; one in moss and liverworts on a grown-over road in deep shadow.

Waitakere: Several specimens in moss and grass under bushes in a garden on the edge of Waitakere forest.

*Totobates microseta* n. sp.; fig. 100.

Colour yellow to light brown. Length about 0.35 mm.

The tip of the rostrum ends in a tiny tip. The rostral hairs, which are situated laterally, are thin, stiff, ?smooth, and no longer than their mutual distance. The lamellar hairs are unusually short and very thin. In no other *Totobates* species described so far are the lamellar hairs so short. The interlamellar hairs are proportionately short like those of *T. antarcticus* and *T. minimus* (HAMMER 1967, figs. 74-75). The head of the pseudostigmatic organ is free.

The pteromorphae are withdrawn and their distal tip is bent ventrally. The curved line across the pteromorphae is very distinct. The hysterosoma is more or less pear-shaped, being broadest anteriorly. The notogastral hairs are very thin and rather short. On the ventral side the hairs 2 a are set close together. Also the hairs 3 a are set close together.

Christchurch: One specimen in moist, brown *Polytrichum* and small plants on a vertical slope near oozing water.

At the revision of the material, besides the eight species just described, some species which were described or mentioned in Parts I-II were found in localities from which they have not previously been registered. The new localities are added in Table I of the occurrence of the species in New Zealand. The above-mentioned species are listed below with statement of the new localities.

#### Part I.

*Machuella ventrisetosa* Ham. .... New Plymouth, Pauatahanui, Nelson.

#### Part II.

*Magnobates flagelliger* n. sp. .... Puketi

*Zealandobates grandis* Ramsay .... Puketi

<i>Setobates medius</i> n. sp.....	Waitakere, Waitomo
– <i>scheloribatooides</i> (Ramsay) .....	Rotorua, Waitomo
– <i>discors</i> n. sp.....	Puketi, Waitakere
<i>Grandjeanobates novozealandicus</i> n. sp. ....	Keri-Keri, Puketi
<i>Scheloribates anzacensis</i> n. sp.....	Keri-Keri, Puketi
– <i>zealandicus</i> n. sp.....	Puketi, Rotorua
– <i>aequalis</i> n. sp.....	Keri-Keri, Waitakere
<i>Incabates angustus</i> n. sp. ....	Keri-Keri, Puketi
<i>Ingella bullager</i> n. sp. ....	Milford
<i>Maculobates luteomarginatus</i> n. sp.....	Christchurch, Milford
– <i>longus</i> n. sp.....	Keri-Keri
– <i>minor</i> n. sp. ....	Keri-Keri, Waitakere
<i>Totobates antarcticus</i> Wallw.....	Puketi
– <i>communis</i> n. sp.....	Keri-Keri
<i>Angulozetes rostratus</i> n. sp.....	Keri-Keri

The species of the group Ptyctima or box mites found in New Zealand have been submitted to Dr. N. A. WALKER, Kansas, U.S.A., for working them up, as Dr. WALKER is a specialist within this group and collected these mites in New Zealand simultaneously with me.

### General Remarks on the the Oribatid Fauna of New Zealand

In Table I all the species found are listed in the order in which they have been published in Parts I-III. The species added in the Addenda, however, are inserted in their respective places, i.e. beside closely related genera or species. The localities in New Zealand have been arranged from north to south, beginning on the left. The columns on the extreme right indicate from left to right the possible occurrence of the species in South America, Europe, and other localities. After the table the number of species, the number of samples, the number of individuals, and the total figures are indicated for each locality.

The highest number of species was found on the North Island (to the left in table I), viz. 232 species. On the South Island only 178 species were found in almost the same number of samples. It appears from Table I that the highest number of species was found at Keri-Keri, viz. 119 species in 32 samples. At Rotorua 91 species were found in 16 samples, only, in Waitakere forest 81 species in 12 samples. Fox Glacier and Mil-ford had 78 and 76 species in 22 and 25 samples, respectively.

It is remarkable that a number of the presumably endemic genera are represented by a astonishingly large number of species, which must mean that a quick development of species has taken place. Of *Neseutegaeus* 5 species have been found so far, of *Tumerozetes* 5, of *Pseudoceratoppia* also 5, and of *Parahyphozetes* 8 species.

TABLE I.

Species	Puketi	Keri-Keri	Waitakere	Rotorua	Waitomo	New Plymouth	Pauatahanui	Pu Pu Springs – Pakawau	Nelson district	Lake Rotoiti	Christchurch	Hokitika, Whatarua, Waitangi	Fox Glacier	Milford	Queenstown	Dunedin	South America	Europe	Other localities
<i>Nanhermannia acutisetosa</i> n. sp. ....	x				x	x	x												
— <i>tenuicoma</i> n. sp. ....			x	x	x													x	x
<i>Hypochthonius luteus</i> Oudms. ....		x	x																x
<i>Eniochthonius minutissimus</i> (Berl.) ....																			x
<i>Brachychthonius jugatus</i> Jac. v. <i>suecica</i> Forssl. ....				x	x													x	x
— <i>novazealandicus</i> n. sp. ....																		x	x
<i>Liochthonius fimbriatissimus</i> (Ham.) ....			x			x											x	x	x
— <i>altimonticola</i> (Ham.) ....					x												x	x	x
— <i>altus</i> (Ham.) ....						x											x	x	x
— <i>idem</i> n. sp. ....						x											x	x	x
— <i>saltaensis</i> (Ham.) ....						x											x	x	x
<i>Cosmochthonius semiareolatus</i> n. sp. ....																		x	x
<i>Thrypochthonius excavatus</i> (Willm.) ....	x			x			x	x									x	x	x
<i>Mucronothrus nasalis</i> (Willm.) ....								x	x								x	x	x
<i>Fossonothrus novaezealandiae</i> n. sp. ....	x							x	x								x	x	x
<i>Trimalacomothrus opisthoseta</i> n. sp. ....		x	x		x	x											x	x	x
— <i>platyrhinus</i> Ham. ....					x	x											x	x	x
— <i>oxyrhinus</i> Ham. ....			x														x	x	x
— <i>angustirostrum</i> n. sp. ....						x											x	x	x
— <i>longirostrum</i> n. sp. ....	x		x														x	x	x
— <i>novus</i> (Selln.) ....						x											x	x	x
— <i>crispus</i> Ham. ....	x						x										x	x	x
— <i>sacculus</i> n. sp. ....	x						x										x	x	x
<i>Zeanothrus elegans</i> n. gen. n. sp. ....				x													x	x	x
<i>Malaconothrus keriensis</i> n. sp. ....	x				x			x									x	x	x
— <i>zealandicus</i> n. sp. ....					x		x	x									x	x	x
— <i>indifferens</i> n. sp. ....						x	x	x									x	x	x
<i>Camisia segnis</i> (Herm.) v. <i>nova</i> n. var. ....				x	x	x	x	x									x	x	x
<i>Nothrus biciliatus</i> C. L. Koch. ....	x	x	x	x	x	x	x	x									x	x	x
— <i>silvestris</i> Nic. v. <i>anauniensis</i> C & F. ....																	x	x	x
<i>Novonothrus flagellatus</i> n. gen. n. sp. ....	x		x						x								x	x	x
— <i>pupuensis</i> n. sp. ....									x								x	x	x
<i>Heminothrus traversus</i> n. sp. ....			x	x	x	x	x	x	x				x			x	x	x	x
— <i>microclava</i> n. sp. ....									x								x	x	x
<i>Platynothrus major</i> n. sp. ....		x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x
— <i>tenuiclava</i> n. sp. ....	x	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x
— <i>peltifer</i> (C. L. Koch) ....	x	x	x	x	x		x	x	x		x	x	x	x	x	x	x	x	x

x Including Upper Takaka.

(x) Concerning localities not listed in the table: these localities are inserted in their approximate place in the table, but not included in the mention of species for the localities in question.

TABLE I (cont.).

Species	Puketi	Keri-Keri	Wairakei	Rotorua	Waitomo	New Plymouth	Pauatahanui	Pu Pu Springs - Pakawau	Nelson district	Lake Rotoiti	Christchurch	Hokianga, Whataroa, Waitangi	Fox Glacier	Milford	Queenstown	Dunedin	South America	Europe	Other localities	
<i>Acronothrus cophinarius</i> (Mich.) .....																				
— <i>brachystrum</i> n. sp. .....	x	x	x	x	x	(x)				x			x							
— <i>caudalis</i> n. sp. .....																				
<i>Austronothrus curviseta</i> n. gen. m. sp. ....	x	x	x	x	x	x	(x)													
<i>Holonothrus pulcher</i> n. sp. ....																				
<i>Hermannia clavasetosa</i> n. sp. ....																				
— <i>microsetosa</i> n. sp. ....																				
— <i>longisetosa</i> n. sp. ....																				
— <i>diversisetosa</i> n. sp. ....																				
<i>Phyllhermannia foliata</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>mollis</i> n. sp. ....																				
— <i>rubra</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>phyllophora</i> (Mich.) ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Liodes nigricans</i> (Ramsay) ....		x																	x	
<i>Scapheremaeus ?patella</i> (Berl.) ....		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>insularis</i> n. sp. ....		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>emarginatus</i> n. sp. ....		x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Scutovortex minutus</i> (C. L. Koch) ....	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Metabelba obtusa</i> n. sp. ....	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Pedrocortesia rotoruensis</i> n. sp. ....				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>luteomarginata</i> n. sp. ....				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Pedrocortesella gymnonotus</i> (Ramsay)....		x																		
— <i>sexpilosus</i> (Ramsay) ....		x																		
— <i>cryptonotus</i> (Ramsay) ....		x																		
— <i>latoclava</i> n. sp. ....		x																		
? — <i>nigroclava</i> n. sp. ....		x																		
? —     sp. ....		x																		
<i>Fosseremus quadripertitus</i> Grdj. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Eremulus flagelliger</i> Berl. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>serratus</i> n. sp. ....																				
<i>Suctobelba falcata</i> Forssl. ....		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>subcornigera</i> Forssl. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>nasalis</i> Forssl. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>longicurva</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>plumata</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>nondivisa</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Zeasuctobelba quinquenodosa</i> n. gen. n. sp. ....		x																		
— <i>trinodosa</i> n. sp. ....	x																			
— <i>nodosa</i> n. sp. ....		x																		
— <i>arcuata</i> n. sp. ....		x																		
<i>Suctobelbila dentata</i> (Ham.) ....	x																x			

TABLE I (cont.).

Species	Puketi	Keri-Keri	Waitakere	Rotorua	Waitomo	New Plymouth	Pauatahanui	Pu Pu Springs - Pakawau	Nelson district	Lake Rotoiti	Christchurch	Hokitika, Whataroa, Waitangi	Fox Glacier	Milford	Queenstown	Dunedin	South America	Europe	Other localities
<i>Machuelia ventrisetosa</i> Ham. ....	x	x		x	x	x		x	x	x					x		x	x	x
— <i>pyriformis</i> n. sp. ....		x	x	x	x														
<i>Hydrozetes lemnae</i> (de Coggi) ....		x	x	x															
<i>Carabodes ornatissimus</i> n. sp. ....	x	x	x																
— <i>variabilis</i> n. sp. ....		x	x	x															
<i>Austrocarabodes maculatus</i> n. gen. n. sp. ....		x	x	x		x				x	x	x	x	x	x	x	x	x	x
— <i>elegans</i> n. sp. ....		x	x	x						x	x	x	x	x	x	x	x	x	x
— <i>nodosus</i> n. sp. ....		x	x	x						x	x	x	x	x	x	x	x	x	x
<i>Nodocepheus dentatus</i> Ham. v. <i>barbatus</i> n. var.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Pseudotocepehus foveolatus</i> n. sp. ....		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>punctatus</i> n. sp. ....		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>tenuiseta</i> n. sp. ....		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>curtiseta</i> n. sp. ....		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Plenotocepehus mollicoma</i> n. gen. n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>delicatissimus</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Neotocepehus colliger</i> n. gen. n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Eutegaeus membraniger</i> n. sp. ....		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Neseutegaeus spinatus</i> Woolley ....		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>consimilis</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>latus</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>angustus</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>distentus</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Bornebuschia peculiaris</i> n. gen. n. sp. ....																			
<i>Compactozetes rotoruensis</i> n. gen. n. sp. ....																			
— <i>niger</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Pterozetes novazealandicus</i> n. gen. n. sp. ....																			
<i>Topalia velata</i> n. sp. ....																			
— <i>clavata</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>granulata</i> n. sp. ....																			
<i>Tumerozetes bifurcatus</i> n. gen. n. sp. ....																			
— <i>circularis</i> n. sp. ....																			
— <i>pumilis</i> n. sp. ....																			
— <i>parallelus</i> n. sp. ....																			
— <i>indistinctus</i> n. sp. ....																			
<i>Adhaesozetes Barbarae</i> n. gen. n. sp. ....																			
<i>Clavazetes decorus</i> n. gen. sp. ....																			
<i>Bulleremaeus reticulatus</i> n. gen. n. sp. ....																			

\*) Main form.

TABLE I (cont.).

Species	Puketi	Keri-Keri	Waltakere	Rotorua	Waitomo	New Plymouth	Pauatahanui	Pu Pu Springs - Pakawau	Nelson district	Lake Rotiti	Christchurch	Hokitika, Whataroa, Waitangi	Fox Glacier	Milford	Queenstown	Dunedin	South America	Europe	Other localities
<i>Bulleremaeus tuberculatus</i> n. sp. ....						x				x				x					
<i>Capillibates Stagaardi</i> n. gen. n. sp. ....				x	x														x
<i>Halozetes otagoensis</i> n. sp. ....				x	x														x
<i>Sellnickia caudata</i> (Mich.) ....																			
<i>Austrogneta multipilosa</i> Balogh....																			
— <i>quadridentata</i> n. sp. ....								x											
<i>Cultroribula lata</i> Aoki.....	x	x		x	x														x
<i>Cuspitegula stellifer</i> n. gen. n. sp. ....	x	x	x	x	x			x		x			x					x	
? <i>Physobates monodactylus</i> n. sp. ....	x	x	x	x	x			x		x			x					x	
<i>Pelops punctatus</i> Ramsay .....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
— <i>monodactylus</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Maorizetes ferox</i> n. gen. n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Neotrichozetes spinulosa</i> (Mich.) .....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	
<i>Tikizetes spinipes</i> n. gen. n. sp. ....																			
<i>Pseudoceratoppia sexsetosa</i> n. gen. n. sp. ....																			
— <i>microsetosa</i> n. sp. ....																			
— <i>asetosa</i> n. sp. ....																			
— <i>clavasetaosa</i> n. sp. ....																			
— <i>diversa</i> n. sp. ....																			
<i>Tectocephalus velatus</i> (Mich.) v. <i>sarekensis</i>																			
Trgdh. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— — — - <i>minor</i> Berl. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— — — - <i>novus</i> n. var. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Lamellobates palustris</i> Ham. ....																			
<i>Parahyphozetes grandis</i> n. gen. n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>bidentatus</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>quadridentatus</i> n. sp. ....																			
— <i>furcatus</i> n. sp. ....																			
— <i>lobatus</i> n. sp. ....																			
— <i>giganteus</i> n. sp. ....																			
— <i>macrodentatus</i> n. sp. ....																			
— <i>maximus</i> n. sp. ....																			
<i>Edwardzetes novazealandicus</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Parafurcobates cuspidatus</i> n. gen. n. sp. ....																			
<i>Macrogena rudentiger</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>crassa</i> n. sp. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Pedunculozetes andinus</i> Ham. ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>minutus</i> n. sp. ....																			
<i>Tutorozetes termophilus</i> n. gen. n. sp. ....																			x*)
<i>Magellozetes clathratus</i> n. sp. ....																			
<i>Ceratozetes gracilis</i> (Mich.) ....	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

\*) See p. 86.

TABLE I (cont.).

TABLE I (cont.).

Species	Puketi	Keri-Keri	Waitakere	Rotorua	Waitomo	New Plymouth	Panatahanui	Pu Pu Springs - Pakawau	Nelson district	Lake Rotiiti	Christchurch	Hokitika, Whataroa, Waitangi	Fox Glacier	Milford	Queenstown	Dunedin	South America	Europe	Other localities
<i>Protoribates capucinus</i> Berl.		x															x	x	x
<i>Liebstadia similis</i> (Mich.)																	x	x	x
<i>Maculobates luteomarginatus</i> n. sp.																			
— <i>magnus</i> n. sp.	x	x	x																
— <i>vulgaris</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>luteus</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>longus</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>longipilosus</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>minor</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
? — <i>acutissimus</i> n. sp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
<i>Totobates ovalis</i> n. sp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x
— <i>latus</i> n. sp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>antarcticus</i> Wallw.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>minimus</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>macroonyx</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>communis</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>capita</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>microseta</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
<i>Angulozetes rostratus</i> n. gen. n. sp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
<i>Andacarus ligamentifer</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
<i>Polyoppia Baloghi</i> n. gen. n. sp.					x														
<i>Tripiloppia Aokii</i> n. gen. n. sp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>Trägårdhi</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>Forsslundi</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>Tarras-Wahlbergi</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
— <i>Dalenii</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x				
<i>Oppiella nova</i> (Oudms.)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>dubia</i> Ham.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>suramericana</i> Ham.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>fallax</i> v. <i>obsolete</i> Paoli		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>Bullanova</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Quadroppia quadricarinata</i> (Mich.)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>circumita</i> Ham.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Belloppia Wahlworki</i> n. gen. n. sp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>Evansi</i> n. sp.		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
— <i>Shealsi</i> n. sp.	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Miroppia zealandica</i> n. gen. n. sp.	x																		
<i>Paroppia Lebruni</i> n. gen. n. sp.																			
<i>Solenoppia Grandjeani</i> n. gen. n. sp.					x														
— <i>Travéi</i> n. sp.					x														
— <i>Taberlyi</i> n. sp.					x														

\*) See p. 87.

TABLE I (cont.).

TABLE I (cont.).

Species	Puketi	Keri-Keri	Waitakere	Rotorua	Waitomo	New Plymouth	Pauatahanui	Pu Pu Springs – Pakawau	Nelson district	Lake Rotoiti	Christchurch	Hokitika, Whataroa, Waitangi	Fox Glacier	Milford	Queenstown	Dunedin	South America	Europe	Other localities
<i>Oppia Haarlovi</i> n. sp. ....					x														
— <i>Perez-Inigoi</i> n. sp. ....	x	x					x											x	
— <i>Pletzeni</i> n. sp. ....																			
— <i>Turki</i> n. sp. ....																			
— <i>Tuxeni</i> n. sp. ....																			
— <i>Covarrubiasi</i> n. sp. ....																			
— <i>Newelli</i> n. sp. ....							x	x											
— <i>Oudemansi</i> n. sp. ....																			
— <i>Baderi</i> n. sp. ....																			
— <i>Mihelcici</i> n. sp. ....	x																		
— ? minus Paoli ....																		x	
— <i>minutissima</i> Sellin ....			x															x	
— <i>arcualis</i> (Berl.) ....	x	x	x															x	
— <i>Winkleri</i> n. sp. ....	x		x															x	
<i>Brachioppia Higginsi</i> n. sp. ....	x					x													
— <i>Hartensteini</i> n. sp. ....		x																	
— <i>Walkeri</i> n. sp. ....	x	x																x	
? — <i>Suciui</i> n. sp. ....	x																	x	
<i>Brachioppiella Rajskii</i> n. sp. ....						x													
— <i>Rafalskii</i> n. sp. ....																			
<i>Ramusella Sengbuschi</i> n. sp. ....	x					x													
<i>Neoribates barbatus</i> n. sp. ....											x				x	x			
<i>Galumna scaber</i> n. sp. ....											x			x					
— <i>rugosa</i> n. sp. ....	x		x																
— <i>microfissum</i> n. sp. ....	x	(x)	x			x					x			x				x	
<i>Acrogalumna longiplanus</i> Berl. ....	x					x			x									x	x
<i>Allogalumna novazealandica</i> n. sp. ....						x													
— <i>remota</i> n. sp. ....	x	x	x	x															
<i>Pergalumna reniformis</i> n. sp. ....					x										x				
— <i>silvestris</i> n. sp. ....																			
Number of species for each locality ...	40	119	81	91	43	47	43	24	21	63	18	13	78	76	16	7	34	33	30
— - samples for each locality ..	8	32	12	16	13	12	14	9	3	10	11	7	22	25	10	5			
— - individuals for each locality	218	6809	966	3907	473	553	470	844	58	714	142	91	1472	1391	579	86			
Total 312 species																			
— 209 samples																			
— about 19000 individuals																			

The richness in forms of the species is amazing and exceeds by far what is known from the Andes Mountains. MICHAEL (1908), who knew oribatids from the whole world, on the basis of a material from New Zealand could immediately see that the

oribatids because of their size belonged under temperate conditions. He published six of the largest and in his opinion most interesting species and in connexion with the size and appearance of these species stated "that the temperate characteristics seem exaggerated, as if they run wild, giving many of the species a very singular appearance." The reason why there are so many large species, is perhaps rather the fertile biotopes than the temperate conditions. Indeed, it is known from forests in Northern Europe, that the rich mould has a few large species, while the poor soil consisting of raw humus harbours many small species. The oribatid fauna of New Zealand is rich in large as well as small species.

The distribution of the species in New Zealand seems to be rather casual, which must be explained as a result of a defective collecting and consequently defective knowledge of their distribution. Most species occur evenly distributed all over the country. Few species are markedly attached to the North or the South Island, but this fact, too, may be accidental.

### The Origin of the Oribatid Fauna of New Zealand and a Comparison with the Oribatid Fauna of the Andes Mountains

As has often been pointed out (HAMMER 1944, 1965), the possibilities of spreading of the oribatids over seas and long distances are very restricted, mainly because of the slight tolerance of these animals of drying-up, of salt water, due to their lack of bearing surfaces in case of possible air transport, etc. As has often been laid down, they are "earth-bound", just as e.g. wingless beetles, and on the whole are only spread in connexion with the moss, the leaves, or the soil in which they live.

In order to form an idea of the origin of the New Zealand oribatid fauna it is necessary to know something about the occurrence of the various species outside New Zealand. It appears from Table 1 that 56 species out of the 312 species found are known out of New Zealand. These species can be divided into two groups: (1) species with a wide distribution on earth, Table II, and (2) species which, apart from New Zealand, are mainly known from South America, only (p. 84).

Australia and Africa have been left out of the survey made here, Australia because, as regards research into oribatids, it is a completely unknown territory, Africa because on the whole no information about known species is available from there, whether this is due to the fact that such species have not been found or the fact that investigators have restricted themselves to the description of new species, of which a large number have been described.

As appears from Table II, most species have a very wide distribution. Thus *Eniochthonius minutissimus*, *Camisia segnis*, *Tectocepheus velatus*, *Ceratozetes gracilis*, and *Oppiella nova* are known among other localities from South America, Europe, and Japan. Other species are recorded from South America and from several localities

TABLE II.

Species	South America	North America	Alaska	Canada	Greenland	Europe	U.S.S.R.	Jordan	Nepal, Himalaya	Thailand	Sunda Islands	Japan	Antarctica
<i>Hypochthonius luteus</i> Oudms.													x
<i>Eniochthonius minutissimus</i> (Berl.)	x	x	x			x	x	x	x			x	
<i>Brachyththonius jugatus</i> Jac. v. <i>suecica</i> Forssl.			x	x	x <sup>1</sup>	x	x	x <sup>1</sup>					
<i>Thrypochthonius excavatus</i> (Willm.)	x	x				x	x	x					
<i>Mucronothrus nasalis</i> (Willm.)	x					x	x	x					
<i>Trimalaconothrus novus</i> (Selln.)	x		x	x	x	x	x	x					
<i>Camisia segnis</i> (Herm.)	x					x	x	x				x	
<i>Nothrus biciliatus</i> C. L. Koch						x	x	x <sup>1</sup>	x			x	
— <i>silvestris</i> Nic. v. <i>anauniensis</i> C & F		x <sup>1</sup>				x	x	x <sup>1</sup>					
<i>Platynothrus peltifer</i> (C. L. Koch)	x	x	x	x	x	x	x	x	x			x	
<i>Scapheremaeus</i> ? <i>patella</i> (Berl.)						x							
<i>Scutovertex minutus</i> (C. L. Koch)						x	x	x					
<i>Fosseremus quadripertitus</i> Grdjn.	?					x	x	x		x		x	
<i>Eremulus flagelliger</i> Berl.						x	x	x					
<i>Suctobelba falcata</i> Forssl.						x							
— <i>subcornigera</i> Forssl.						x							
— <i>nasalis</i> Forssl.						x							
<i>Machuelia ventrisetosa</i> Ham.		?				x							
<i>Hydrozetes lemnae</i> (de Coggi)	x					x	x	x	x		x		
<i>Sellnickia caudata</i> (Mich.)													
<i>Cultorribula lata</i> Aoki										x		x	
<i>Tectocephalus velatus</i> (Mich.) v. <i>sarekensis</i> Trgdh.	x	x	x	x	x	x	x	x	x		x	x	
— — — - <i>minor</i> Berl.						x	x	x	x				
<i>Lamellobates palustris</i> Ham.	x					x	x	x	x	x			
<i>Ceratozetes gracilis</i> (Mich.)	x	x	x			x	x	x	x			x	
— <i>mediocris</i> Berl.		x				x	x	x	x			?	4
<i>Punctoribates punctum</i> (C. L. Koch)	x	x				x	x	x	x			x	
<i>Rostrozetes foveolatus</i> Selln.	x					x	x	x	x		x		
<i>Zygoribatula connexa</i> (Berl.)	x					x							
<i>Protoribates capucinus</i> Berl.	x					x	x	x	x				
<i>Liebstadia similis</i> (Mich.)			x	x	x	x	x	x	x				
<i>Totobates antarcticus</i> Wallw.						x	x	x	x				x
<i>Oppiella nova</i> (Oudms.)	x	x	x	x	x	x	x	x	x		x <sup>5</sup>	x <sup>6</sup>	
— <i>fallax</i> v. <i>obsolete</i> Pauli						x	x	x	x				
<i>Quadroppia quadricarinata</i> (Mich.)	x	x	x	x	x	x	x	x	x			x	
<i>Oppia</i> ? <i>minus</i> Paoli	x			x		x	x	x	x				
— <i>minutissima</i> Selln.	x			x		x					x	x	?
— <i>arcualis</i> (Berl.)						x				x	x	?	7
<i>Acrogalumna longiplumus</i> Berl.						x							

<sup>1</sup> Main form.    <sup>2</sup> ? = *saltaensis* Ham.    <sup>3</sup> Wahlwork (not published).    <sup>4</sup> ? = *japonicus* Aoki.<sup>5</sup> v. *sumatrensis* Willm.    <sup>6</sup> Main form.    <sup>7</sup> ? = *viperea* Aoki 1959.

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in the northern hemisphere but not from Japan so far. These are *Thrypochthonius excavatus*, *Mucronothrus nasalis*, *Trimalaconothrus novus*, *Hydrozetes lemnae*, *Zygoribatula connexa*, *Protoribates capucinus* and *Oppia minutissima*.

Several species are, beside from New Zealand, only known from the northern hemisphere. These are *Hypochthonius luteus*, *Brachychthonius jugatus* var. *suecica*, *Nothrus biciliatus*, *Nothrus silvestris* var. *anauniensis*, *Platynothrus peltifer*, *Punctoribates punctum*, *Scutovortex minutus*, *Eremulus flagelliger*, three *Suctobelba* species, *Liebstadia similis*, *Oppia fallax* var. *obsoleta*, *Quadroppia quadricarinata*, and *Oppia minus*.

A few species are recorded only from more southern regions, i.e. *Sellnickia caudata*, *Lamellolobates palustris*, and *Rostrozetes foveolatus*.

The spreading of all these species has probably taken place by the animal's own active movements. The spreading must be supposed to have taken place by a gradually wider distribution through millions of years at so early a time in the history of the earth that the continents still constituted a whole.

Group (2), species which besides in New Zealand are so far known from South America, comprises the following 17 species:

<i>Liocthonius fimbriatissimus</i> (Ham.)	<i>Austrogneta multipilosa</i> Balogh
– <i>altimonticola</i> (Ham.)	<i>Neotrichozetes spinulosa</i> (Mich.)
– <i>altus</i> (Ham.)	<i>Pedunculozetes andinus</i> Ham.
– <i>saltaensis</i> (Ham.)	<i>Punctoribates manzanoensis</i> Ham.
<i>Trimalaconothrus platyrhinus</i> Ham.	<i>Oppiella suramericana</i> (Ham.)
– <i>oxyrhinus</i> Ham.	– <i>dubia</i> Ham.
– <i>crispus</i> Ham.	<i>Quadroppia circumita</i> Ham.
<i>Suctobelbila dentata</i> (Ham.)	<i>Amerioppia longiclava</i> Ham.
<i>Nodocepheus dentatus</i> Ham.	

Even though we should make reservations as regards a small number of these species which may be doubtful, such as *L. saltaensis*, the characters of which are very indistinct, and *Nodocepheus dentatus*, and *Punctoribatus manzanoensis*, which have close relatives in Africa (see p. 87), there are here a number of species which so far have only been found in South America and New Zealand. The cause why these species have not been found e.g. in Europe, which has been comparatively closely investigated, is probably in the case of some species that they do not live there. The species in question have certain characters which indicate that it can be said with the very highest degree of probability that these species do not occur in Europe. *Trimalaconothrus platyrhinus* and *T. oxyrhinus*, e.g., have on the genital plates four pairs of hairs, the three anterior ones of which are on the anterior part of the genital plates and are retroverse, whereas the fourth is located on the posterior edge of the plates separated from the three anterior ones by a considerable distance and is antrorse (Part I, figs. 16 a, 19 a). This peculiar position of the hindmost pair of hairs, which these two species share with *T. opisthoseta* Ham. and *T. angustirostrum* Ham.,

both from New Zealand, is not known from European species, on which all the hairs (usually more than four) are set at fairly the same distance and all are retrorse. Nor is it known from the *Trimalaconothrus* species from the Sunda Islands described by WILLMANN (1931 a).

These four *Trimalaconothrus* species, which belong to the primitive oribatids, are very closely related. Furthermore there are in *T. platyrhinus* and *T. opisthoseta* all possible combinations of certain characters in individuals found at Milford, which would seem to indicate that a development of species continually takes place. We have here an example of part of a group of species (and in part the same species) having been found in New Zealand as well as in Chile, South America. This can only mean that the two regions have been direct connected by land.

New Zealand has a total of 33 species so far recorded in common with South America. This comparatively high number does not, however, tell very much about the actual relationship, which is only evident in species with common special morphological features such as the species of the *Trimalaconothrus opisthoseta* group mentioned above.

After this discussion of Group 1, species with a wide distribution on the earth, and Group 2, species which besides in New Zealand also occur in South America, the whole huge complex of New Zealand species is left. This group consists of two species described by MICHAEL 1908 (*Acronothrus cophinarius* and *Phyllhermannia phyllophora*), seven species described by RAMSAY, but not published (*Liodes nigricans*, *Pedrocortesella gymnotus*, *P. sexpilosus*, *P. cryptonotus*, *Pelops punctatus*, *Zealandobates grandis*, and *Peloribates magnisetosus*), one species described by WOOLLEY 1965 (*Neseutegaeus spinatus*), one species described by RAMSAY 1966 (*Setobates scheloriboides*), and 244 new species. Together they constitute 82 per cent. A very large number of them are presumably endemic species, perhaps most of them.

An investigation of the oribatid fauna of South Eastern Australia will, however, most probably show some relationship with the oribatid fauna of New Zealand and some of the presumably endemic species of New Zealand will probably appear to be common with Australia.

### A Comparison with the Oribatid Fauna in Antarctica, Australia, Africa, and the Pacific Area

The close relationship between the oribatids in New Zealand and those in South America having been illustrated, there is reason to investigate the problem whether there is any connexion between the oribatid fauna of New Zealand and that of the surrounding areas. If from the relationship of the New Zealand fauna with the oribatid fauna of South America it is assumed that South America and New Zealand before the Tertiary Period were connected by land, it must have been by way of Antarctica

and the Subantarctic islands. Antarctica, which today is completely glaciated and hardly harbours life, must be left out of consideration. On the Subarctic islands Dr. J. L. GRESSITT has in recent years been extremely active. Many species have been brought home and the oribatids have been determined and described, mainly by WALLWORK (1963, 1964, 1966).

The Subantarctic islands, which include Macquarie Island, Campbell Island, the Auckland Islands, and others, were in the case of some islands (thus Macquarie Island) glaciated during the Glacial Age. Therefore we can only on the non-glaciated islands expect to find remnants of the fauna from the connexion between South America and New Zealand. In Table I a species is recorded, *Totobates antarcticus* (Wallw.), which outside New Zealand is known only from Campbell Island, from where it has been described (WALLWORK 1964 a). From Campbell Island we furthermore know two *Globoppia* species, three *Oppia* species, and one *Campbelllobates* (WALLWORK 1964 c), as well as (WALLWORK 1966) *Acronothrus brevicornutus* n. sp., *Holothrus concavus* n. sp., *Pedrocortesia*? *australis* Ham., *Andacarus campbellensis* n. sp., *Macrogena monodactyla* n. sp., *Halozetes plumosus* n. sp., *H. macquariensis* (Dalenius), *H. crozetensis* (Richt.), *Eutegaeus bostocki* (Mich.), and *Scheloribates flagellatus* n. sp. Through these recent finds a closer connexion is formed partly with South America, with which Campbell Island apparently has *Pedrocortesia*? *australis* in common, partly with New Zealand, where *Eutegaeus bostocki* has been found (MICHAEL 1908).

From Macquarie Island a *Holothrus* species, an *Oppia* species, five *Halozetes* species, two *Totobates* species (thus *T. antarcticus* Wallw.) are known, as well as some genera not known from South America or New Zealand. Among these the island has only *Totobates antarcticus* in common with New Zealand. These oribatids must have immigrated to the island after the Glacial Age, if they cannot have survived the Glacial Age in a locally ice-free area. A survival through the ages in an ice-free area on the Subantarctic islands is certainly not unimaginable, considering the somewhat similar conditions in Greenland, where part of the present fauna is supposed to have survived the whole Glacial Age. Under the severe climatic conditions and the extremely poor ecological possibilities it must be supposed that the above-mentioned genera on the Subantarctic islands have developed a number of species most of which are different from the representatives of the genera in New Zealand or in South America. Instead of this suggested survival of previous faunal elements through the Glacial Periods the present fauna can be supposed to be descendants of later elements immigrated from New Zealand which under the difficult conditions have changed into what is now found there. Apparently there can be no doubt that these islands form a connecting link between South America and New Zealand.

The relation of New Zealand to Australia and Tasmania must also be briefly mentioned. As Australia is a practically unknown area as regards oribatids, we must pass lightly over it. *Sellnickia caudata* (Mich.), however, has been recorded there. Some few species from Tasmania collected by Colonel J. STAGAARD (*Tutorozetes ter-*

*mophilus* Ham. and *Belloppia Wahlworki* Ham. (not published)) suggest a connexion between the oribatid fauna on this island and New Zealand.

So far New Zealand and Africa south of Sahara do not seem to have any species in common, even though a few genera have species so much alike in the two areas that there must once have been a certain connexion. *Nodocephus dentatus* Ham. and *N. hammerae* Balogh (1961 b) from Central Africa are hardly distinguishable. The former only differs from the latter by its pseudostigmatic organ having a shorter hairy club as well as by its longer notogastral hair. It has been asked (WALLWORK) whether *Oppiella suramericana* (Ham.) (1958) should be identical with *Oppia bituberculata* Balogh, Angola (1961 a). *O. suramericana* is, however, much more elegant, with narrower lamellae, which distally end in an extremely acuminate cuspis, and furthermore it has a small chitinous semilunar plate in front of the anterior margin of the hysterosoma. The appearance of the lamellae, however, might be conceived from a subjective estimate, a coarser drawing, etc. I have therefore made a comparison with a few specimens kindly submitted to me by Dr. BALOGH, and have found that the difference is clear enough, i. a. implied in the coarser structure of the lamellae of Dr. BALOGH's specimens. *Puncitoribates longiporus* Balogh, Angola (0.398 mm, 1963, figs. 12–13), greatly resembles *P. manzanoensis* Ham., the Argentine (0.45 mm, 1958), but is a little smaller.

Some genera with vicarious species are common to New Zealand, South America, and Africa, or only to two of these areas. This is a case of genera which are widely distributed on the southern hemisphere, e.g. *Austrocaraabodes*, *Pseudotocepheus*, *Eutegaeus*, *Lamellobates*, *Setobates*, and *Rostrozetes*. *Pseudotocepheus* and *Setobates* are common to New Zealand and Africa, but have not been recorded from South America.

In connexion with the mention of Africa it should be pointed out that there is a remarkable similarity between the genera *Mikizetes* (HAMMER 1958, 1961) from the Argentine and Peru, respectively, and *Zetomotrichus* (GRANDJEAN 1954) from North Africa. These two genera in practically all characters differ so highly from all other genera described that it is beyond doubt that once in the beginning of time, when the continents constituted a connected whole, they must have had common ancestors. *Zetomotrichus* essentially differs from *Mikizetes* by Genu IV and Tarsus IV being provided with a long, thick spine, which enables the animal to jump. From Central Asia a closely related genus *Ghilarovus* has recently been described (KRIVOLUTSKY 1966 b). This very widely scattered occurrence of three closely related genera shows the great age of the group.

New Zealand, with its situation in the Pacific, must to some degree be expected to have been influenced by the fauna of the surrounding islands. Even though an immigration by way of the ocean must be assumed to take place extremely rarely, it does take place. In *The Development of Insect Faunae in Oceania* (1960) p. 59 GRESSITT writes: "The native insects of Hawaii, though numbering between five and ten thousand species, belong to only 103 families. This is hardly more than one-tenth of the existing families of insects. Even some families with 40,000 world species are

lacking in Hawaii. Moreover, the number of genera of native Hawaiian insects is not much more than double that number and all native insects are said to be descended from only 240 natural introductions." This extremely rare immigration shows how homogeneous the composition of the fauna must be. (New Zealand has no species and few genera in common with Hawaii (JACOT 1934)). Some ancestors of the endemic species in New Zealand must be assumed to have come from without, but with our present slight knowledge of the fauna in these regions it cannot be decided from what part of the Pacific area they have come, or they have come from Australia. *Sellnickia caudata* (Mich.), besides from Australia and New Zealand is also known from Sumatra. *Oppiella nova* (Oudms.) has also been found in Sumatra. *Oppia arcualis* (Berl.) and *Rostrozetes foveolatus* Selln. have been recorded from Java, but apart from that, New Zealand has no species in common with the Indonesian islands, from which, indeed, Berlese has brought home some species. Apart from *Sellnickia caudata* the species referred to here have a wide distribution, and the establishment of their presence indicates nothing about a possible relation to New Zealand. The following genera are common to New Zealand and the Pacific area: *Nothrus*, *Acronothrus*, *Liodes*, *Hermannella*, *Astrocarabodes*, *Carabodes*, *Oppia*, *Protoribates*, *Scheloribates*, and *Pellops* (SELLNICK 1959). It must, however, be admitted that comparisons with areas north\*) and east of New Zealand suffer highly from our lack of knowledge of the fauna in the areas in question.

### Transantarctic Relationships

If the spreading of oribatids took place by air currents or sea currents, there would be a much closer agreement between the faunas of the various regions. The chance of New Zealand being populated from the Pacific area, if so, would presumably be as great as that of being populated from South America, which, indeed, is situated considerably farther away. When the above-mentioned comparison of the oribatid fauna of New Zealand with the oribatid faunas in other regions in the southern hemisphere decidedly redounds to the advantage of South America, there can hardly be any doubt that there has previously been a connexion by land between these two territories, a connexion which was broken off at the latest in the beginning of the Eocene Period, i.e. about 58 million years ago.

The Transantarctic relationships have been the object of discussion between biologists for more than a century. Numerous research workers have contributed to this discussion, each within his special sphere. The botanist HOOKER was the first to note the great similarity between the floras of the southern countries. During his long voyage from 1839 to 1843 he visited the Antarctic areas and had a rich opportunity to make observations. I shall not here go into the great number of discussions in

\*) In a material of about 90 oribatid species from the Fiji Isls. recently examined by me, not a single one of New Zealand's presumably endemic genera or species was found (not published).

favour of and against the theory of Transantarctic relationships, but refer to BRUNDIN's great work on chironomids (1966), probably the most profound and exhaustive work of this kind, and to smaller but rather convincing works by EVANS (1959), PARAMONOV (1955), BRITTON (1949, 1957), USINGER & MATSUDA (1959), BREHM (1949), and FREEMAN (1959).

The connecting link between New Zealand and South America within the oribatids is fairly strong, consisting with certainty of the species of the *Trimalaconothrus opisthoseta* group. The large number of species common to New Zealand and South America (p. 84) perhaps with a thorough knowledge of the fauna in southern Australia and Tasmania and all the surrounding regions may establish other ties. The knowledge of the oribatids, not only of their distribution, but of their close mutual relationship, must be an absolute condition before a wider Transantarctic relationship can be demonstrated within this group.

### Summary

In Part III 100 species of oribatids are mentioned, distributed on 30 genera. 88 species are new. A total of 312 species have been found in New Zealand. 244 new species have been set up, and 40 new genera. Nearly all the species have been found to be evenly distributed all over the country.

The oribatid fauna of New Zealand can be classed in three groups: (1) Species widely distributed all over the earth, 39 species. The species within this group are assumed to be very old, and to have had a wide distribution before New Zealand became an isolated area, (2) Species which besides from New Zealand are known only from the Andes Mountains in South America, 17 species. This group includes some species within the genus *Trimalaconothrus*, which because of some special morphological characters common to them clearly suggest Transantarctic relationships, while the other species which are common to New Zealand and South America do not show such special characters, for which reason it cannot be decided whether their presence in New Zealand and South America is also due to Transantarctic relationships. (3) 255 endemic species. These constitute about 82 per cent.

A comparison between the oribatids of New Zealand and those of the surrounding territories, i. e. Africa, the Subantarctic Islands, Australia, and the Pacific area, shows a certain relationship with the Subantarctic Islands, with which New Zealand has a few species and some genera in common, several of which also occur in South America. The oribatid fauna of New Zealand thus by way of the Subantarctic Islands seems to be closely connected with that of South America (the Andes Mountains), which must be a result of Transantarctic relationships. The knowledge of the oribatid fauna round New Zealand, however, is very defective, for which reason future investigations presumably still more clearly will reveal a connexion between the oribatid faunas of New Zealand and South America.

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## Explanation of the Figures on Plates I-XXXIII

Fig. 1. *Polyoppia Baloghi* n. gen. n. sp.

- 1a. — — ventral side.
- 2. *Tripiloppia Aokii* n. gen. n. sp.
- 2a. — — ventral side.
- 3. — *Trägårdhi* n. sp.
- 4. — *Forsslundi* n. sp.
- 5. — *Tarras-Wahlbergi* n. sp.
- 6. — *Dalenii* n. sp.
- 6a. — — tip of rostrum.
- 6b. — — pseudostigmatic organ.
- 7. *Oppiella nova* (Oudms.)
- 8. — *dubia* Ham.
- 9. — *suramericana* Ham.
- 10. — *fallax* var. *obsoleta* (Paoli).
- 11. — *Bullanovae* n. sp.
- 11a. — — ventral side.
- 12. *Quadroppia quadricarinata* (Mich.).
- 13. — *circumita* Ham.
- 14. *Belloppia Wallworki* n. gen. n. sp.
- 14a. — — pseudostigmatic organ.
- 14b. — — ventral side.
- 15. — *Evansi* n. sp.
- 15a. — — pseudostigmatic organ.
- 16. — *Shealsi* n. sp.
- 17. *Miroppia zealandica* n. gen. n. sp.
- 17a. — — anterior part of hysterosoma and surroundings.
- 17b. — — ventral side.
- 17c. — — Genu, Tibia and Tarsus I.
- 17d. — — the end of Tarsus I.
- 17e. — — - - - IV.
- 18. *Paroppia Lebruni* n. gen. n. sp.
- 18a. — — ventral side.
- 18b. — — Tibia and Tarsus I.
- 19. *Solenoppia Grandjeani* n. gen. n. sp.
- 19a. — — pseudostigmatic organ.
- 19b. — — ventral side.
- 19c. — — Leg I.
- 19d. — — Leg II.
- 20. — *Travei* n. sp.
- 20a. — — pseudostigmatic organ in different views.
- 21. — *Taberlyi* n. sp.

- Fig. 21 a. *Solenoppia Taberlyi* n. sp., pseudostigmatic organ.  
 - 22. *Operculoppia Kunsti* n. gen. n. sp.  
 - 22 a. — — pseudostigmatic organ.  
 - 22 b. — — ventral side.  
 - 23. — *Jelevae* n. sp.  
 - 23 a. — — pseudostigmatic organ in different views.  
 - 23 b. — — ventral side.  
 - 23 c. — — Leg I.  
 - 24. — *crassiseta* n. sp.  
 - 24 a. — — ventral side.  
 - 24 b. — — Tibia and Tarsus II.  
 - 25. *Membranoppia Krivoluzkyi* n. gen. n. sp.  
 - 25 a. — — pseudostigmatic organ.  
 - 25 b. — — ventral side.  
 - 26. — *Sitnikovae* n. sp.  
 - 26 a. — — pseudostigmatic organ.  
 - 27. — *Karppineni* n. sp.  
 - 27 a. — — pseudostigmatic organ in different views.  
 - 28. *Globoppia* sp.  
 - 29. — *nidicola* n. sp.  
 - 30. *Hamoppia Lionsi* n. gen. n. sp.  
 - 30 a. — — ventral side.  
 - 31. — *Thamdrupi* n. sp.  
 - 32. *Laminoppia Blocki* n. gen. n. sp.  
 - 32 a. — — propodosoma in an oblique lateral view.  
 - 32 b. — — ventral side.  
 - 32 c. — — Genu, Tibia and Tarsus I.  
 - 32 d. — — Leg IV.  
 - 33. *Amerioppia longiclava* Ham.  
 - 34. — *Woolleyi* n. sp.  
 - 34 a. — — pseudostigmatic organ.  
 - 35. *Lanceroppia Sellnicki* n. sp.  
 - 36. — *Strenzkei* n. sp.  
 - 36 a. — — pseudostigmatic organ.  
 - 36 b. — — ventral side.  
 - 37. — *Willmanni* n. sp.  
 - 38. — *van der Hammeli* n. sp.  
 - 38 a. — — — pseudostigmatic organ.  
 - 39. — *Märkeli* n. sp.  
 - 40. — *Becki* n. sp.  
 - 41. — *Knullei* n. sp.  
 - 42. — *Poppi* n. sp.  
 - 43. — *Schusteri* n. sp.  
 - 43 a. — — ventral side.  
 - 44. — *Ramsayi* n. sp.  
 - 44 a. — — pseudostigmatic organ in different views.  
 - 45. — *Luxtoni* n. sp.  
 - 46. — *Moritzi* n. sp.  
 - 46 a. — — ventral side.  
 - 47. — *Woodringi* n. sp.

- Fig. 48. *Lancetoppia Menkei* n. sp.  
 - 49. — *Mahunkai* n. sp.  
 - 50. — *Schweizeri* n. sp.  
 - 50a. — propodosoma in lateral view.  
 - 51. — *Csiszarae* n. sp.  
 - 52. — *Vaneki* n. sp.  
 - 53. — *Seydi* n. sp.  
 - 54. — *Jacoti* n. sp.  
 - 54a. — propodosoma in lateral view.  
 - 55. — *Berlesei* n. sp.  
 - 56. — *Banksi* n. sp.  
 - 57. — *Ewingi* n. sp.  
 - 58. — *Thori* n. sp.  
 - 59. — *Bertheti* n. sp.  
 - 60. — *rigidiseta* n. sp.  
 - 60a. — ventral side.  
 - 61. — *Pifflı* n. sp.  
 - 62. *Oppia Feideri* n. sp.  
 - 62a. — pseudostigmatic organ.  
 - 62b. — ventral side.  
 - 63. — *Haarlövi* n. sp.  
 - 63a. — pseudostigmatic organ.  
 - 63b. — ventral side.  
 - 64. — *Perez-Inigoi* n. sp.  
 - 64a. — Leg I.  
 - 64b. — ventral side.  
 - 65. — *Pletzeni* n. sp.  
 - 65a. — ventral side.  
 - 66. — *Turki* n. sp.  
 - 66a. — ventral side.  
 - 67. — *Tuxeni* n. sp.  
 - 67a. — ventral side.  
 - 68. — *Covarrubiasi* n. sp.  
 - 68a. — ventral side.  
 - 69. — *Newelli* n. sp.  
 - 69a. — ventral side.  
 - 70. — *Oudemansi* n. sp.  
 - 71. — *Baderi* n. sp.  
 - 71a. — ventral side.  
 - 72. — *Mihelcici* n. sp.  
 - 72a. — ventral side.  
 - 73. — ? minus (Paoli)  
 - 73a. — sketch of ventral side.  
 - 74. — *minutissima* Selln.  
 - 75. — *arcualis* (Berl.).  
 - 75a. — pseudostigmatic organ.  
 - 75b. — ventral side.  
 - 76. — *Winkleri* n. sp.  
 - 76a. — pseudostigmatic organ.  
 - 77. *Brachioppia Higginsi* n. sp.

Fig. 78. *Brachioppia Hartensteinii* n. sp.

- 79. — *Walkeri* n. sp.
- 80. ? — *Suciui* n. sp.
- 80a. - — pseudostigmatic organ.
- 80b. - — ventral side.
- 81. *Brachioppiella Rajskei* n. sp.
- 82. — *Rafalskii* n. sp.
- 83. *Ramusella Sengbuschi* n. sp.
- 83a. — — pseudostigmatic organ.
- 84. *Neoribates barbatus* n. sp.
- 84a. — — propodosoma in oblique lateral view.
- 84b. — — pseudostigmatic organ.
- 84c. — — ventral side.
- 85. *Galumna scaber* n. sp.
- 85a. — — propodosoma in lateral view.
- 85b. — — ventral side.
- 86. — *rugosa* n. sp.
- 86a. — — propodosoma in lateral view.
- 86b. — — ventral side.
- 87. — *microfissum* n. sp.
- 87a. — — propodosoma in lateral view.
- 87b. — — ventral side.
- 88. *Aerogalumna longiplumus* (Berl.).
- 88a. — — propodosoma in lateral view.
- 89. *Allogalumna novazealandica* n. sp.
- 89a. — — propodosoma in oblique lateral view.
- 89b. — — ventral side.
- 90. — *remota* n. sp.
- 90a. — — propodosoma in lateral view.
- 90b. — — ventral side.
- 91. *Pergalumna reniformis* n. sp.
- 91a. — — propodosoma in lateral view.
- 91b. — — pseudostigmatic organ.
- 91c. — — ventral side.
- 92. — *silvestris* n. sp.
- 92a. — — propodosoma in lateral view.
- 92b. — — different shapes of Aa.
- 92c. — — ventral side.
- 93. *Zeasuctobelba arcuata* n. sp.
- 94. *Machuelia pyriformis* n. sp.
- 94a. — — ventral side.
- 95. *Scheloribates maoriensis* n. sp.
- 95a. — — pseudostigmatic organ.
- 96. ? *Xylobates sicafer* n. sp.
- 96a. - — part of ventral side.
- 97. *Lauritzenia acutirostrum* n. sp.
- 98a. — *rotundirostrum* n. sp.
- 98. — — ventral side.
- 99. *Totobates capita* n. sp.
- 100. — *microsela* n. sp.

## **PLATES**



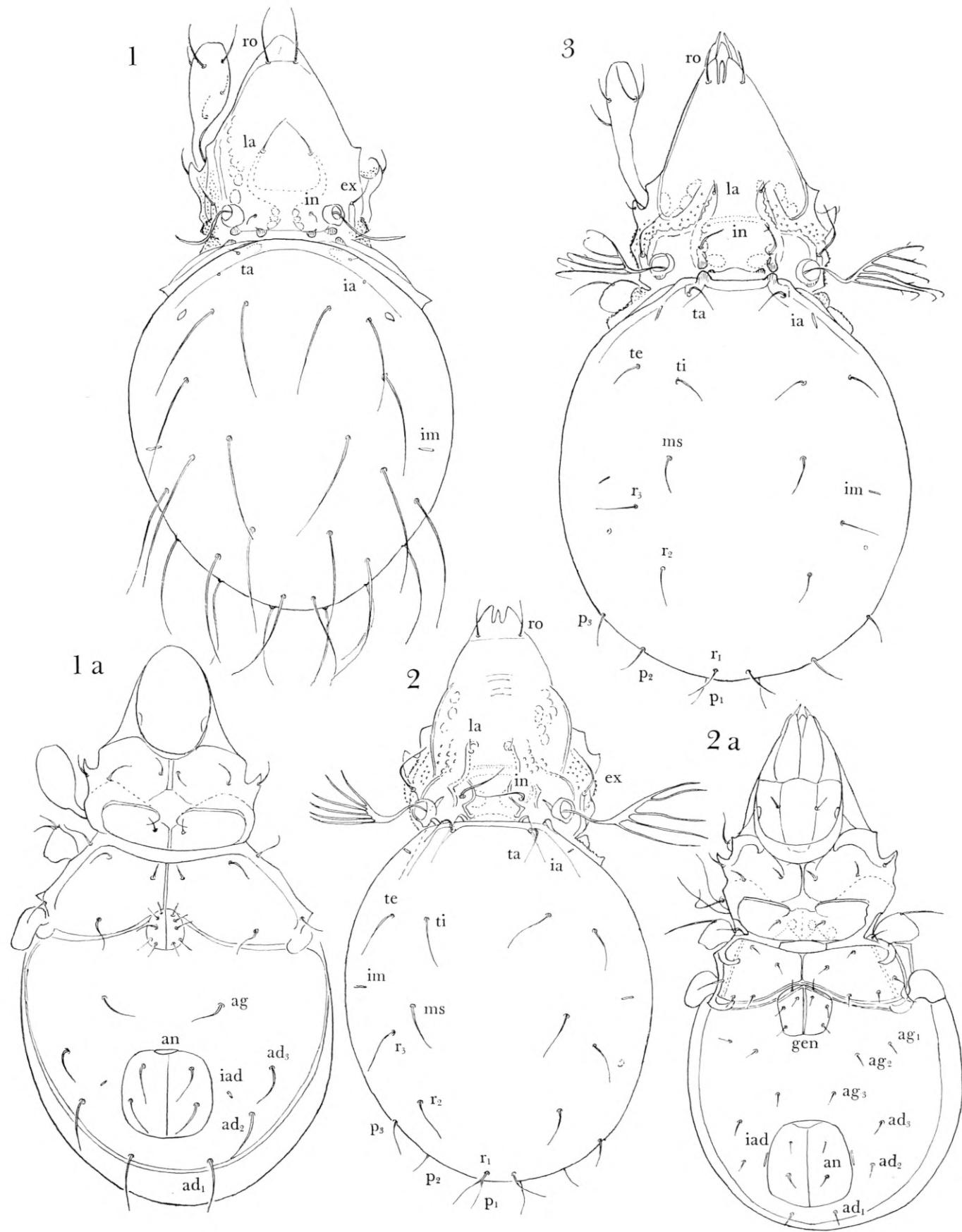
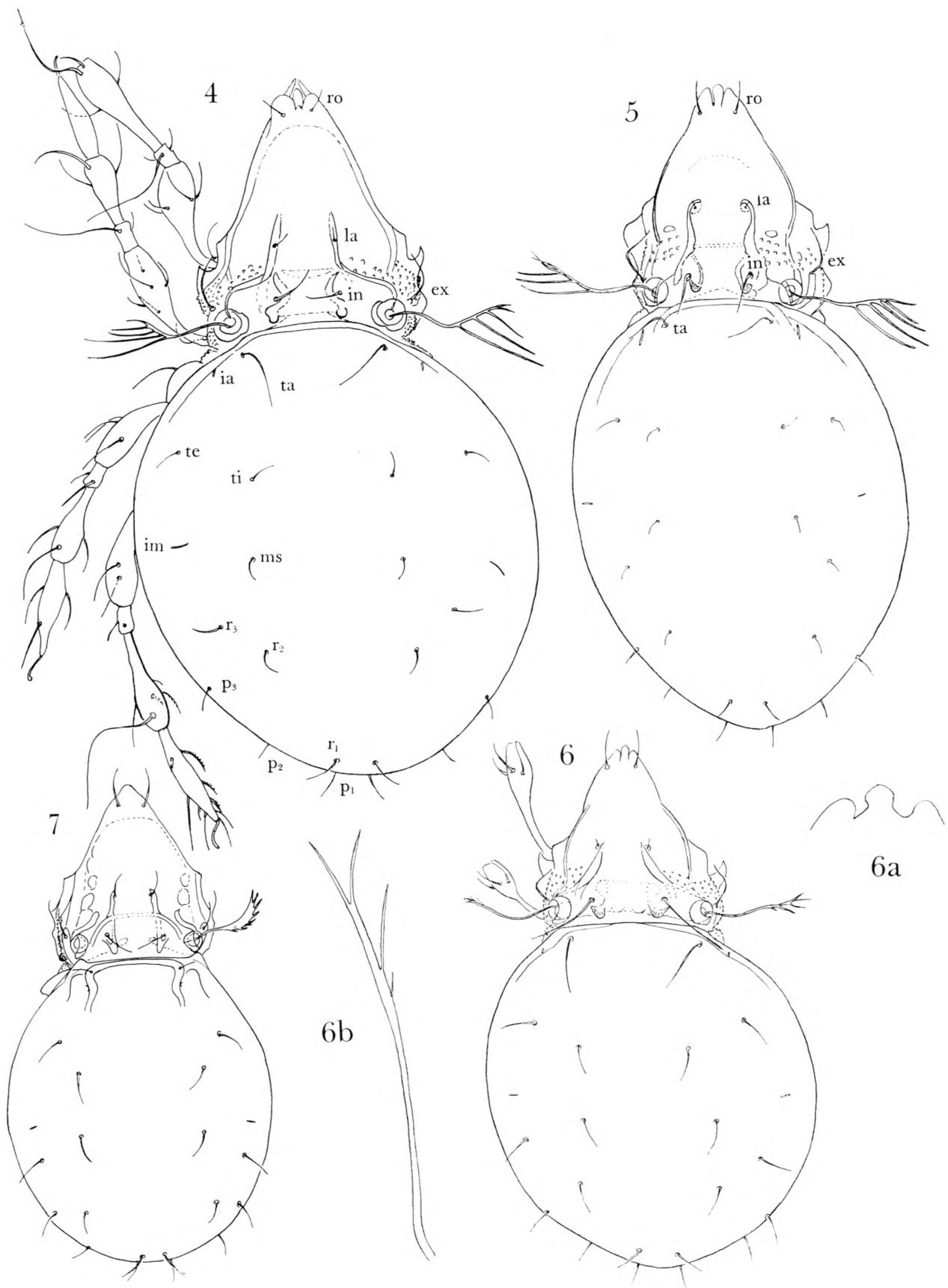
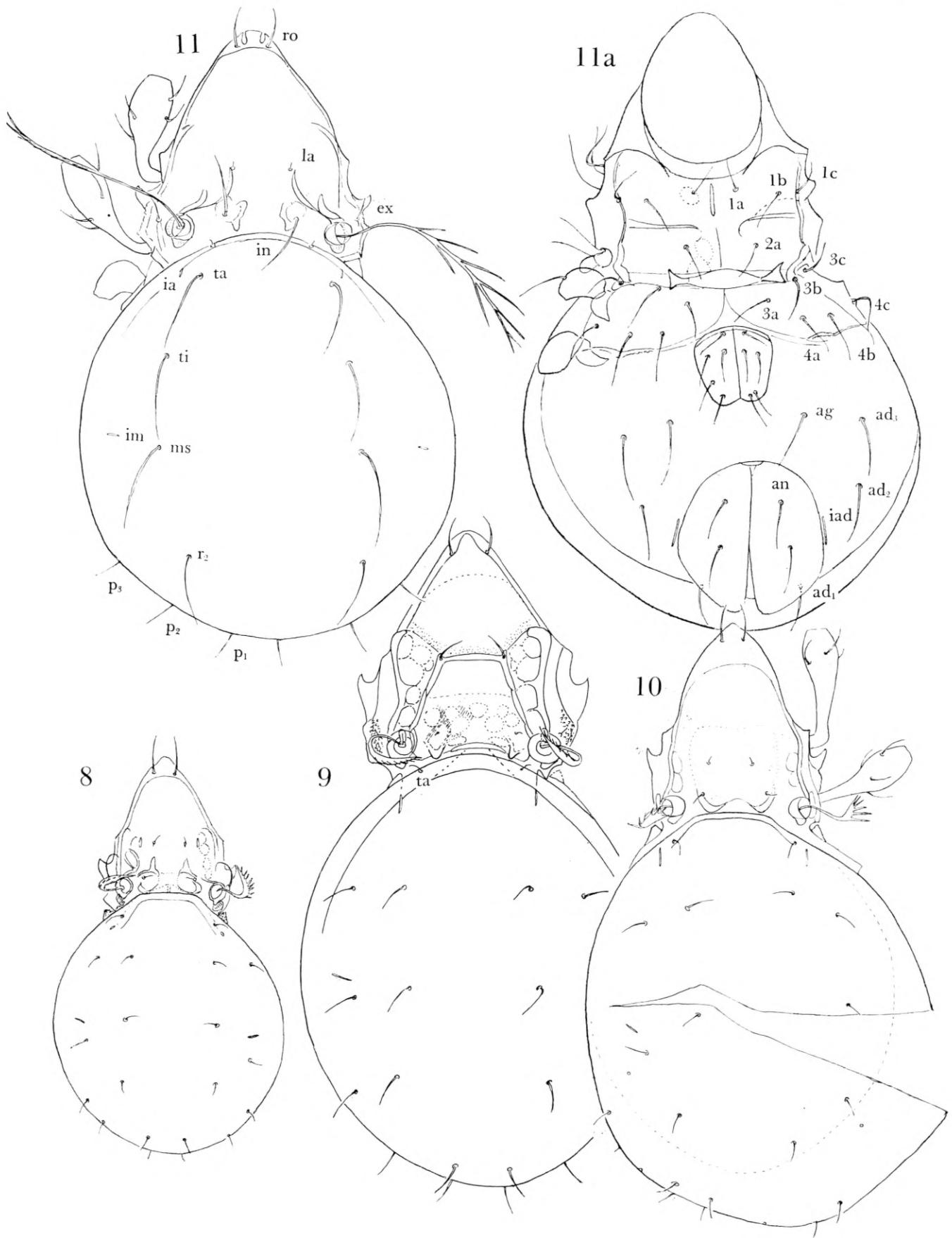


PLATE II





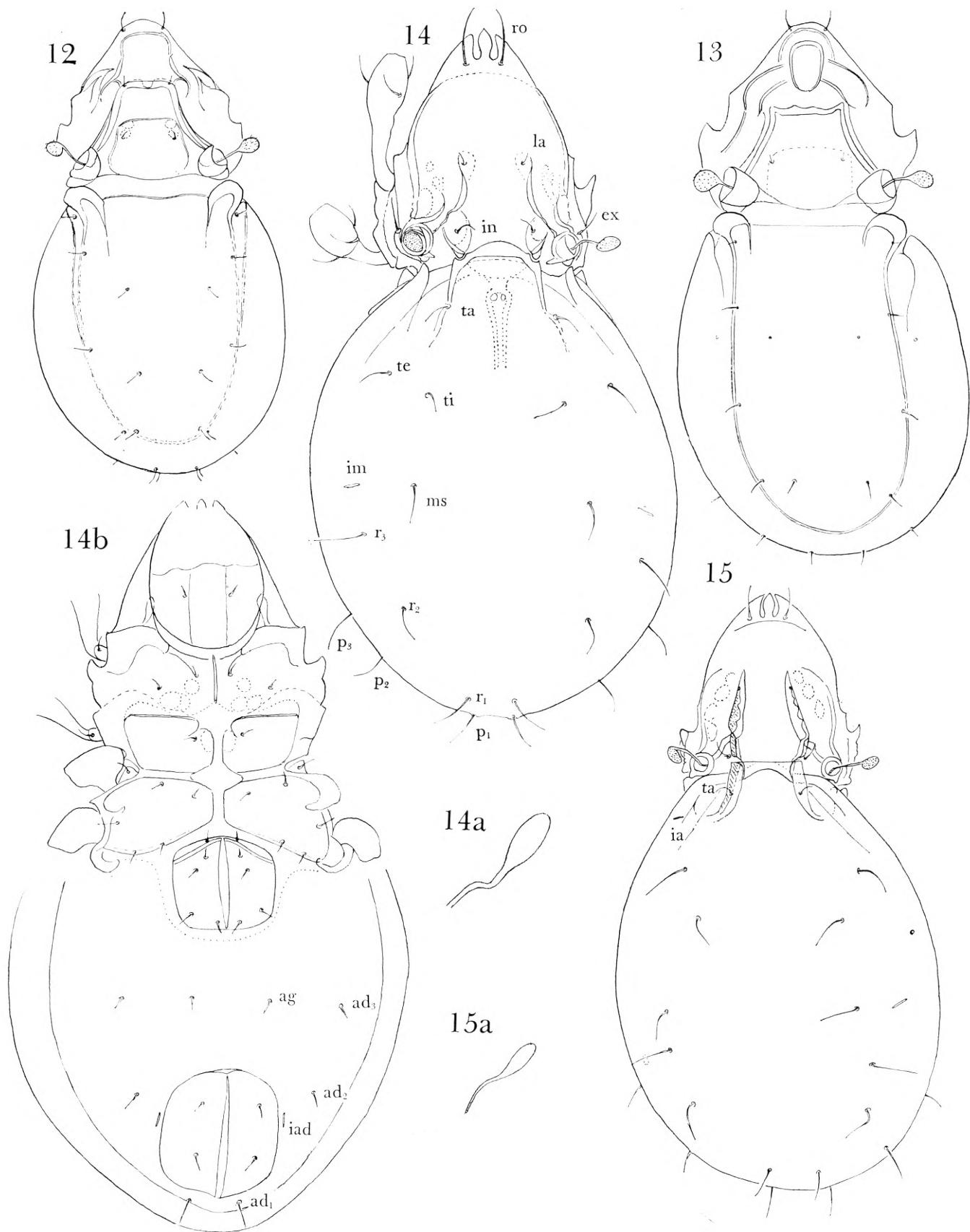
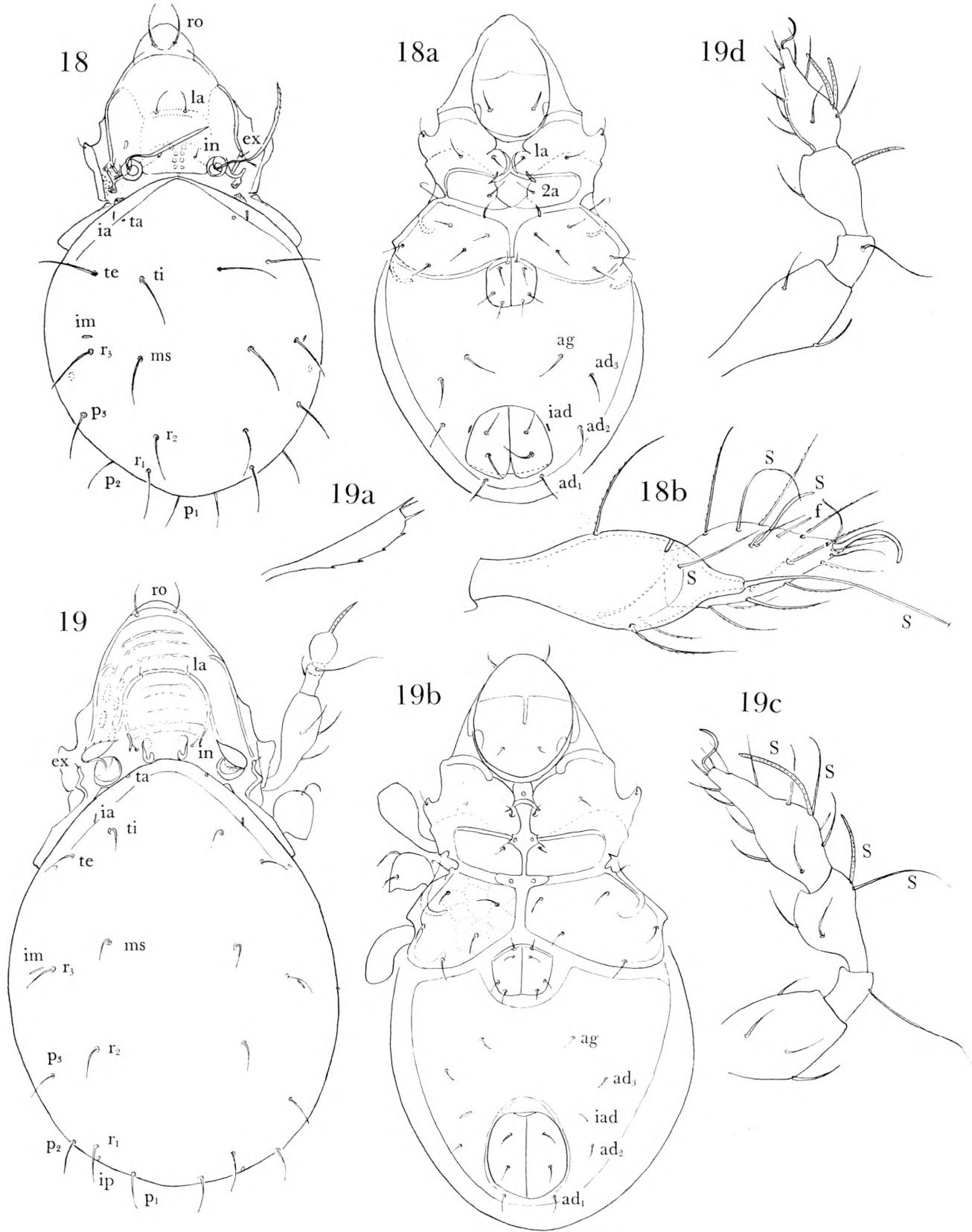
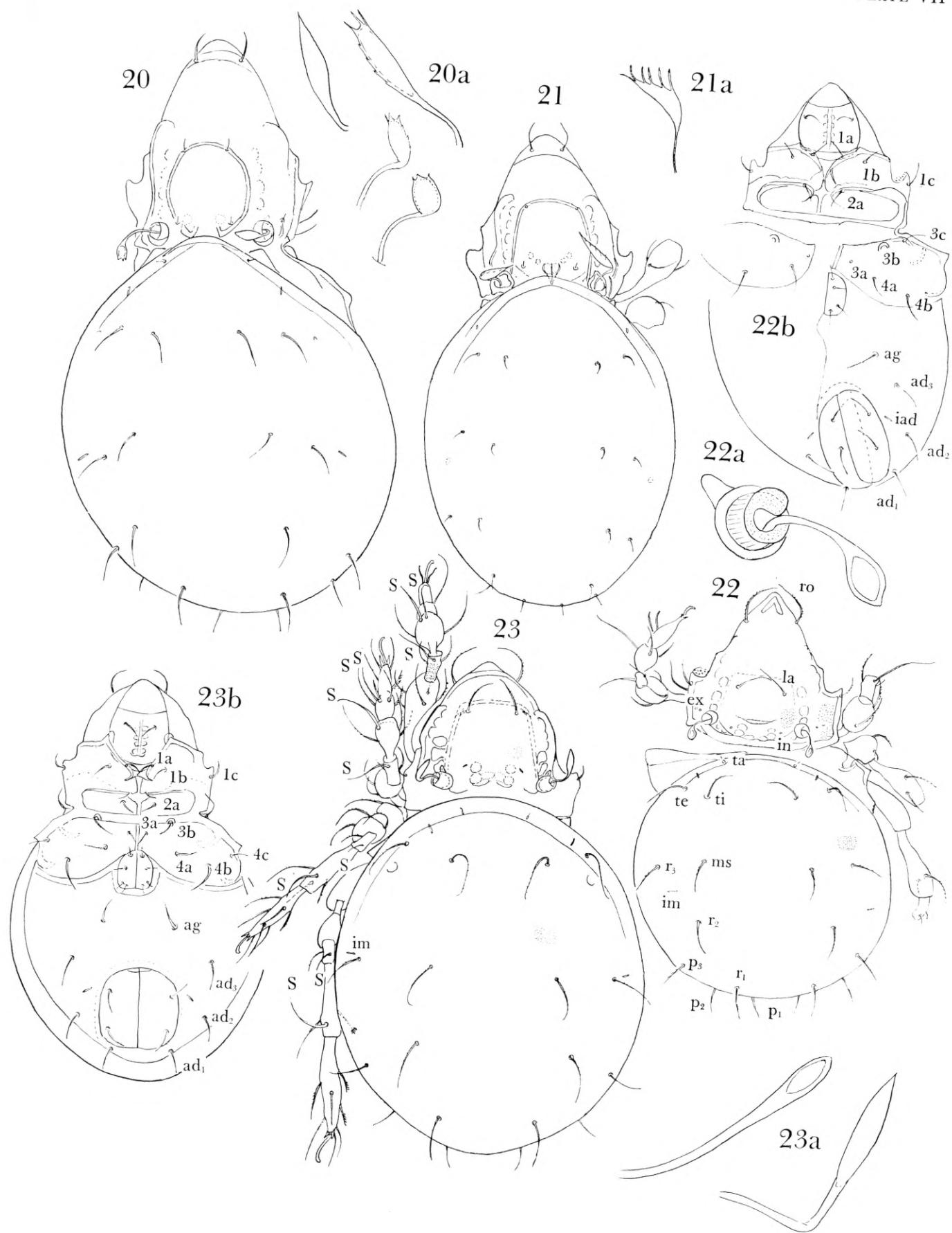
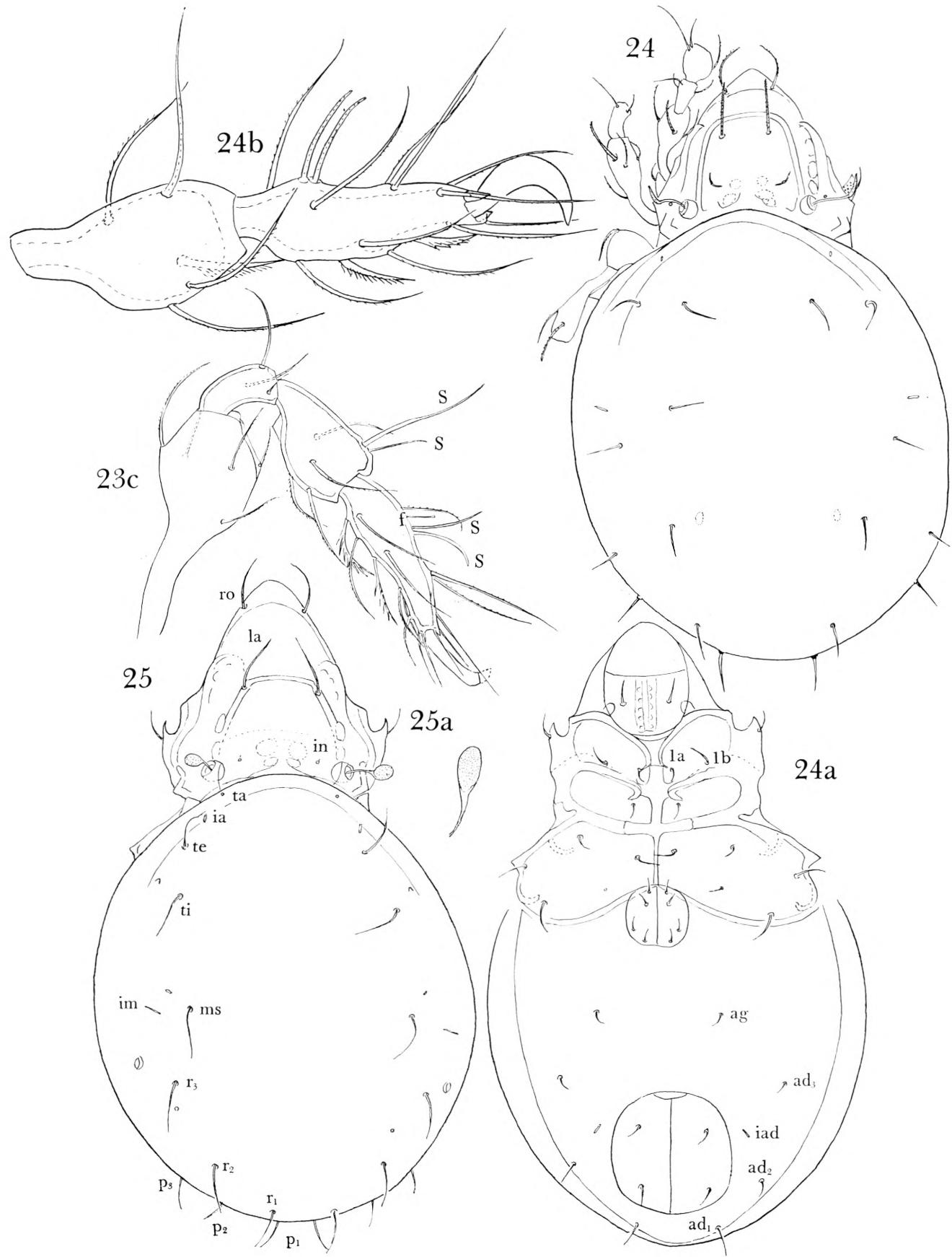


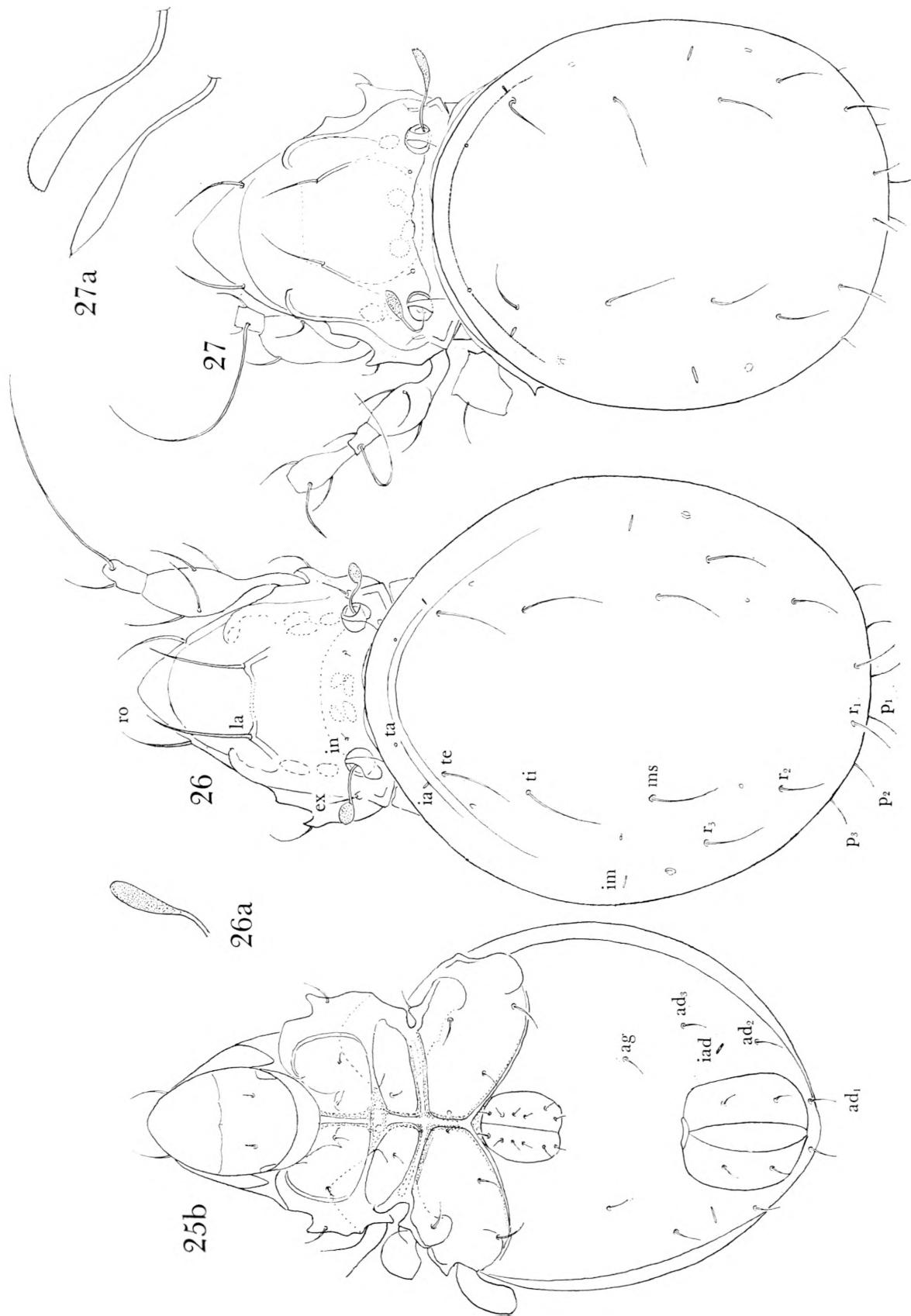


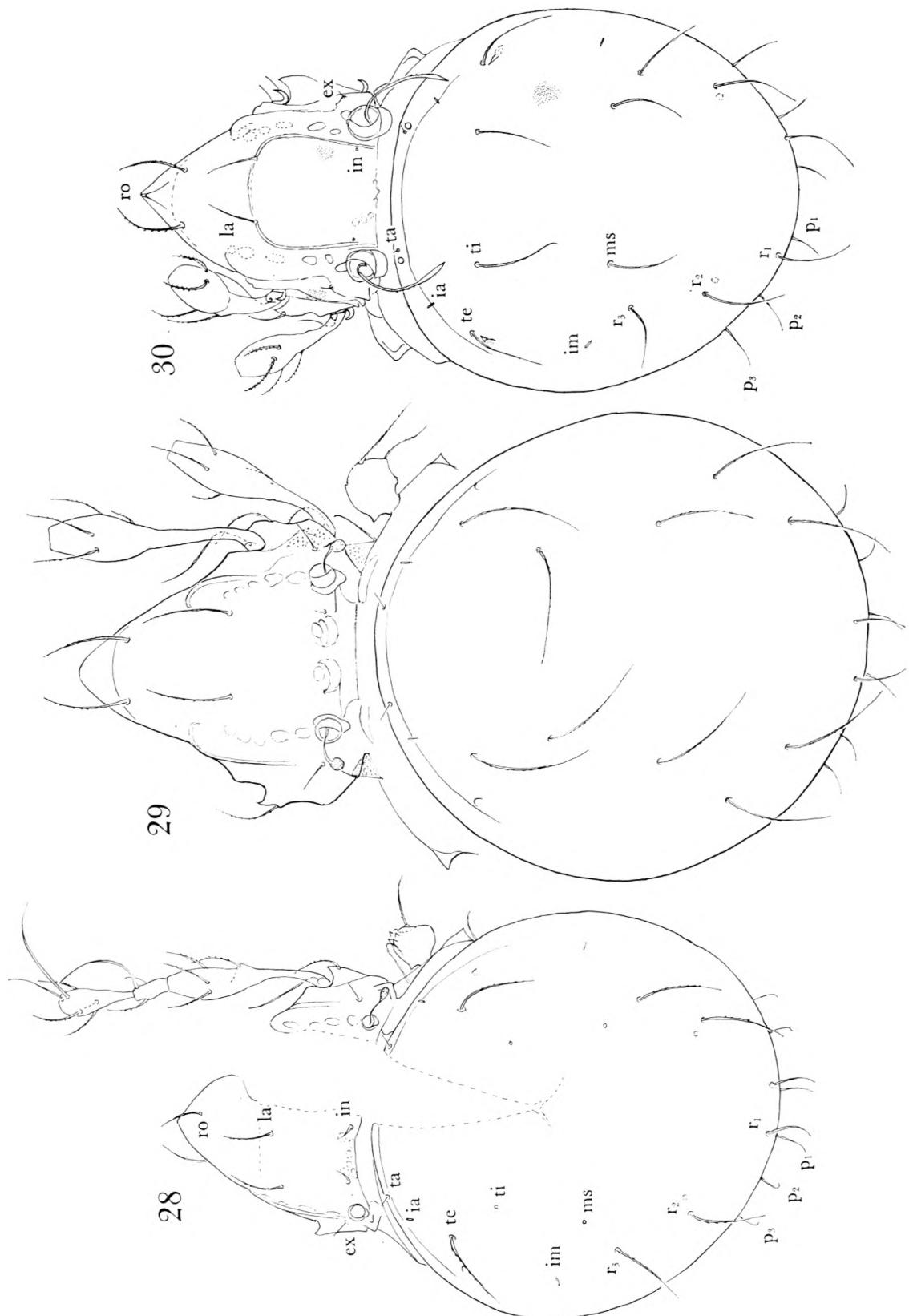
PLATE VI

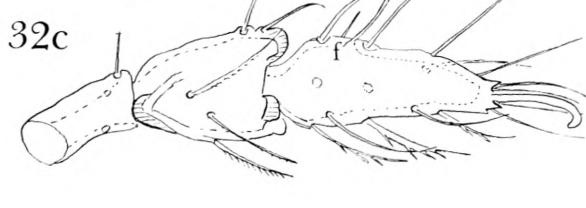
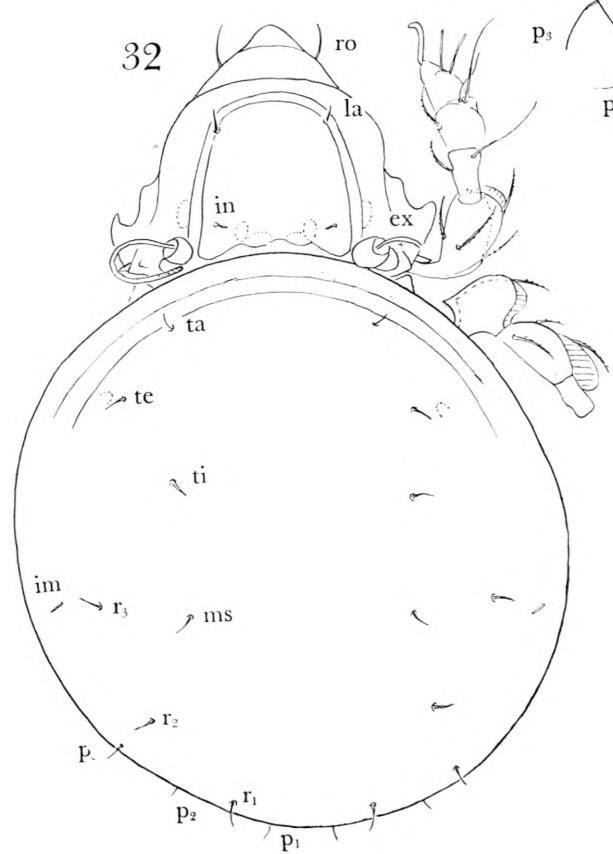
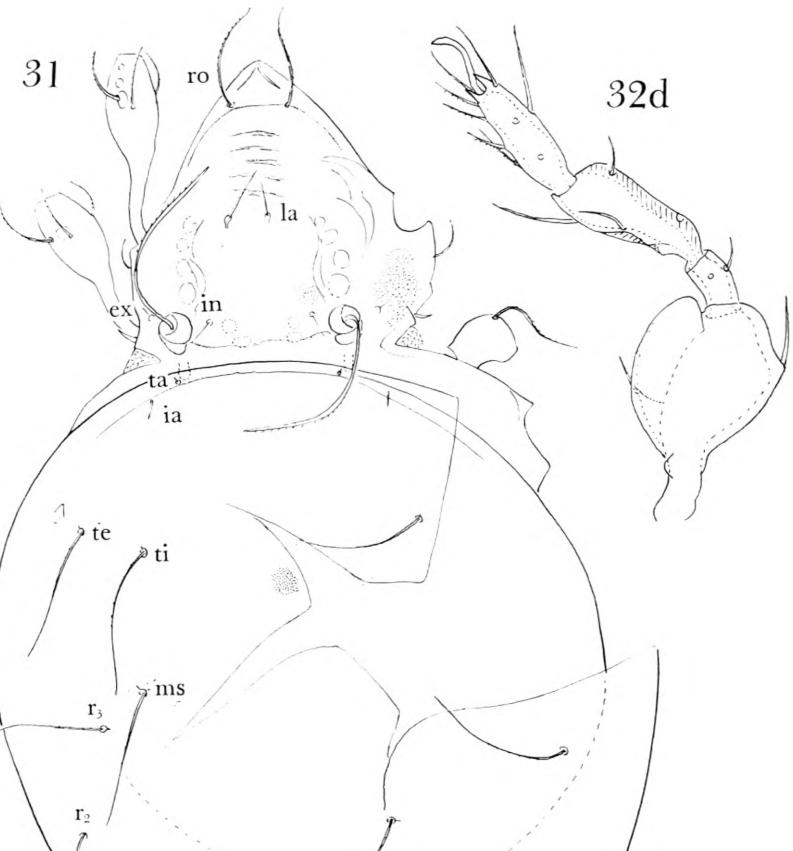
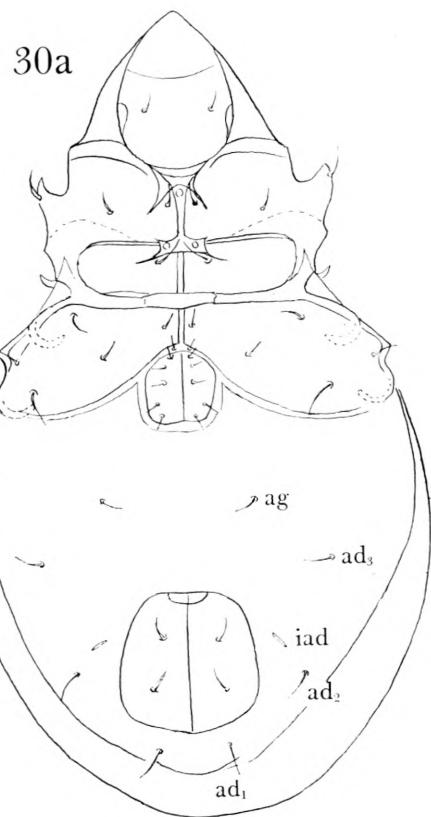




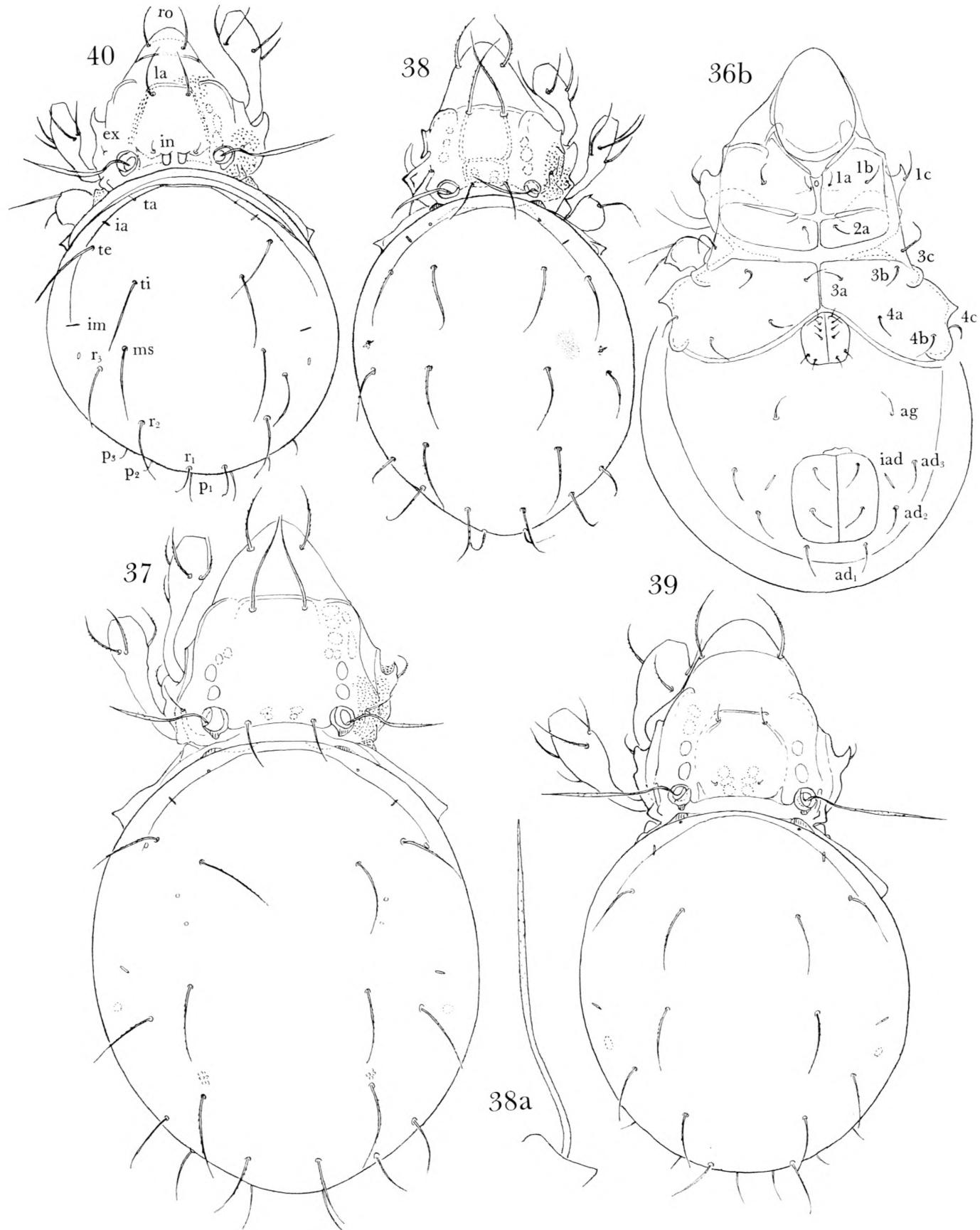


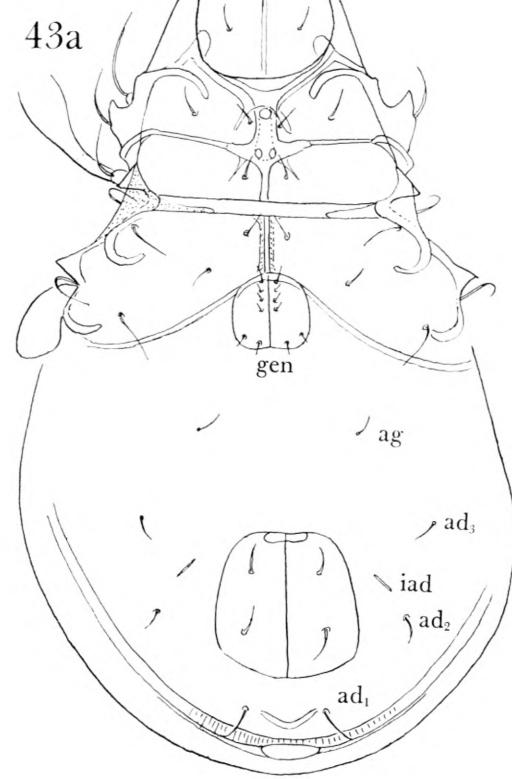
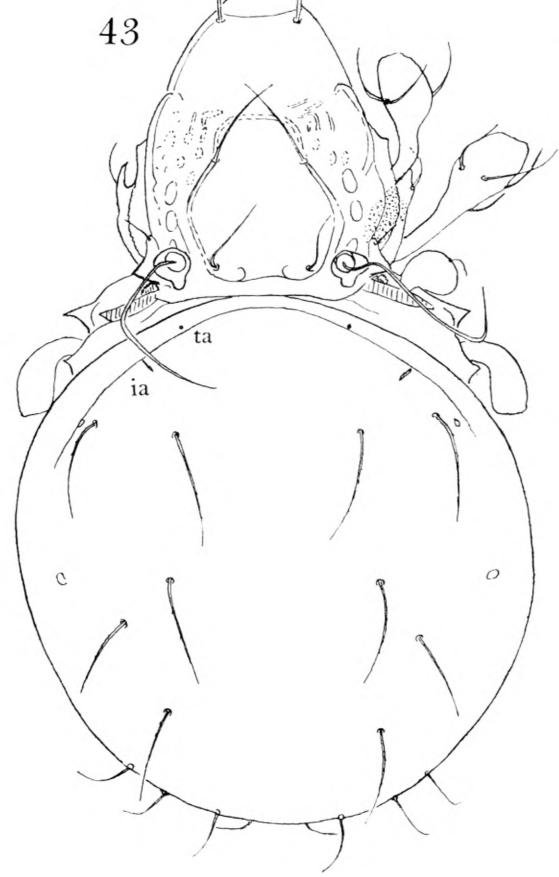
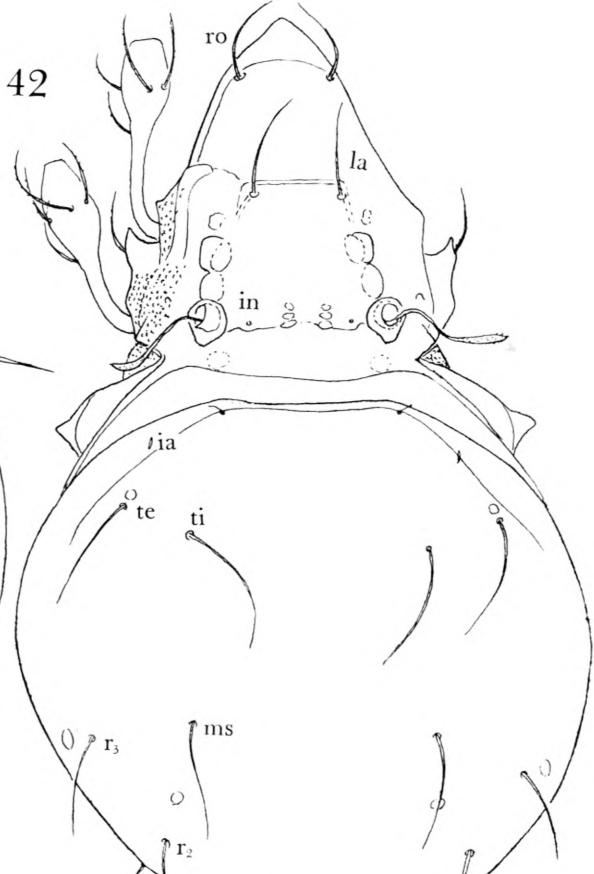
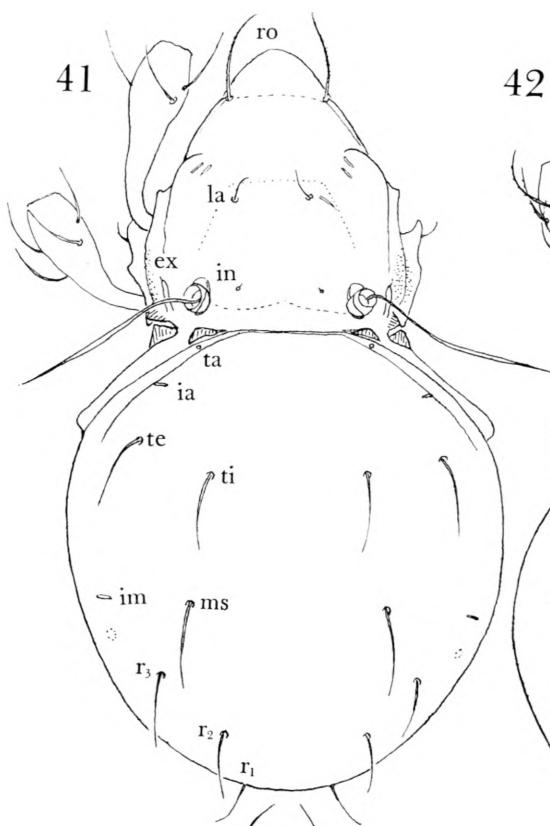


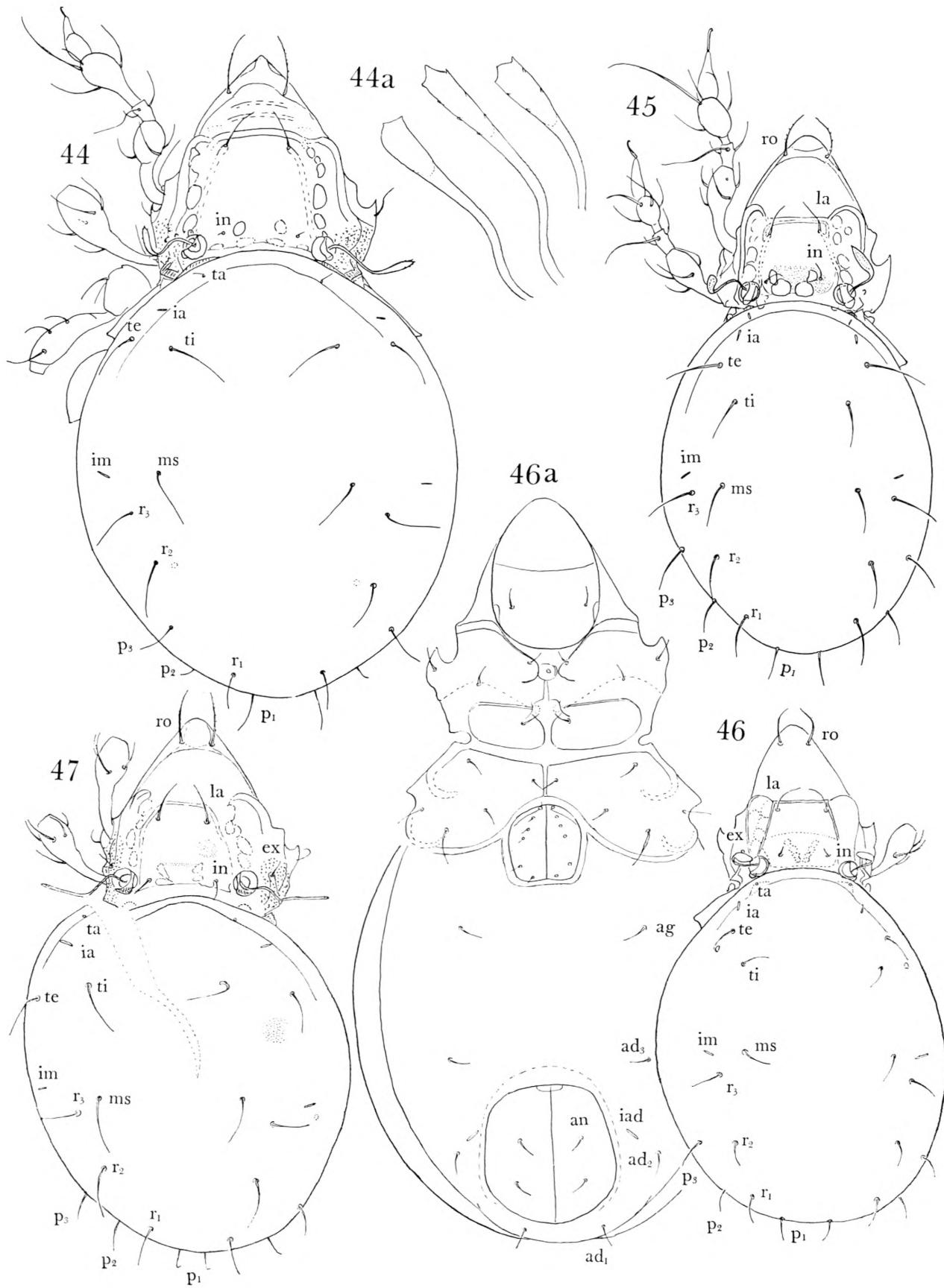


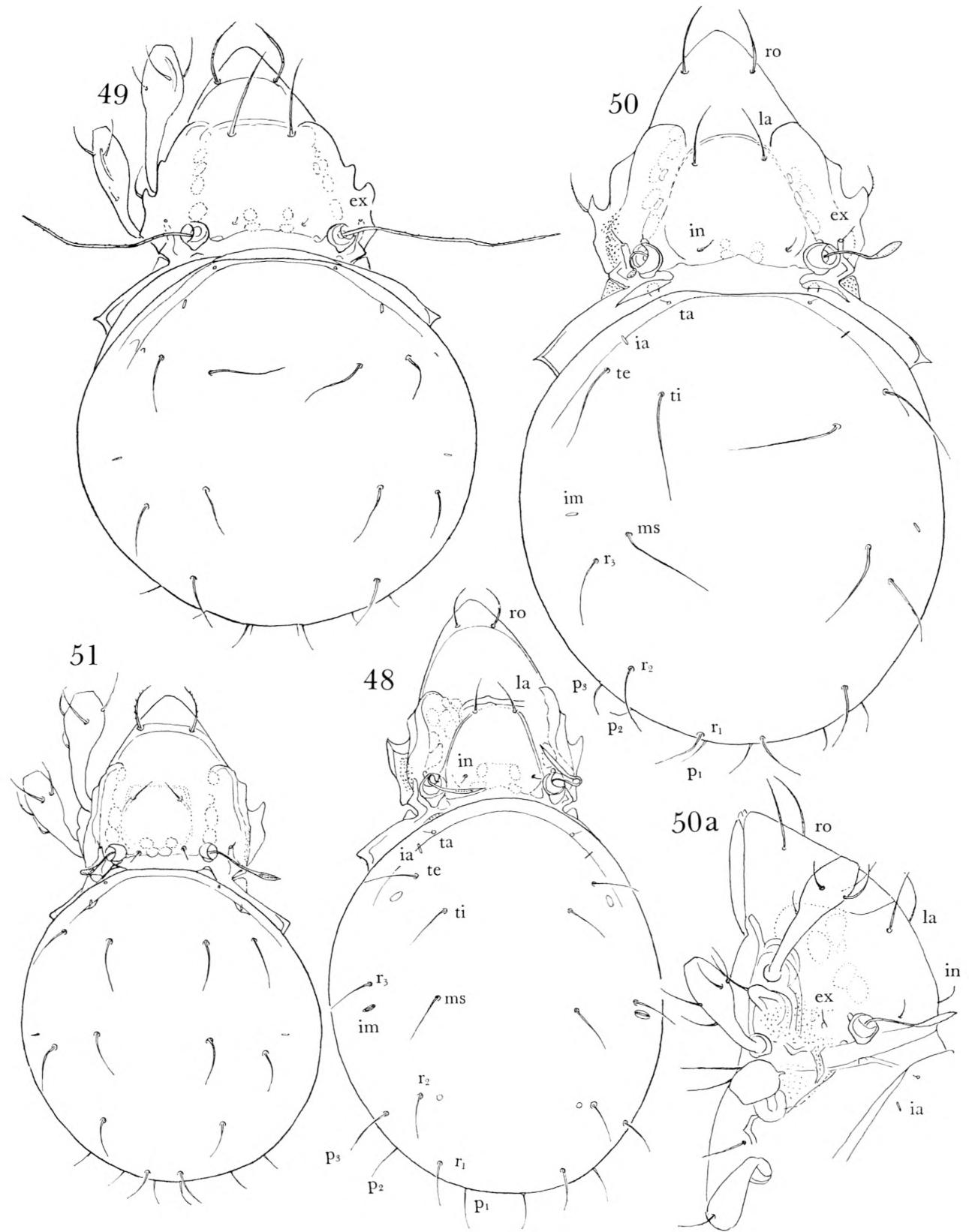


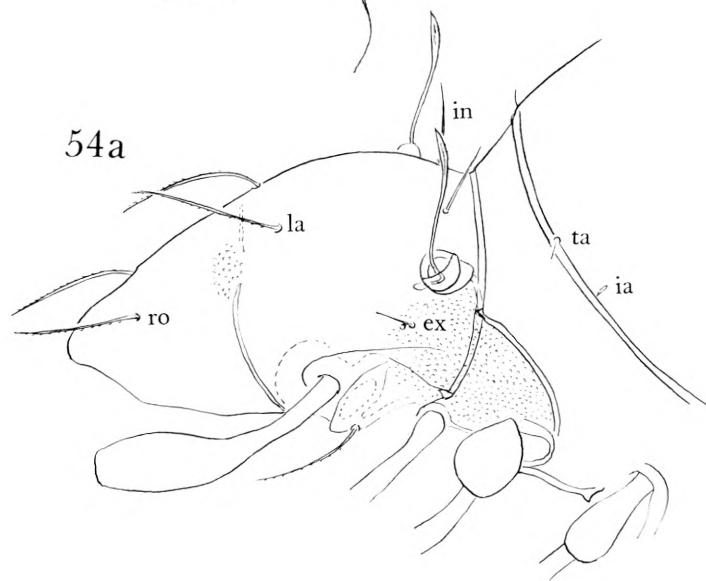
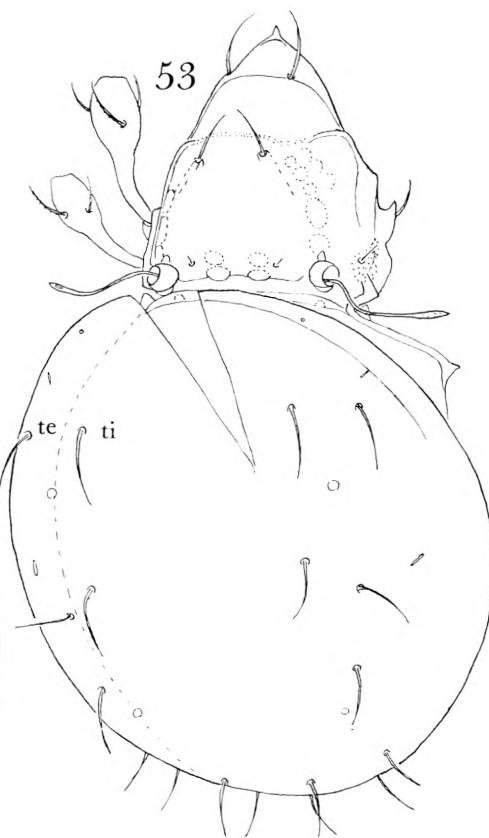
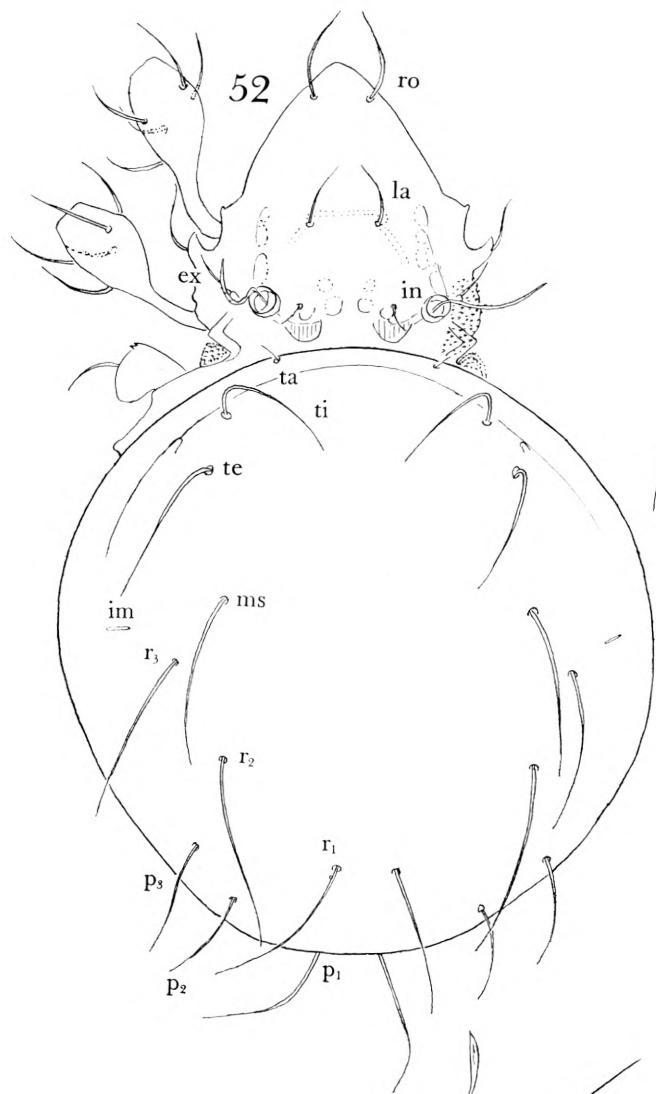


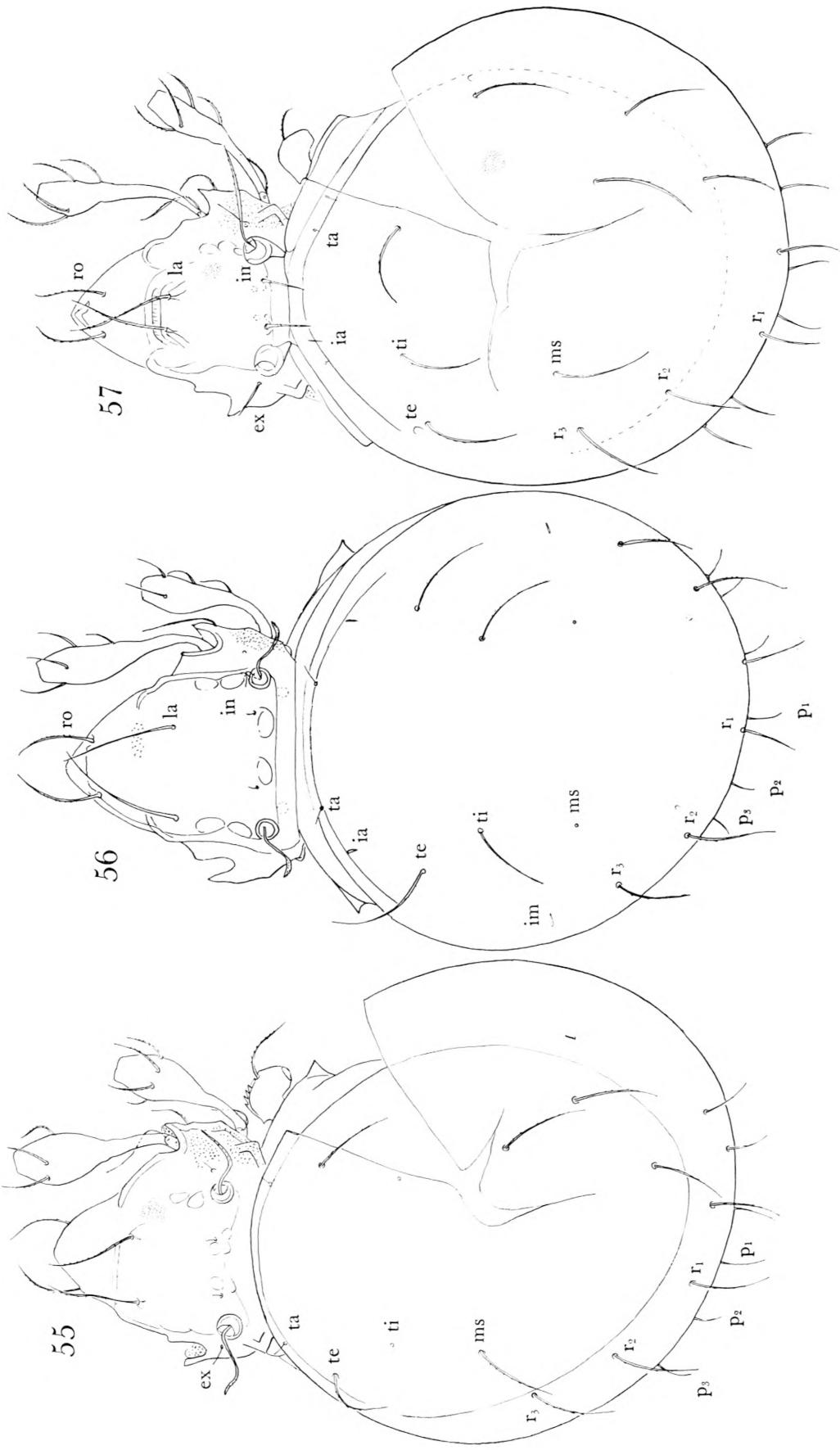


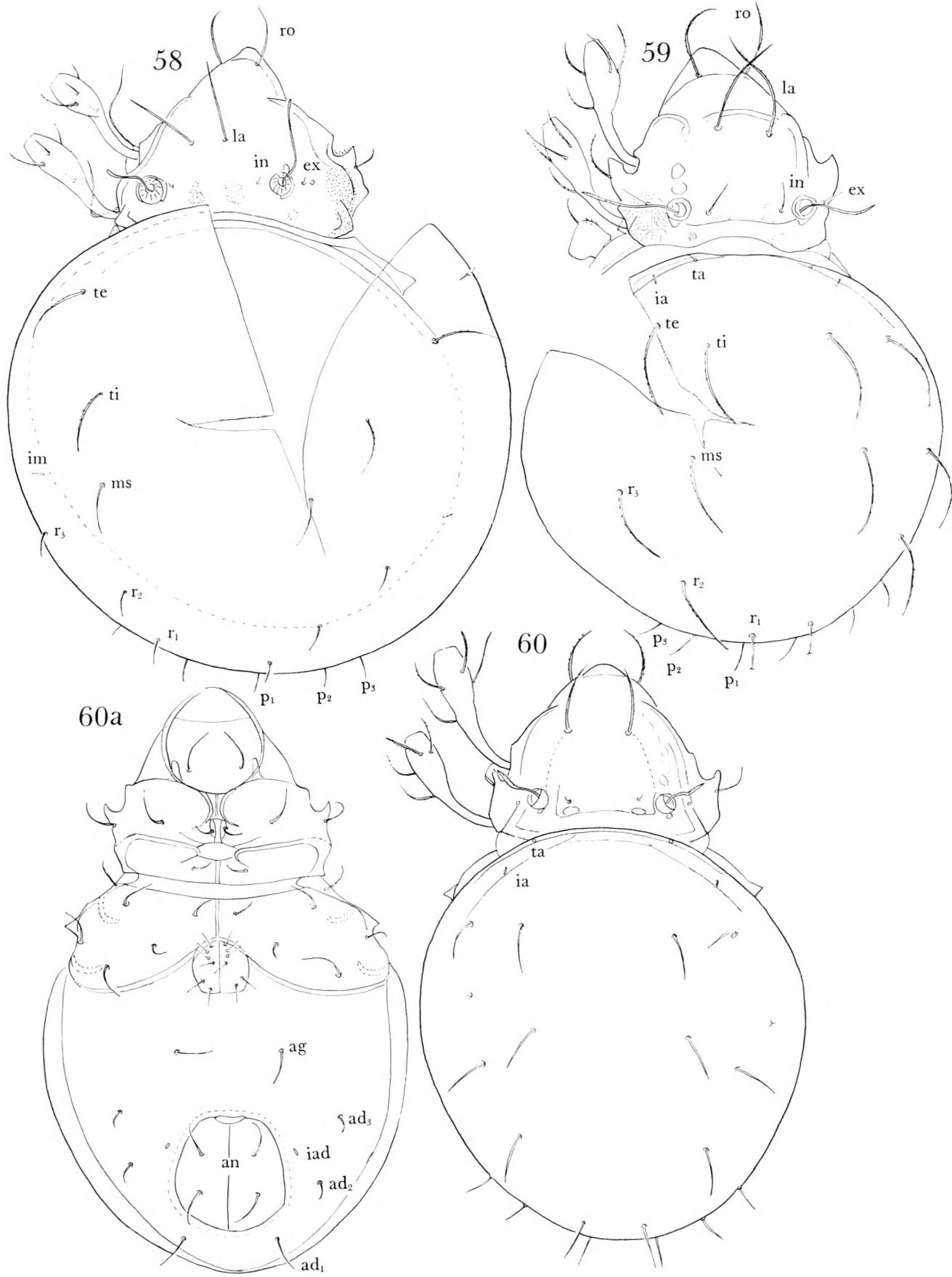


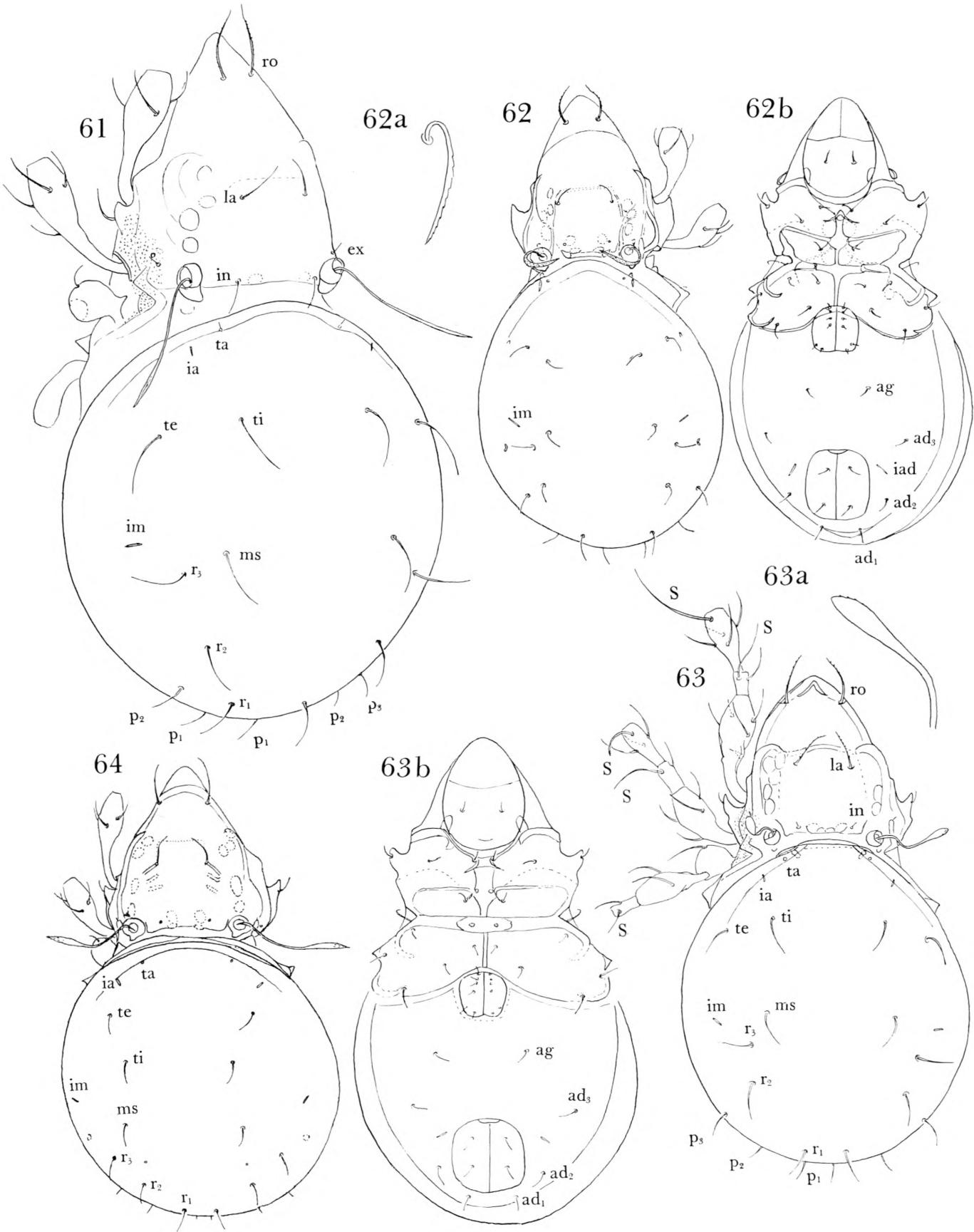


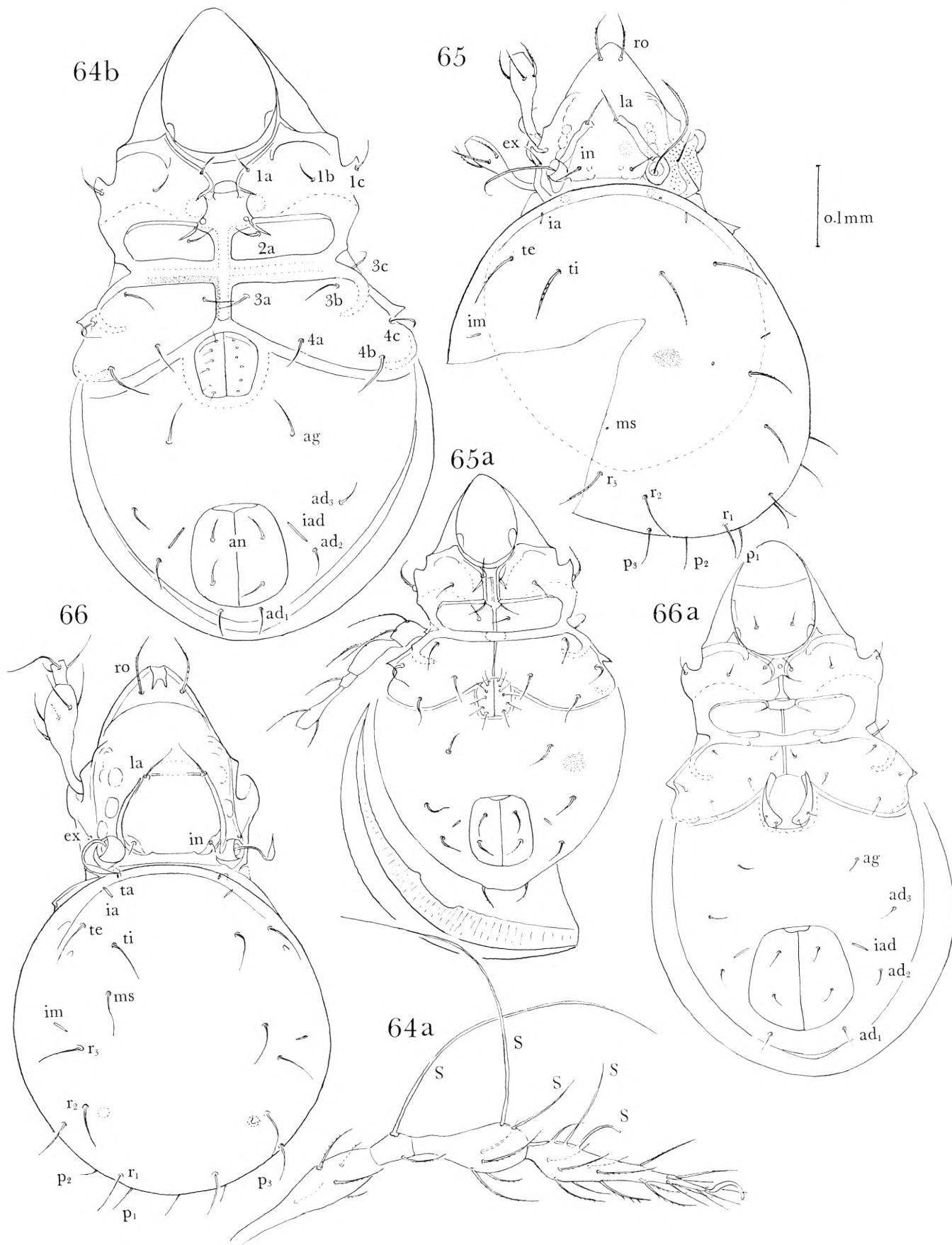


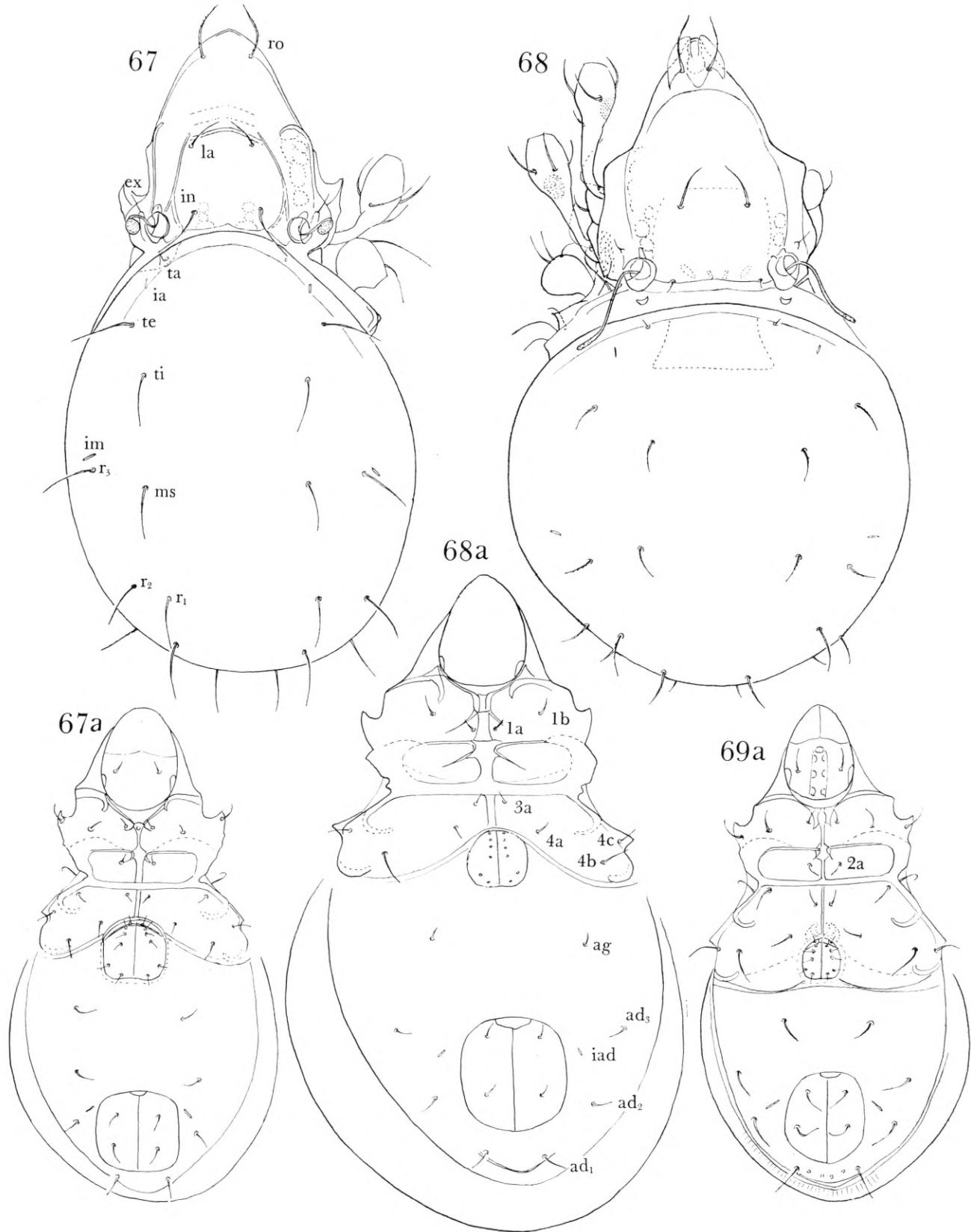




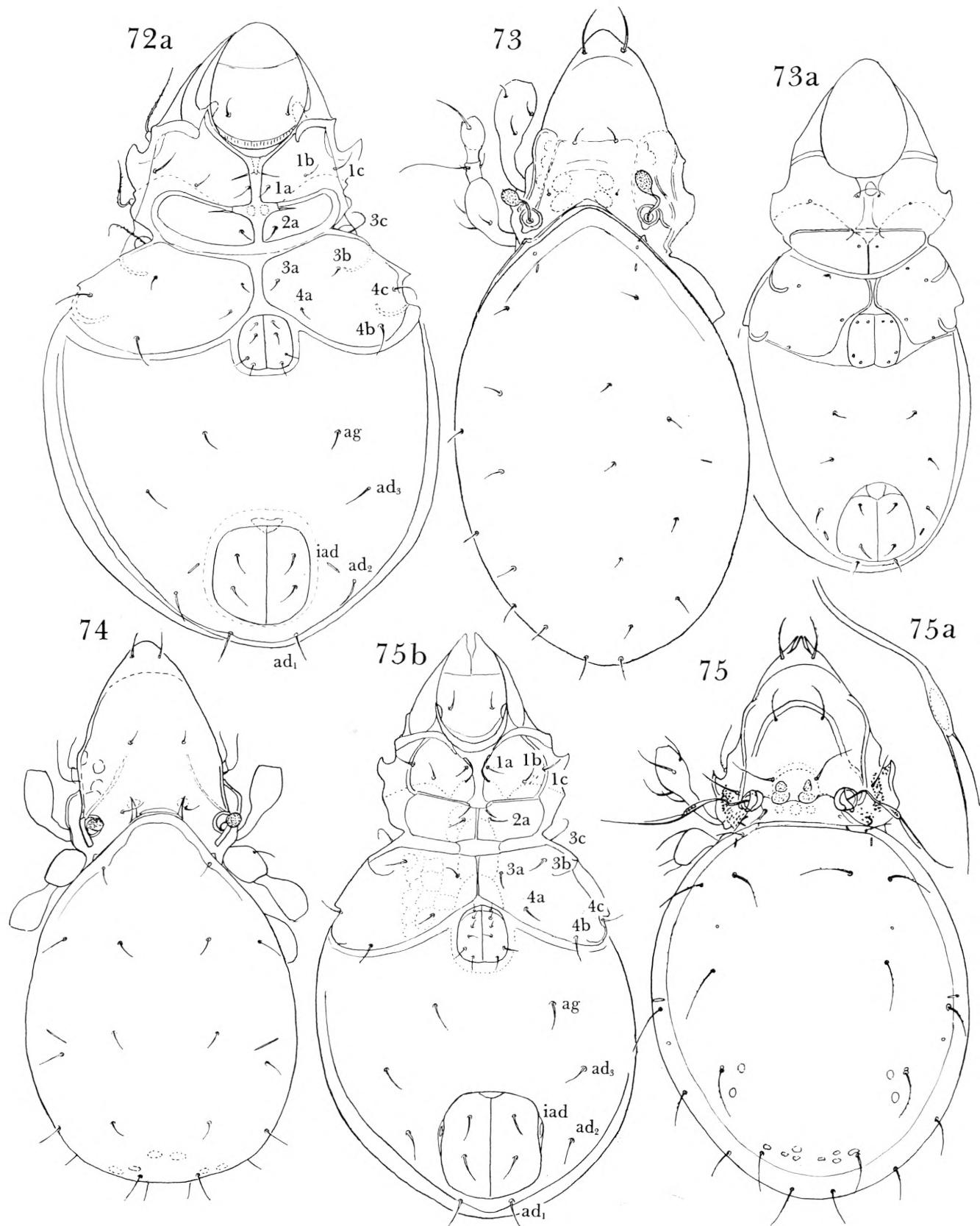


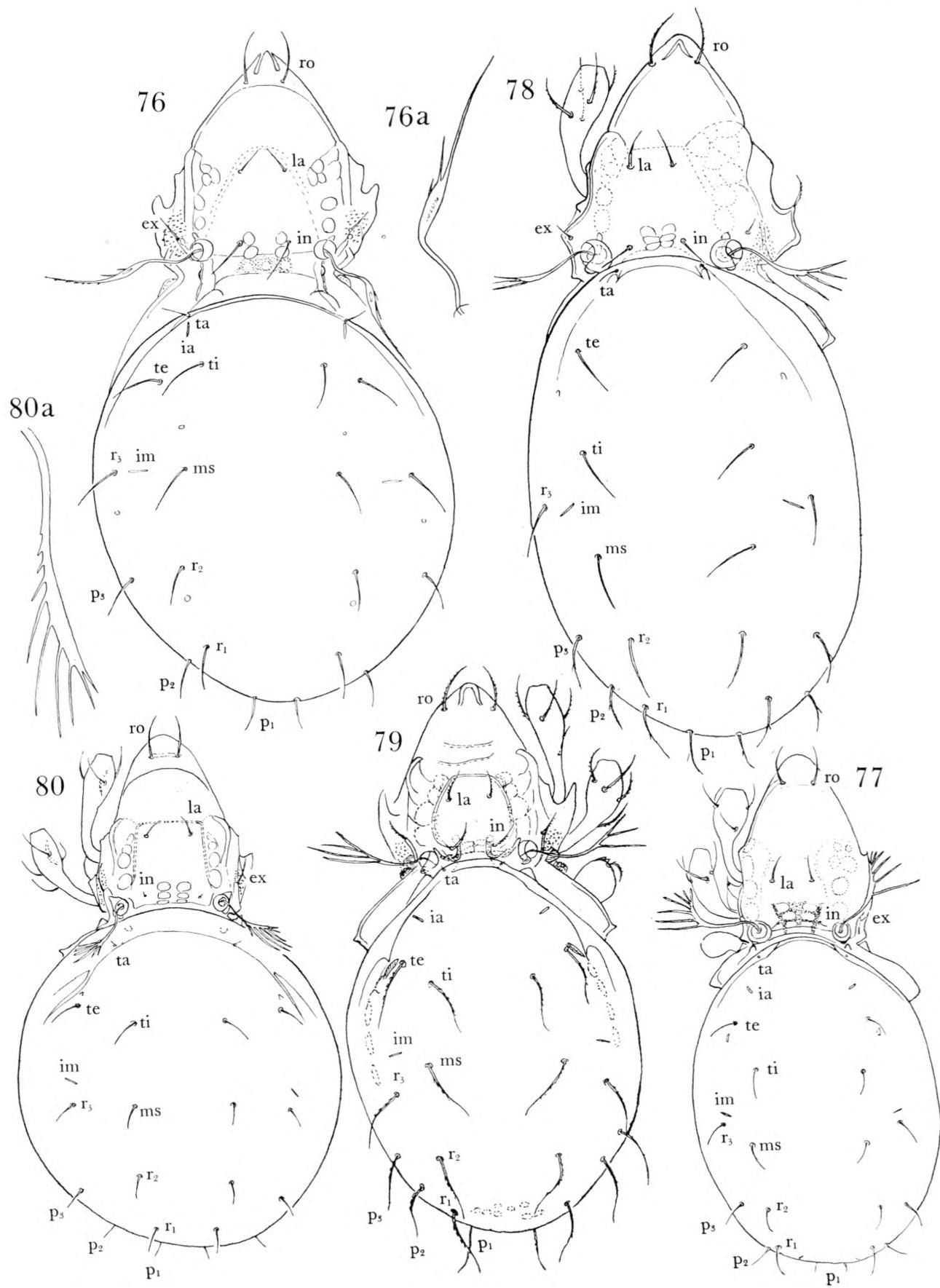


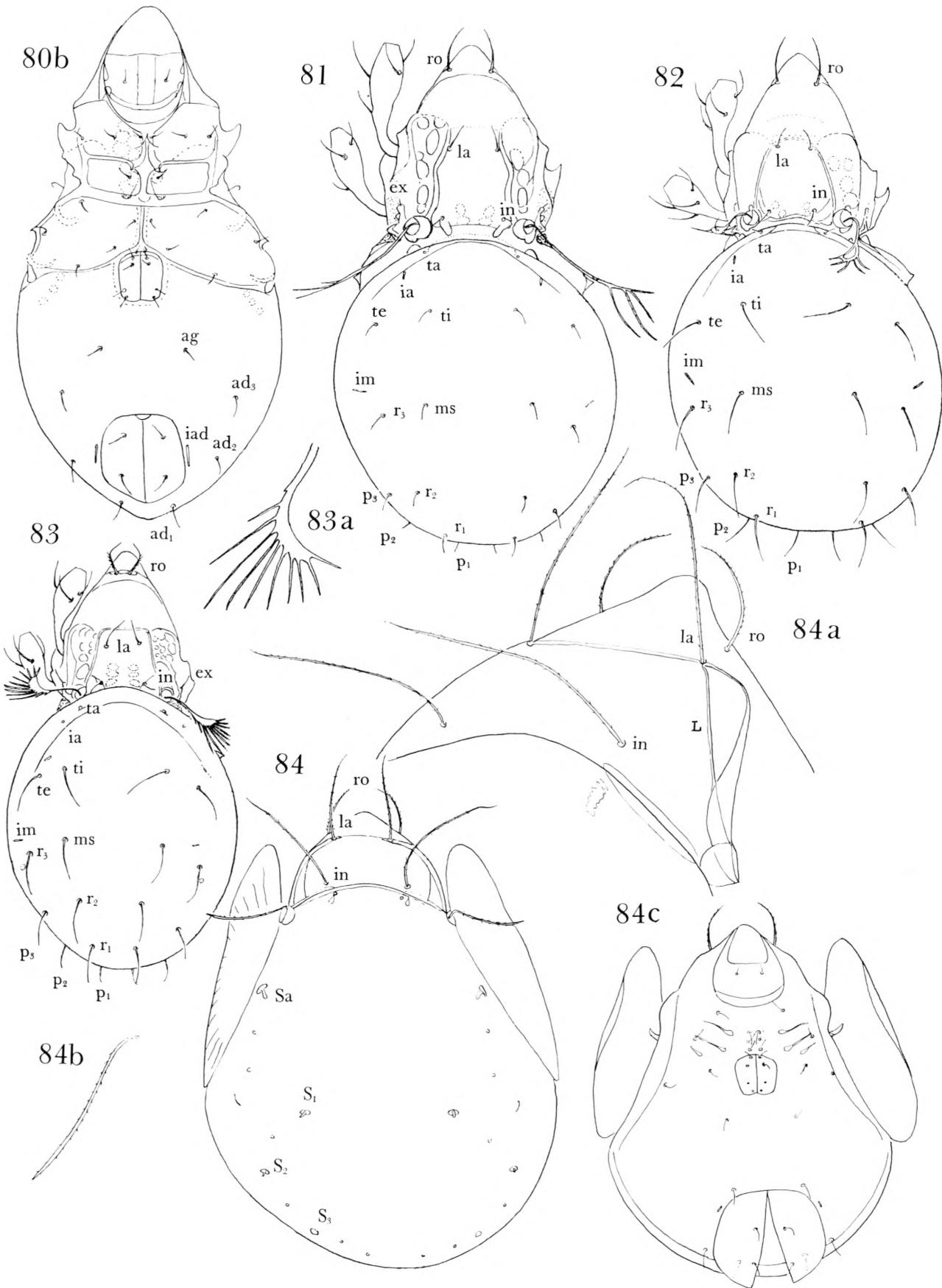


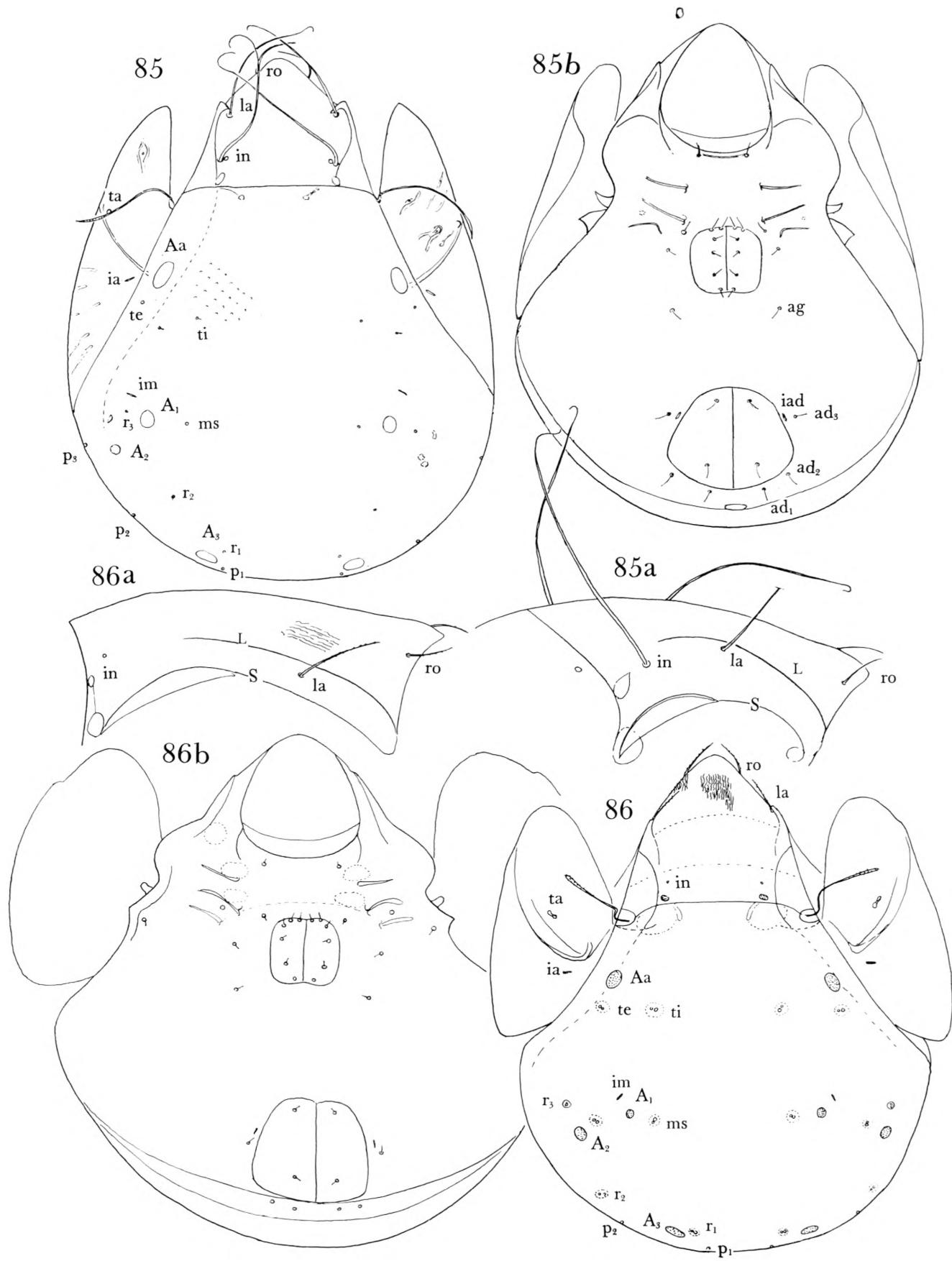




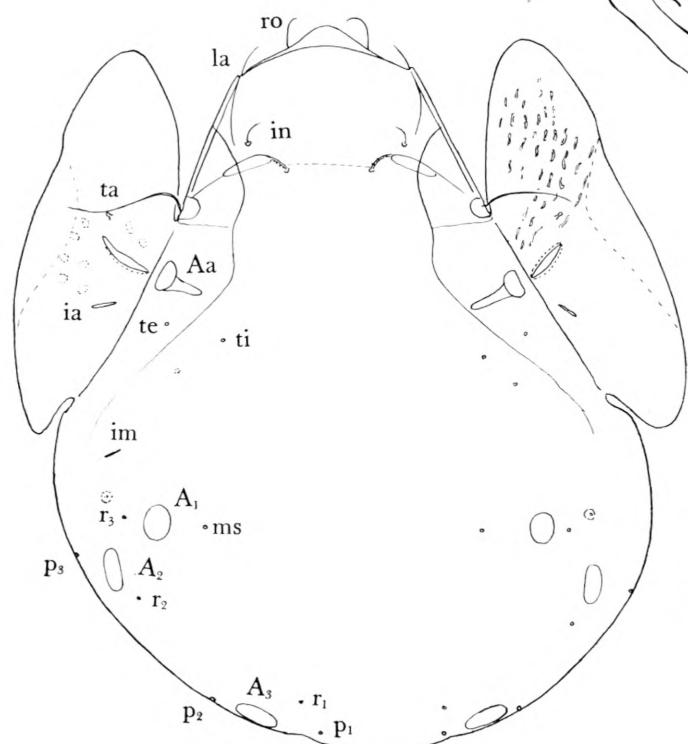




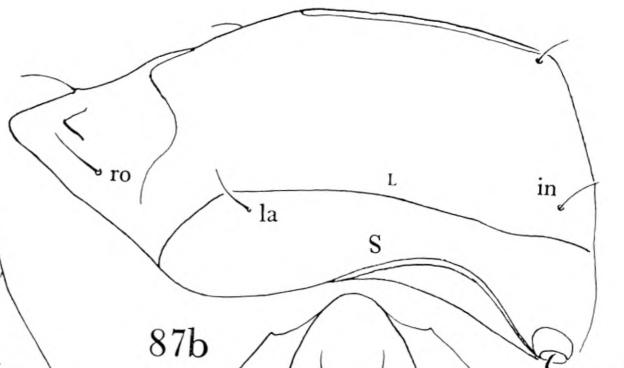




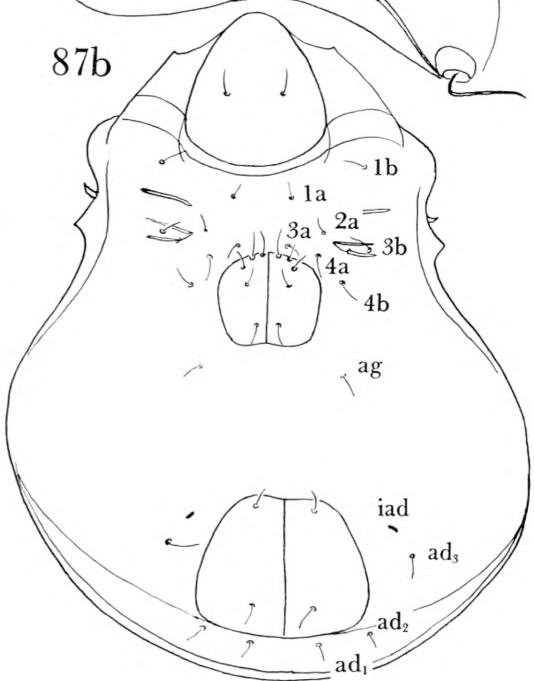
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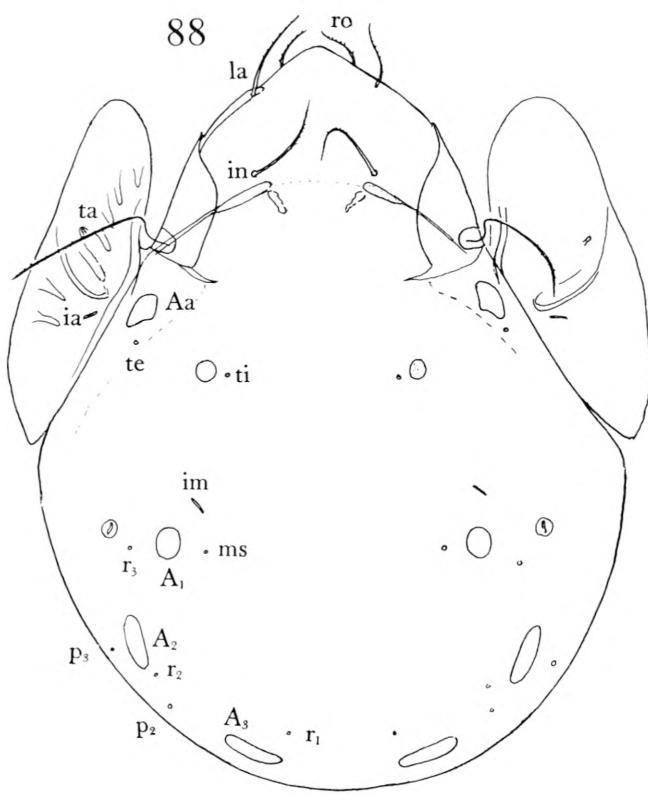
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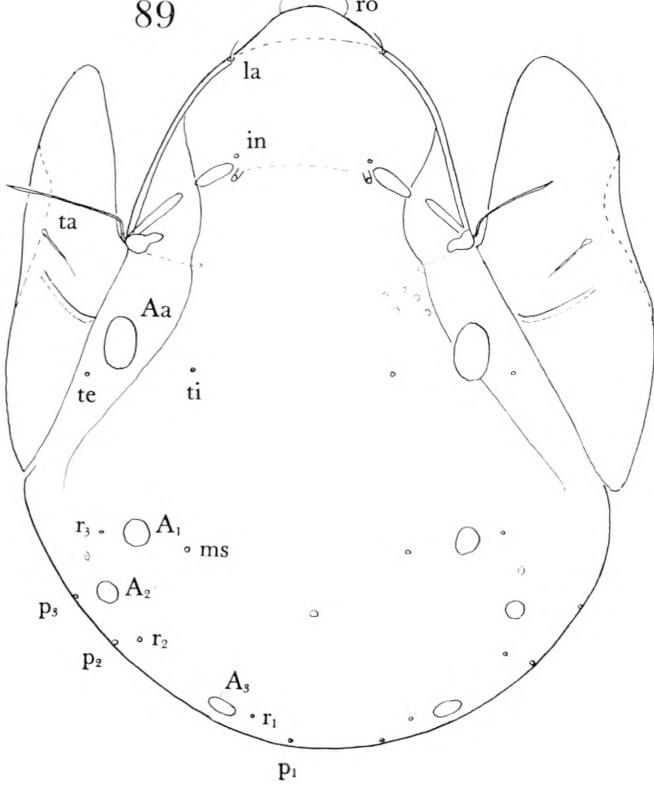
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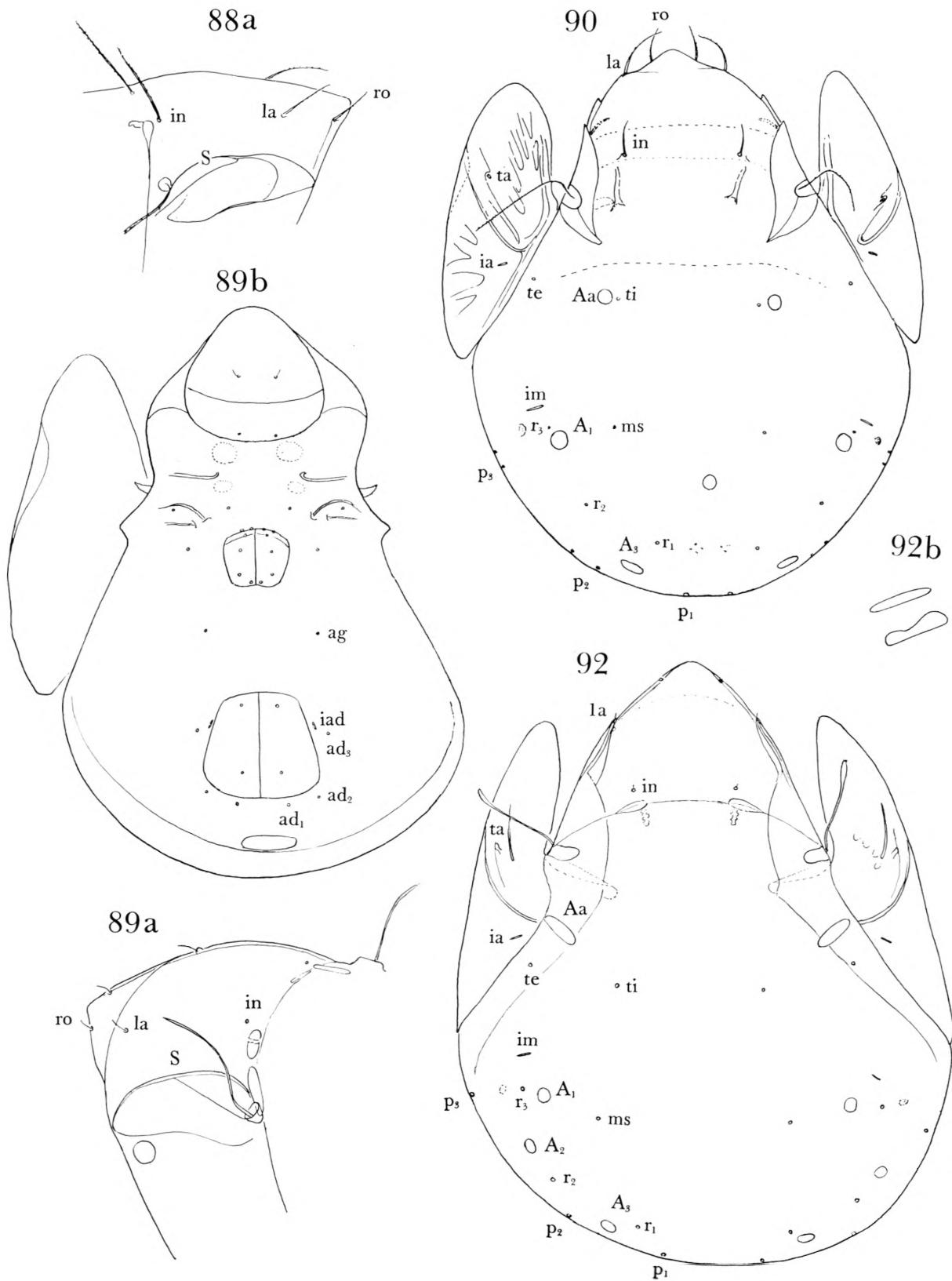


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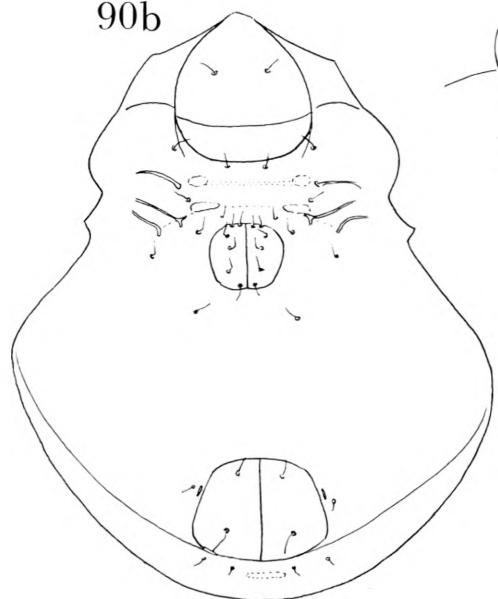


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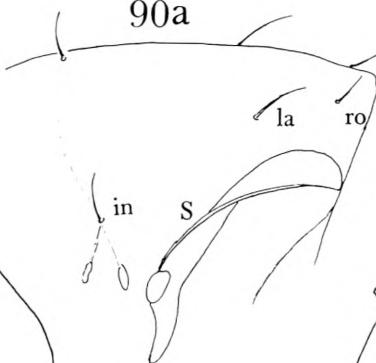




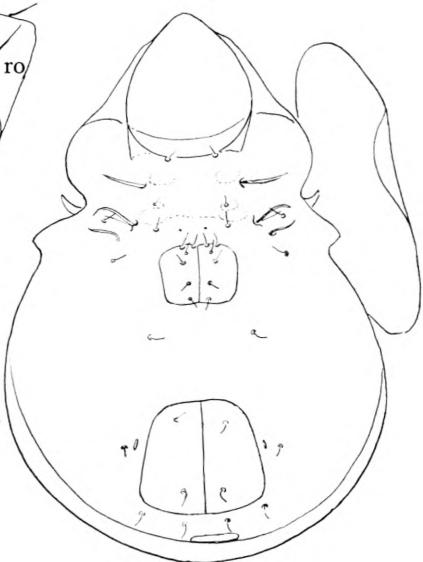
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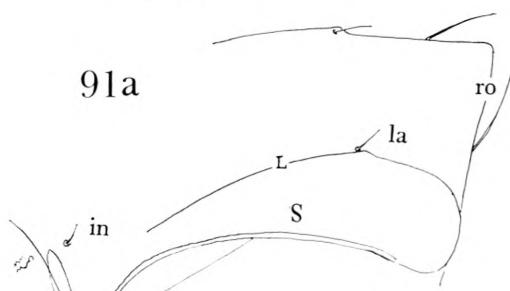
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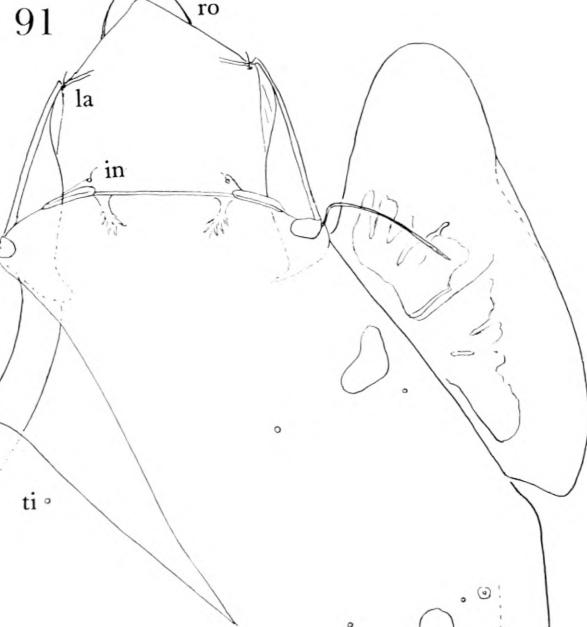
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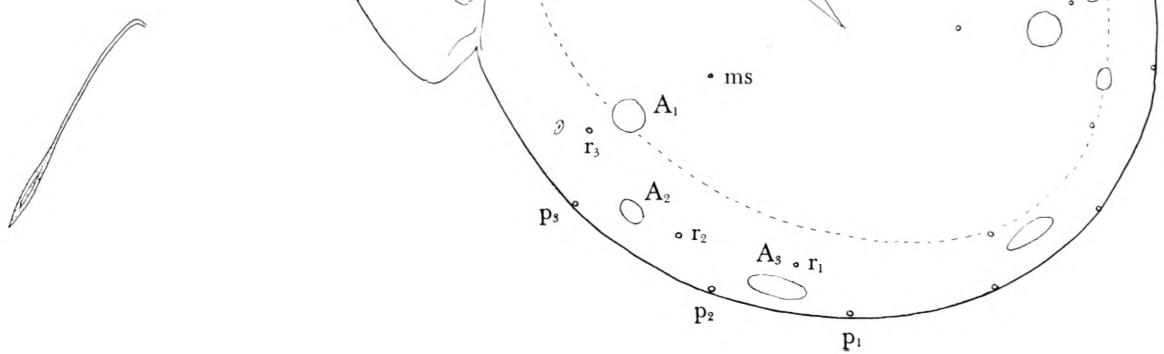
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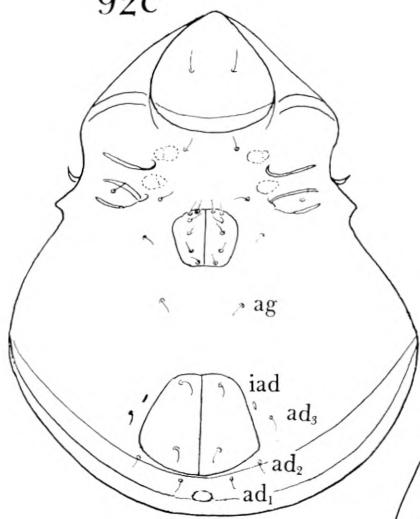
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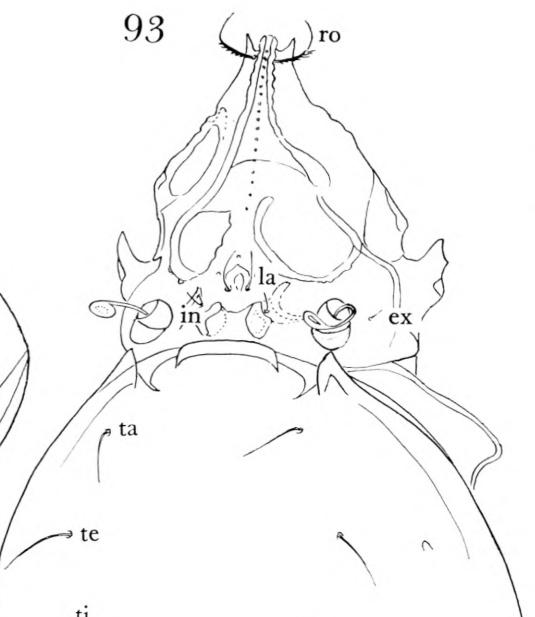
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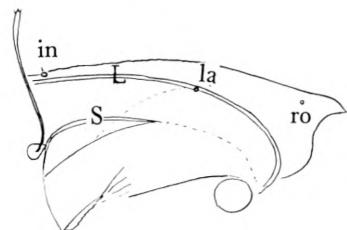
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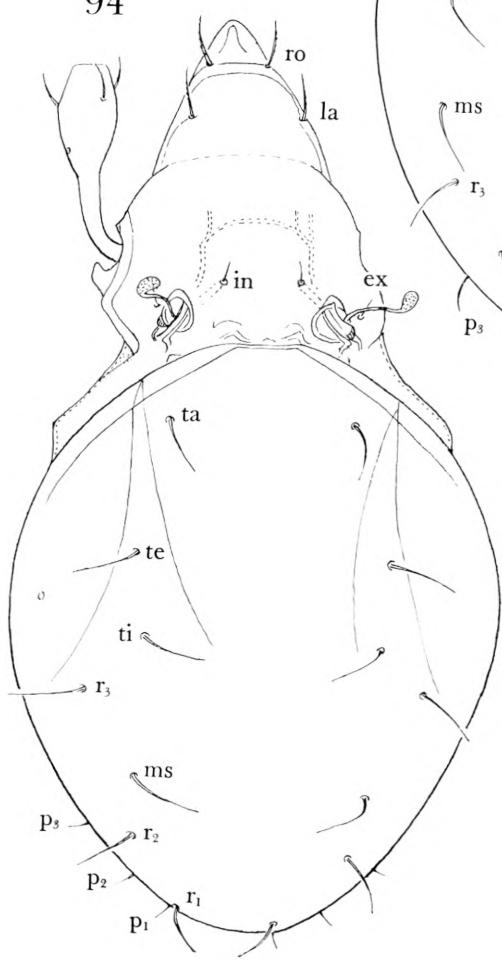
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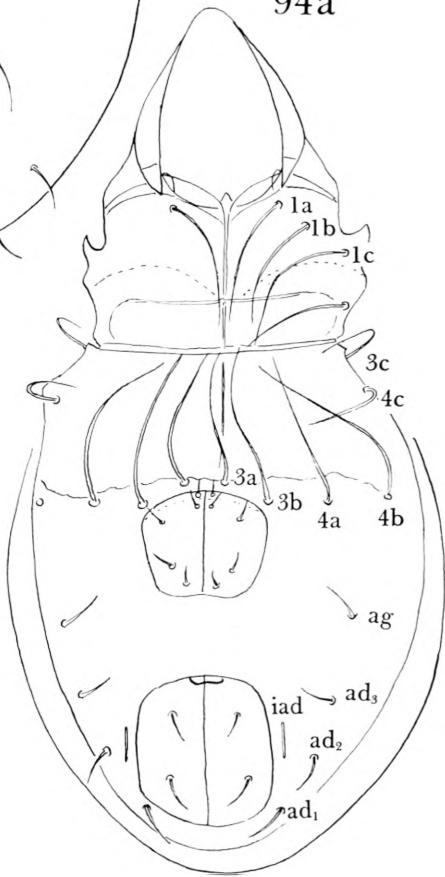
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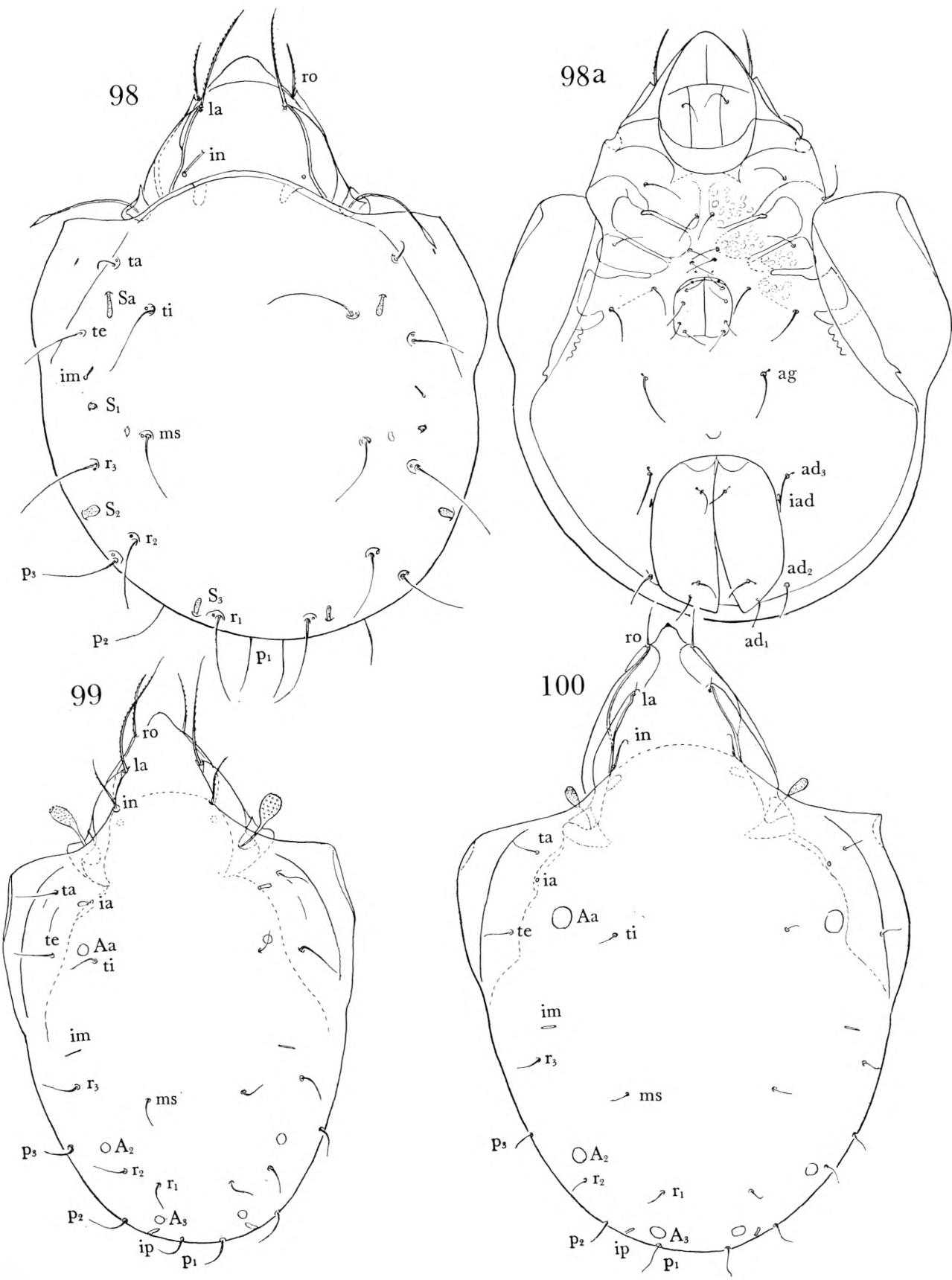
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TYGE W. BÖCHER & OLE B. LYSHEDE

# ANATOMICAL STUDIES IN XEROPHYTIC APOPHYLLOUS PLANTS

## I. MONTTEA APHYLLA, BULNESIA RETAMA AND BREDEMAYERA COLLETIOIDES

Det Kongelige Danske Videnskabernes Selskab  
Biologiske Skrifter **16**, 3



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### Synopsis

Three xerophytic leafless shrubs from the Monte region of Western Argentina were studied anatomically, the idea being to compare the internal structures of different plants belonging to the same life-form. The three species, viz. *Monttea aphylla* (*Scrophulariaceae*), *Bulnesia retama* (*Zygophyllaceae*) and *Bredemeyera colletioides* (*Polygalaceae*) are referred to the terete apophylls. Anatomically the three species have some interesting common features: the lack of fibre strands, leaf traces and other vascular bundles in the cortex, the development of a many-layered palisade tissue in the cortex and a sinking down of the stomata in deep pits or pitchers. Two of the species develop a multiple epiderm while one, *Monttea aphylla*, produces a very thick cuticular coating, which represents a special type of cuticular layer, characterized by vesicles of fatty substances secreted by the epiderm cells and limited by dome-shaped lamellae containing cellulose. The cuticular coating in *Monttea* has been studied in more detail, as have the stomatal pitchers in *Bredemeyera*. Wax plays an important part in the cuticular layers in both species; in *Bredemeyera* the narrow entrances to the pitcher cavities are densely covered by hair-like wax figures. In this species the front cavities are partly covered by a thin diaphragm which is formed as a continuation of the outer ledges. Thus, there are here two cavities with narrow openings outside the stomatal apertures.

## 1. Introduction

Xerophytic apophyllous plants with assimilatory stems constitute a life-form which seems to occur mainly in subtropical subdesert shrublands but extends to areas with macchia. The main idea of the present investigation is to undertake an anatomical analysis of members belonging to this life-form class. Life-forms represent final stages of convergent evolutionary lines. In many different families broom-like, "apophyllous" species have evolved. In this first contribution three species from the families *Scrophulariaceae*, *Zygophyllaceae* and *Polygalaceae* are described. They are undoubtedly secondary stem-photosynthetic species, descendants of foliate ones. While *Bulnesia retama* carries small foliate leaves on young shoots the two other species have only scale leaves. They represent therefore the final stage in the evolution from foliate plants.

RAUNKLÆR (1916, 1934) treated leaf size classes as biological types or life-forms. He regarded the diminution in leaf size (the evaporating surface) as an important adaptation to increasing drought. He operated with six classes from "Megaphylls" to "Leptophylls". Although stem assimilatory leafless plants are not mentioned by RAUNKLÆR, they represent the very extreme in his series and might be called "Apophylls". Apophylls are not stem-succulents, but many transitions between such succulents and apophylls exist, thus e.g. *Anabasis articulata* (cp. FAHN & NINA DEMBO 1964).

As pointed out in an earlier paper (1963) life-forms are initiated by ecotypes, the ecotype being a heritable common morphological-physiological response of several species to the same environment. Ecotypes and life-forms have mostly been studied morphologically only; but the significance of their structural pattern can only be fully understood by anatomical and eco-physiological investigations. In the case of apophylls several questions arise, some of the most obvious being the following:

To what extent is the transition from foliate to apophyllous habit followed by a convergent evolution of anatomical characters and what kind of taxonomic characters (family-characters etc) are able to survive or influence a convergent evolution which tends to wipe out most vegetative or non-floral differences? If apophyllous non-succulent plants represent an ultimate or perhaps most advanced step of adaptation towards deficiency of moisture, they ought to show a higher degree of xeromorphy than other plants. Hence we may ask: Are such features, which usually are looked upon as xeromorphic, exaggerated in apophyllous species?



Fig. 1. *Bulnesia retama* (Zygophyllaceae) in gravelly desert east of the Andes north of Mendoza. The white area in the background is a dried up salty clay flat which sometimes receives water from a river rising in the high mountains. — T.W.B. phot. Jan. 1st, 1956.

#### Acknowledgements

The present study was planned and material collected by the senior author during an expedition to the arid areas of Western Argentina in 1955–56. This expedition was made possible by grants from the Fundacion Williams in Buenos Aires and the Danish State Science Foundation. The authors are indebted to Mag. scient. Ole Mattsson for much valuable advice during the microscopical work.

#### 2. *Monttea aphylla* (Miers) Benth. & Hook.

**Material:** Prov. Mendoza, San Rafael, circ. 2 km south of the town, Altitude 900 m, near Ruta 144 (Böcher, Hjerting & Rahn No. 1125). — Prov. Neuquén, 12 km south of Buta Ranquil, near Ruta 4 (Böcher, Hjerting & Rahn No. 1561).

*Monttea aphylla* (Scrophulariaceae) is a tall shrub which can reach a height of 3–4 m and trunk-diameters of 10 cm. The branchlets end in thorns. Small leaves are found on young stems; they are shed very early. The species is distributed in the western provinces of Argentina between Tucuman (Tafi) and Rio Negro (Valcheta). According to CABRERA (1961) it is characteristic of the phytogeographical province called “Monte” (cp. MORELLO 1958).

### Leaf anatomy

The leaves are very small; only a single leaf was available. In cross sections it was rhomboid but somewhat flattened and clearly isolateral, although rows of palisade cells radiated to all sides from the central vascular bundles. The epidermal cells had thick walls and the stomata were raised a little above the other cells. The cuticular layer was not particularly thick (see Plate VIII b) except at the leaf margins where a thick layer was formed. It is interesting to find that the character of producing a very thick cuticular layer is deeply rooted in the stems only, which are longliving and must be able to withstand very dry climatic conditions.

### Stem anatomy

#### Epidermis

In contrast to the two following species the epidermis remains one-layered. In young stems the cells are, apart from the enormous cuticular layer, almost isodiametric and the outer walls convex (Plate VIII a), but later they enlarge tangentially and the outer non-cutinized walls become concave. The inner periclinal wall and the anticlinal ones are thick. The outer periclinal wall is usually thin and covered by a cuticle and a cuticular layer of quite unusual dimensions and properties. CABRERA (1961), who rightly states that the stem in *Monttea aphylla* is very conspicuous from an ecological point of view because of this very thick layer, uses the word cuticle for it, but in *Monttea* there is a thin normal cuticle and below, a thick coating which, although deviating in many characters, must be regarded as a special type of cuticular layers.

#### Cuticula

The cuticular layer is always bounded by a thin cuticle. The cuticle is continuous but may be broken if fissures are formed in the cuticular layer beneath. Its surface can be nearly smooth, but frequently it covers a system of folds and grooves (Plate VII a). It stains yellow with iodine-zinc chloride and in many cases shows a weak birefringence (Plate IV c). It fluoresces with a golden yellow shine.

#### Cuticular Layer

Immediately below the cuticle there is a very thin layer which resembles the layer rich in pectin described in epidermis cells of *Aloë* by FRITZ (1935: 723). It appears dark in polarized light (Plate IVc) but may show up when observed with phase contrast (Plate IVb). In material treated with ruthenium-red it stains red and with periodic acid-Schiff reagent (PAS) it appears to be very slightly salmon-coloured.

Inside this very thin and homogeneous looking outer layer follows the main part of the cuticular layer. Its thickness increases considerably with the age and size of the branchlet. In very young parts it is 20–25  $\mu$  (Plate VIII a), later in about one-

year-old branchlets it is  $50\ \mu$  (Plate VIIId) and finally it reaches  $140\text{--}180\ \mu$  in older branchlets (Plate Ic and Fig. 4a). CABRERA measured a breadth of  $140\ \mu$  in three-year-old branchlets.

#### Chemical properties

With Sudan IV the whole layer stains intensively red. Nile-blue gives a blue colour only. Chlor-zink-iodine stains the outer part yellow, the inner part very pale yellow.

Using Johansen's quadruple staining the inner part remains almost unstained while the outer part becomes purplish (Fig. 2b, Plate Ia–b). With this staining procedure which includes tertiary butyl alcohol the layer as a whole shrinks to about two thirds and a number of lamellae appear (Plate Ia). Very frequently the weakly stained parts resemble vesicles arising from a group of epidermal cells (Plate IIIb, Fig. 6b). Hot alcoholic alkali ( $5\%$  and  $12\%$  KOH) dissolve the cuticular layer. Treatment with Sudan IV with NaOH leads to a strong shrinkage (Plate VIIc).  $4\%$  NaOH (after pretreatment with ammonium oxalate) affects the layer strongly and reduces it to about half its thickness and,  $17\%$  NaOH dissolves the layer completely. The cuticle and cutinized parts of the guard cell walls and those of the subsidiary cells (see later) also disappear after treatment with alcoholic alkali.

These chemical data suggest that the main part of the cuticular layer consists of substances of lipid character, e.g. cutin and wax.

The above-mentioned vesicles or bubbles in the inner part of the layer were examined for carbohydrate contents. Ruthenium-red stains the limiting membranes of the vesicles red in rare cases only, but they were heavily stained by methylene blue (Plate VIb). With periodic acid-Schiff (PAS) the membranes of the vesicles were clearly stained (Plate IIc–d). This shows that thin dome-shaped carbohydrate lamellae enclose the contents of the vesicles.

The chemical composition was further investigated by following the extraction procedure of cell wall components worked out by JENSEN (1962). After the extractions with ammonium oxalate and/or NaOH the material was stained with PAS, Sudan IV or Nile-blue.

The treatment with ammonium oxalate alone had no or a very limited effect as no shrinking was observed. This suggests that the cuticular-layer apart from the above-mentioned thin external membrane does not contain pectin. The same result is obtained with ruthenium-red. This dye stains the middle lamellae in the epidermis, cortex and the stele intensively red but leaves the major part of the cuticular layer unstained. As already mentioned, however, pectin was present in some of the dome-shaped vesicle membranes.

When the slides, after the extraction with ammonium oxalate, were treated with  $4\%$  NaOH the result was a great shrinkage, a dissolution of some of the components along  $\pm$  cylindrical corrosion cavities and greater distinctness of the vesicles (Plate VI). The tubular cavities are orientated perpendicular to the surface of the outer wall

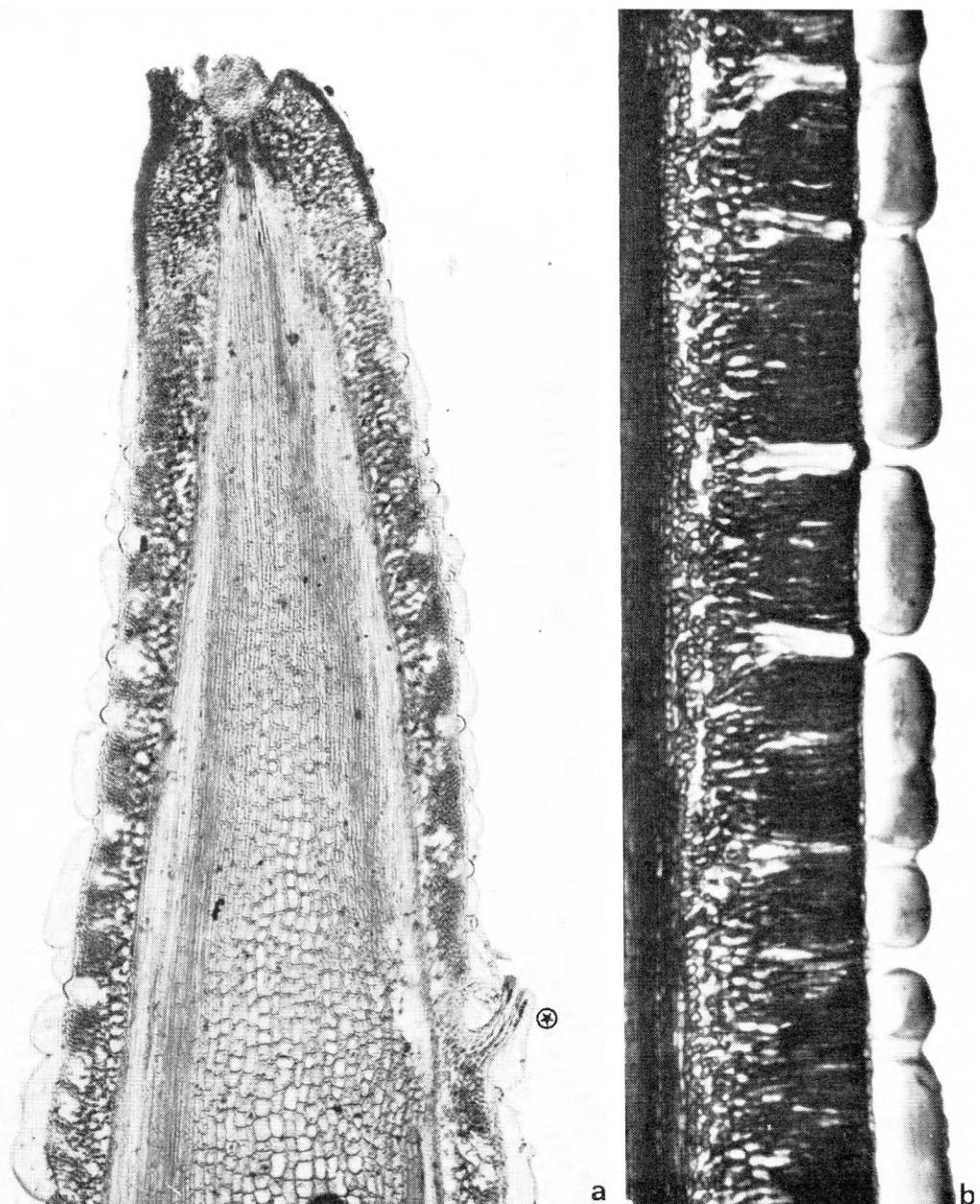


Fig. 2. *Monttea aphylla*. A longitudinal section through young stem terminating in thorn and bud-like structure, which probably is a hydathode. Dark colour on cells which sclerify. At asterisk is a rudimentary leaf.  $\times 64$ . — b. Longitudinal section of branchlet showing thick cuticular coating, palisade layers and spongy parenchyma in cortex; several stomata and substomatal air spaces.  $\times 100$ .

from which they arise. Only very rarely do they reach the outer surface. They develop mainly outside the anticlinal walls and preferably in the basal parts of the membranes of the dome-shaped vesicles, but sometimes the corrosion takes place in all parts of such a membrane (Plate VI d). By using phase contrast the cavities appear to be much more numerous and some of them clearly distend in the abaxial part (Plate VI d-e). The most important fact is that all have the same orientation which is perpendicular to the surface and that they show that  $\pm$  pillarshaped parts of the cuticular layer are less resistant and are dissolved by 4% NaOH. It is difficult to interpret these results. If hemicelluloses were present they would probably be dissolved by 4% NaOH. However, the great shrinkage must be due to the disappearance of substances which are more abundant, viz. some of lipid character. Two different processes seem to take place simultaneously; a dissolution of less resistant carbo-hydrates (e.g. hemicelluloses, slimy substances) and a beginning decomposition of the fatty substances.

By addition of cuoxam (Schweitzer's reagent) the limiting vesicle membranes are dissolved. A comparison of untreated material stained with PAS and material treated with cuoxam shows that cuoxam unveils many more vesicle borders. This means that the amount of carbohydrates changes from one vesicle to another and that it is only immediately above the epidermis cells that the vesicles contain carbohydrates in such densities that they can be demonstrated with PAS. As a rule the carbohydrate lamellae, when the vesicles grow, are stretched considerably; finally they become invisible. A rare case is shown in Plate II d. Here the margin of a vesicle which had almost reached the upper surface was stained with PAS.

After treatment with ammonium oxalate succeeded by 4% NaOH the whole cuticular layer was often loosened. This is probably due to a complete dissolution of the pectin layer which occurs in the outer wall beneath the cuticular layer. A layer of this kind was already found by FRITZ (1935) and several workers later.

In *Monttea* a continuous layer of pectin, however, seems only to be present in epiderms, where the production of new material to the cuticular layer is small or has stopped. In young stems there is usually a pectin layer except outside the anticlinal walls. This fact explains why the cuticular layer is not loosened after extraction with ammonium oxalate only.

#### Physical properties

In the fluorescence microscope the cuticular layer appeared dark. Some areas, however, had a light bluish fluorescence suggesting the presence of wax. By adding acridine orange the walls in the epidermis, cortex and stele shone reddish. There was no trace of such a reddish fluorescence in the cuticular layer after this treatment.

Very instructive pictures were obtained by using the polarizing microscope. Observations were made on (1) slides produced from herbarium material and mounted in glycerol, (2) slides produced from alcohol material and mounted in

glycerol, (3) slides stained with PAS, Lightgreen-Safranin or Johansen's quadruple stain, all treated with xylene before mounting in canada balsam.

(1) In the slides originating from the herbarium material the whole cuticular layer was birefringent. Whole vesicles showed up brightly and had crossing black extinction lines (cp. Plate IIIa). On heating most of the birefringence disappeared and returned on cooling. Outside the anticlinal walls, however, pairs of brightly shining lines perpendicular to the surface persisted. In slides which were treated with cuoxam these lines disappeared while the generally distributed light persisted. Using the Red I plate the lines always had the opposite colour to most of the light which came from the rest of the layer. Very often there was a change in colour along a periclinal, somewhat undulating, line through the layer. When the inner part and the perpendicular lines were blue, the outer part was orange. In many cases there were areas mainly with blue lines along the outer cell walls and roundish orange areas in the exterior part of the cuticular layer corresponding to outer parts of vesicles.

(2) Slides made from branches fixed' and kept in 70% alcohol for 10 years had almost the same qualities although the general birefringence was clearly less bright.

(3) In slides which, during preparation were treated with xylene, the birefringence was usually restricted to the lines off the anticlinal walls (Plate IIIc, IVa). However, very locally, clearly birefringent areas had survived and sometimes the whole cuticular layer appeared to be slightly shining (Plate IVc).

From this the following conclusions may be drawn: The lines outside the anticlinal walls must be due to cellulose micells while the more extensive birefringence is caused by wax. The fact that some birefringence persisted after heating or after treatment with strong alcohol and xylene may perhaps be ascribed to wax which is adsorbed to cutin (cp. ROELOFSEN 1959: 265). It is impossible to estimate the amounts of cutin and wax, but the wax component is undoubtedly a prominent one.

In many cases there are two shining lines outside each of the anticlinal walls (Plate IVc) or one broader line which divides below into two thin ones. Obviously each cell produces a dome-shaped vesicle with cellulose arranged in the limiting lamellae or membrane and membranes from two adjacent cells may remain separate or merge. The lines taper towards the periphery, but at the same time they branch or split up into a number of very delicate shining lines. This splitting up is due to the stretching of the vesicles which are filled up with substances of lipid character. The beginning of this process can be studied in small (young or slowly enlarging) dome-shaped membranes, where the cellulose is stained with PAS. Near the anticlinal walls such domes appear rather compact although sometimes clearly lamellated, but their distal parts, which correspond to the middle parts of the original outer cell walls, are expanded and here the membrane shows a fine network of stained fibrillae (cp. Plate IIc). It is usually the middle parts of the enclosing lamellae which during the expansion are split up and appear to burst, but sometimes the stretching primarily affects the marginal parts, resulting in a displacement of small cellulose caps to the outermost part of the cuticular layer (Plate II d, IIIa arrow).

The question is, what happens to the cellulose and possible hemicelluloses which from time to time are pushed out towards the periphery. It was sometimes possible to detect some slightly birefringent pairs of lines near the surface, they were independent of the bright lines near the epidermal cells but had probably the same origin being remains of old vesicle membranes. This seems to show that with increasing distance from the cell surface the cellulose is obscured, being perhaps more and more enveloped by cutin. At the same time, however, hemicelluloses or pectin which are probably placed together with the cellulose may be decomposed. If products of such hydrolyses reached the surface through fissures in the cuticle the common occurrence of colonies of fungal cells on the surface would be more comprehensible (cp. p. 15 and Fig. 6 a).

As the production of new carbohydrate lamellae takes place with certain intervals, the matrix inside the lamellae will also be formed intermittently. Even when no limiting cellulose is detectable the matrix seems to be deposited in  $\pm$  cubical or more irregular and elongated entities which have almost the same breadth as the epidermal cells beneath. This is particularly easy to see with phase contrast.

According to the chemical and physical properties of the cuticular layer previously referred to the matrix probably has lipid character and may consist of procutin and wax. Immediately outside the outer periclinal cell walls the Sudan IV reaction is as strong as at some distance from the wall. On the other hand, with the quadruple stain, the dark purplish colour indicating fatty substances only occurs in the outer area. With this method the major part of the wax is removed. The lighter area in the inner part of the cuticular layer (e.g. Plate I a, b and Fig. 2 b) may therefore contain less cutin, but possibly procutin.

That substances of lipid nature are formed as a matrix between lamellae which consist of carbohydrates is illustrated by Fig. 3c-d. In Fig. 3c the majority of an epidermis cell is filled with a substance which stains red with Sudan IV as the cuticular layer above. In Fig. 3d a small part of another cell behaves in the same way. In both cases the areas which stain in the same way as the cuticular layer are limited towards the layer and towards the living part of the cell by firm cell walls. For some reason the cells in question stopped or slowed down the production of material for the cuticular layer. Hence, the outer membrane did not bulge and split up but remained firm or returned to a firm stage and developed into a wall. The inner membrane also developed into a wall, which now limits the cell from the cuticular island.

The formation of the thick cuticular layer in *Monttea aphylla* has the character of a secretion. In the young epidermis almost all cells are involved except the guard cells (Plate VIII a, c, d), and perhaps the subsidiary cells. The cells adjacent to the guard cells in young branchlets are less active and in older branchlets there are 3-4 cells on each side of the stomatal pore which do not have a thick cuticular coating (Plate VIII e, f). As a result of this differential activity in the epidermis, the stomata and the surrounding cells will be placed in the bottom of cavities formed by the thick cuticular coating produced by the other epidermal cells.

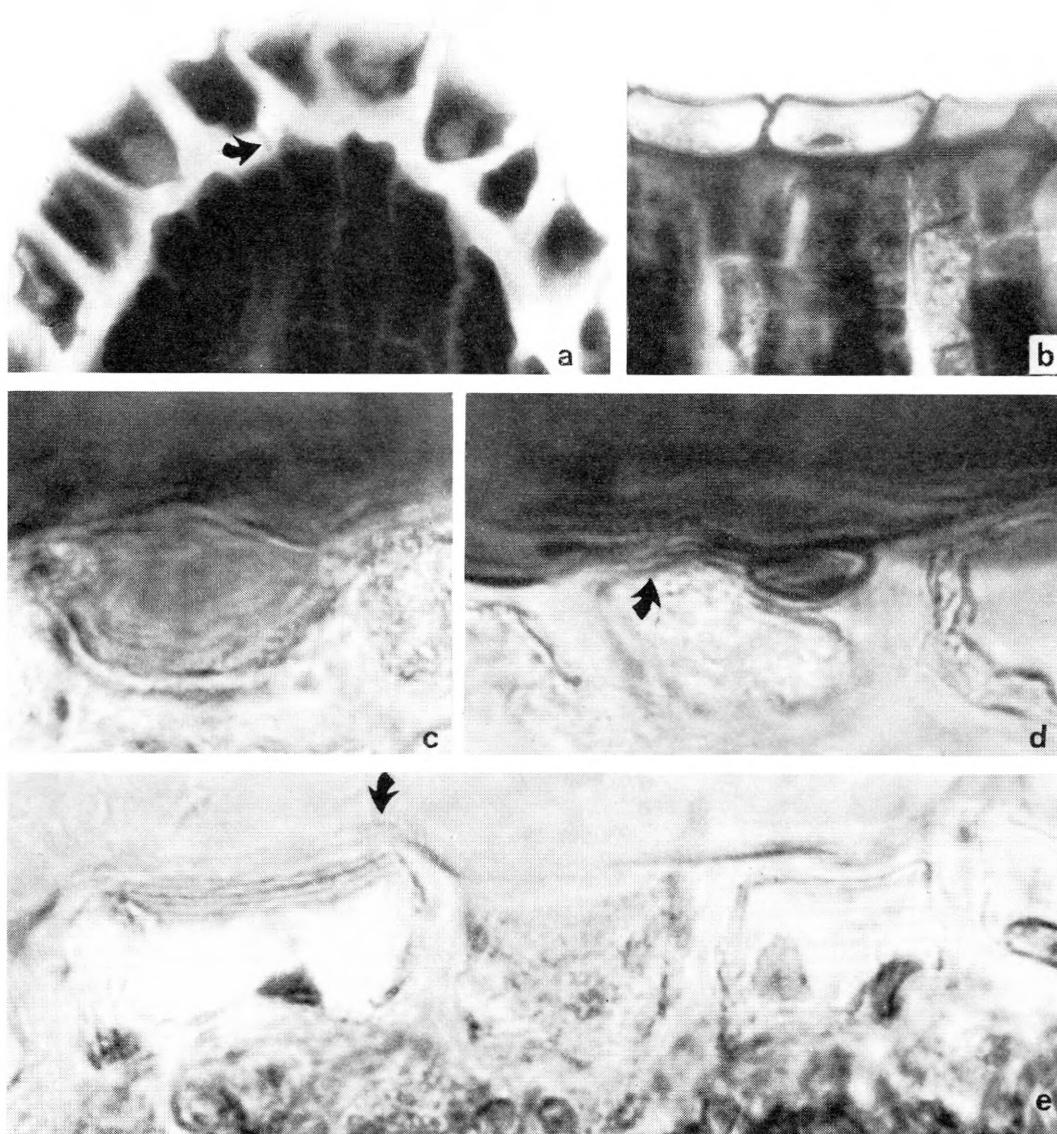


Fig. 3. *Monttea aphylla*. a. Young very active epidermal cells forming a ridge. The non-cutinized outer walls hardly visible, but a few thin lamellae. At the arrow is a wide primordial pit through the inner wall.  $\times 1376$ . — b. Older, not very active epiderm cells showing complete non-cutinized outer walls and the grooves outside the anticlinal walls.  $\times 800$ .

c-d. Insular areas of epiderm cells filled with matrix which is stained with Sudan IV. In c a major part, in d a minor part of the original cell was demarcated by walls towards the rest of the cell and towards the cuticular layer. At the arrow where the outer cell wall is very thin a number of short lines issuing from the surface.  $\times 1950$ .

e. Part of epiderm showing cells at different stages and degree of secretory activity. From the left: Cell with six lamellae in outerwall (two nuclei), cell where outer wall is nearly decomposed, a single lamella can be traced, cell with two nuclei and solid outer wall. At arrow delicate short lines perpendicular to the surface. Nile blue staining of cuticular coating.  $\times 1950$ .

In young branchlets the secreting activity of the epidermal cells is reflected in the shape and behaviour of the non-cutinized part of the outer walls. In such branchlets the areas between stomatal cavities bulge and form ridges (Fig. 3a and Plate VIII d) which are later smoothed out. With increasing distance from the cavities the cuticular coating becomes thicker and at the same time the epidermal cells undergo considerable changes: The outer walls become blurred and seem to disappear, at the same time the cytoplasma appears to bulge inwards (Fig. 3a). The cells look as if they were surrounded on three sides by thick walls, whereas the outer wall was replaced by the enormous cuticular layer common to all the cells. The anticlinal walls seem to be projected in the cuticular layer and fork (Plate VIII d, arrow), but this forking is merely due to the fact that those parts of the outer walls which border the anticlinal ones are often maintained whereas the middle parts are more or less decomposed.

By adding ruthenium-red it became evident that the thick inner periclinal and the anticlinal walls stained intensively red. Non-decomposed parts of the outer walls were also stained (Plate III f). However, using high magnification and phase contrast it is possible to trace some kind of wall substance in the middle parts. In many cells a very thin translucent lamella was seen bridging the gap between areas with firm wall substance (Plate III e, f). Sometimes there was clearly a number of thin lamellae (Fig. 3e). In other cases the translucent lamella appeared to be traversed by very delicate pores and in oblique views it seemed to be densely perforated. Some pictures lead to the assumption that the openings were like small protruding tubes or that perhaps some material passed through (see e.g. Fig. 3d and e at arrows, Plate II e, f).

According to our observations it seems possible to distinguish between three steps in structure which correspond to three grades in excretory activity.

- (1) Low activity. External wall distinct, occasional occurrence of delicate pores.
- (2) Medium activity. Middle part of external wall indistinct, sometimes present as a very thin translucent lamella with numerous delicate pores.
- (3) High activity. Majority of external wall decomposed, split up into a network of cellulose fibrillae.

In this connection some granular structures deserve to be mentioned. In phase contrast many small dark granules occur in two ways. They may either follow the boundaries of the vesicles (Plate Va), or they occupy areas off the anticlinal walls (Plate Vb). Near these walls they run perpendicular to the surface but when they approach the outer part of the coating they usually spread out as in a fountain. In slides mounted in water some larger translucent granules had the same positions (Plate III f). Although the origin of these granules is obscure it seems obvious that they represent particles which are placed on the surface of enlarging dome-shaped vesicles; if such vesicles do not merge, we get the linear arrangement and the "fountains" of granules near the surface. A possibility which cannot be excluded is

that the granules are small remnants of the decomposed outer walls which in this way glide aside when the vesicles grow. However, they are not birefringent and thus hardly composed of cellulose.

Evidently older branches have less active epidermal cells. But the cells are never at the same stage. Particularly active cells are found inserted between some in which the excretion is probably slowed down to a minimum or has stopped. In Plate II a, b the middle cells are probably actively producing a number of thin lamellae. Less active cells possess outer walls with a characteristic shape. Outside the anticinal walls there is usually a groove (Fig. 3 b). Sometimes, however, this groove is bordered by ridges. Each cell may bear a ridge of wall substance along the groove, which is cut twice into transverse sections (Plate II b). In polarized light the shining lines radiate from the corners along the grooves or the ridges. The domeshaped cellulose lamellae all issue from the corners of the ridges (Plate II d). The ridges, therefore, are interpreted as basal parts of a number of domes the upper part of which during expansion of the encircled matrix were distended, split up and burst.

#### *Stomatal apparatus*

The surface of the thick cuticular layer is not smooth. A system of very low grooves gives the surface a labyrinthic or network-like appearance. The entrances of the cuticular cavities around the stomata are elliptic (Plate VII a). By lower focussing these cavities in some cases become narrower and longer, but often they enlarge and elongate (Plate VII a, b on the right). The walls of the cuticular cavities are delicately striated (Plate VII b). Usually each of them at the bottom contains one stoma only, but not infrequently two stomata occur (Fig. 4 a).

The guard cells have their longitudinal axes parallel to the axis of the stem (Fig. 2), but the major axis of the elliptic entrances is perpendicular to the axis of the stem (Plate VII a). The stomatal apparatus, as a whole, is raised above the surface of the non-cutinized outer walls of the neighbouring epidermal cells. This elevation is due to the growth of the subsidiary cells which turn outwards (Plate VIII e, f). The bending takes place in three small cells following after the cells which are adjacent to the guard cells. In older stems none of these cells take part in the production of the thick cuticular layer. Sometimes this cessation may be infectious so that even some more adjacent cells stop or slow down production. The thick surrounding layer may in such cases form a roof which covers an expanded part of the cavities containing stomatal openings. The subsidiary cells next to the guard cells attain a dark blue-violet colour in slides treated with Johansen's quadruple stain. The other epidermal cells remain green (cp. Plate I b).

As in *Bredemeyera colletioides* (p. 30) the outer ledges are very conspicuous. They form an arched roof over the big stomatal front cavity, only leaving a narrow fissure open. By closure of the stomatal pore the two ledges approach one another very much. The walls of the front cavity are covered by the cuticle and are cutinized.

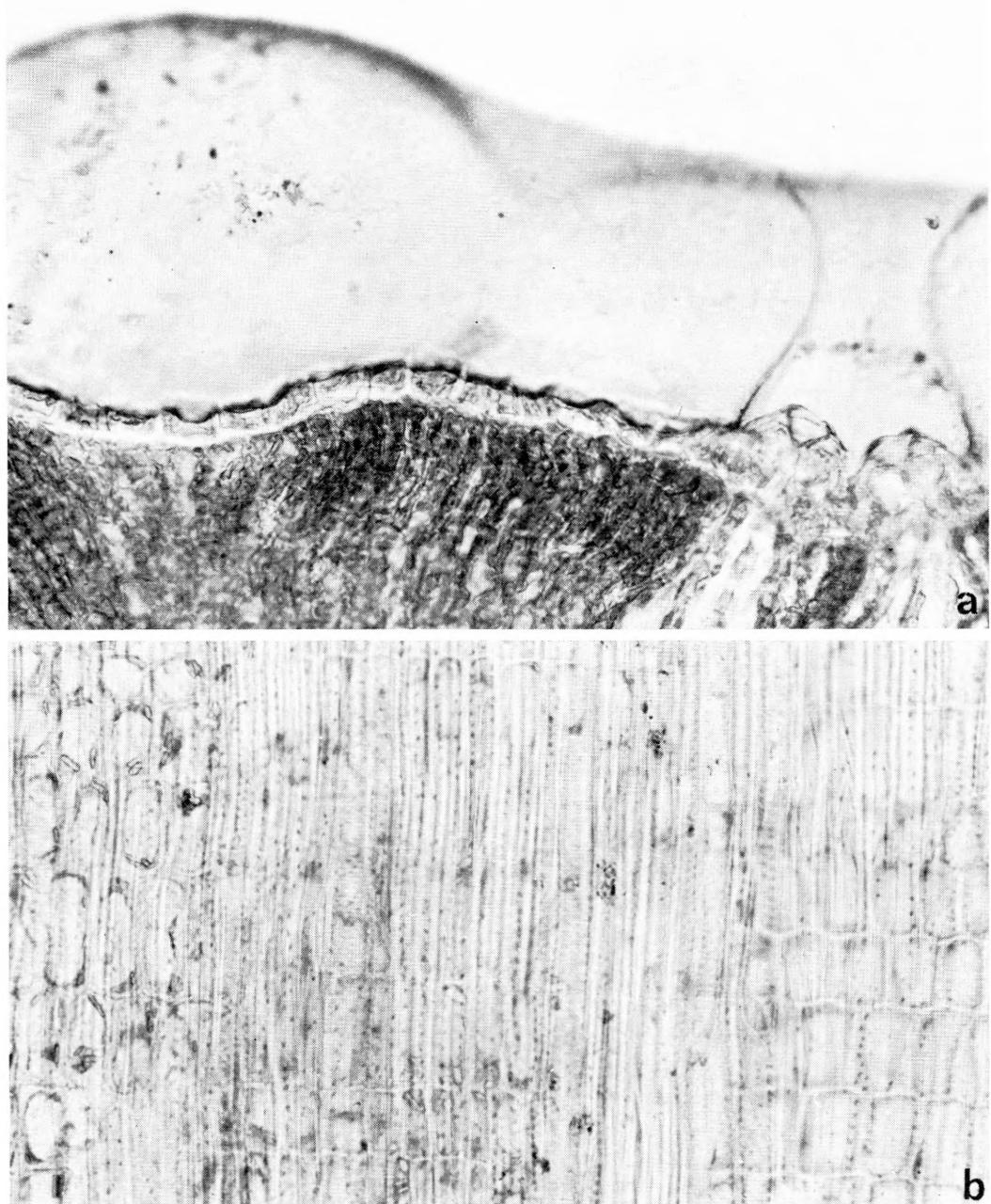


Fig. 4. *Monttea aphylla*. a. Cross section of epiderm and outer part of palisade tissue in cortex. Note two stomata in one cavity in the thick cuticular coating. — b. Radial section through wood, showing high ray cells, on the left with crystals.  $\times 320$ .

The same is the case with the walls which form the outer limitation of the substomatal air chambers, except in the areas just inside the pore where the inner walls of the guard cells are particularly thick (Plate VIII f). The same wall areas which are stained with Sudan IV, however, also stain weakly with Safranin and may therefore also contain lignin. Wax is present in the cutinized outer walls of all subsidiary cells and the guard cells apart from the outer ledges. These walls show very bright birefringence while there is no double refraction in the walls of the front cavity and the substomatal air chamber.

After treatment with hot alcoholic alkali the guard cells lose wax, cutin and pectic substances. This causes a complete change in their appearance. The rather thick outer wall shrinks so much that only a thin wall of cellulose is left, forming part of an arc of a circle and terminating towards the aperture with a very small tip which is the only thing left of the outer ledge. Also the projecting wall areas where the guard cells are closest together (cp. Plate VIII) disappear, with the exception of one lamella bordering the cell lumen and one near the aperture. The best preserved wall sections are those between the cell lumina and the substomatal chamber. Here the thick wall contains a number of cellulose lamellae which by using phase contrast and high magnification stand out very clearly, the pictures reminiscent of those found by means of the electron microscope (cp. ROELOFSEN 1959: 243–244). Obviously the guard cells of *Monttea* contain very much of pectic substances, this especially applies to the inner walls, which by using the quadruple stain attain a dark violet colour (Plate I b, III d). Whether the above-mentioned collapse of the outer walls in the guard cells of *Monttea* is connected with the existence of many small lacunae is doubtful. Such cavities were found near the outer ledges in *Helleborus* by HUBER et al. (1956).

The outer and inner thick walls of the guard cells increase their thickness as they grow older. The increase in thickness may be about  $5\ \mu$  or  $20\%$ .

In most parts of the material which after collecting in nature was fixed in alcohol, the cuticular cavities and sometimes even the stomatal front cavities were infected by an imperfect fungus with brownish cells (Fig. 6 a). It occupied the entrances and sometimes single cells in the front cavities acted as a kind of plug (Plate I c). Such fungal plugs probably reduce stomatal transpiration and the fungal cells receive some moisture escaping from the apertures. However, this partnership, in spite, perhaps, of being mutually advantageous, is hardly more than an accidental symbiosis. The fungus was absent from some part of our material thus all the younger branchlets, and no fungal infection was mentioned by CABRERA (1961) and may have been absent from his material.

#### Thorns

The branchlets of *Monttea aphylla* are terete, usually tapering and terminating in a thorn. In Fig. 2 a a beginning sclerification of the tip is seen, at the same time, however, there is a structure on the very tip which probably may serve as a hydathode or water gland. It resembles a bud and may be a transformed terminal bud. The

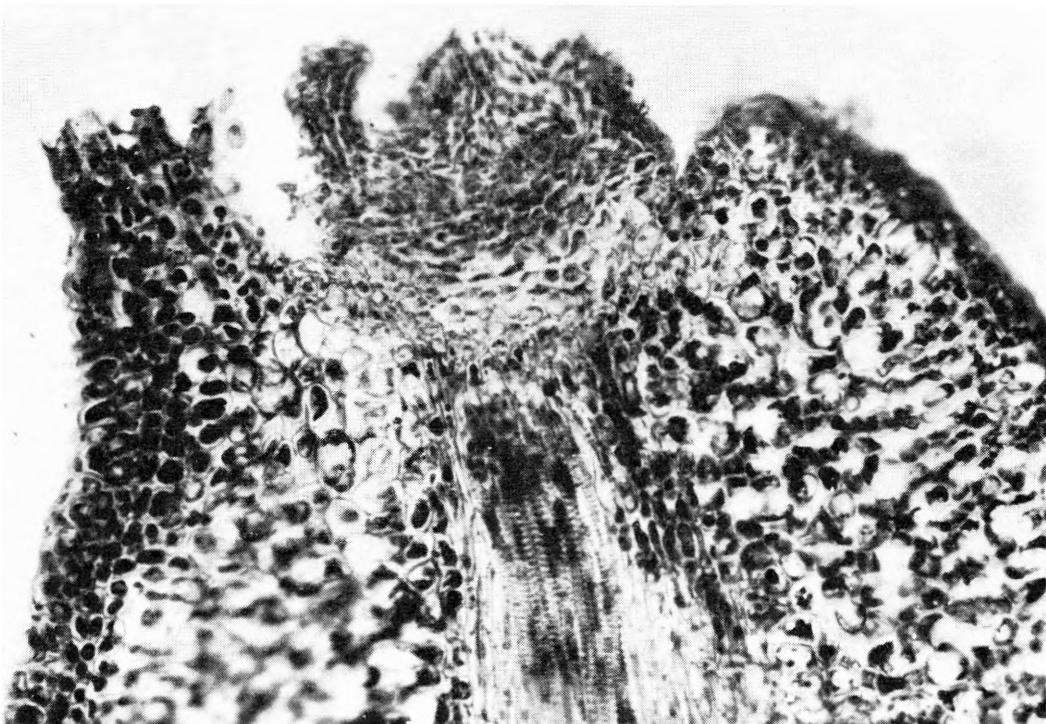


Fig. 5. *Monttea aphylla*. End of thorn showing bud which possibly functions as a hydathode and is supported by a reduced leaf (on the left). On the right the tip of the branch (cp. Fig. 2a). Below the bud a strand of tracheids.  $\times 320$ .

cells are small with unlignified walls and very dense, they may serve as an epithem. A strand of many tracheids ends abruptly just below the small-celled tissue (Fig. 5). If the interpretation is correct we must assume that the function as water gland is restricted to the period of growth of the branchlet. Later the bud-like structure may be shed. In fact most thorns in our material have small circular scars in their tips.

#### Increase of girth

As the branchlet has a secondary growth the tissues in the cortex and the epidermis must adapt themselves to this growth. In the epidermis the cells enlarge tangentially, but also anticlinal divisions occur. Particularly this may be the case outside such areas where the cortex undergoes a dilatation. Here, a fan-shaped arrangement of the rows of palisade cells is common (Figs. 4a, 6b), and many epiderm cells seem actively to take part in the production of the cuticular layer. Another increase in girth is obtained by initiation of periderm areas, which seem to be able to expand rapidly. This type of diameter growth is presumably the most important one in older branches.

### Periderm

The first periderm commonly originates in a similar way as in *Bulnesia retama* (p. 27) as local cork formation resembling a lenticel. In any case only localized phellogen occur which bend inward and soon become rather deeply situated. On the other hand some periderm areas in old branchlets grow very large, the result being a localized rhytidome formation.

The initiation of the phellem areas most frequently takes place in an unusual way. Epidermal cells situated below the thick cuticular layer and often in areas of girth increase, undergo periclinal divisions and initiate a phellogen (Fig. 6a). Next the cuticular layer may break and the phellem expand in the crack (Fig. 7c). During this process the expanding phellem tissues merge with the cuticular layers which surround them and which they penetrate (Fig. 7c, 9b). The first cells which are found in abaxial direction, however, may sometimes at the beginning be living and even contain chloroplasts (Plate Vc). Later such cells die as their walls become suberized and finally they are pushed out by the normal phellem which is formed beneath. In many cases, however, there are no ruptures in the cuticular coating. What happens is a sideways and inward growth of the periderm areas which finally reach the substomatal air chambers and inwards may even reach the phloem. The substomatal spaces may be filled with phellem cells but in some cases it looks as if cells which are perhaps a kind of phelloiderm grow into the substomatal air chambers and other intercellular spaces in the cortex and fill them (Fig. 7a, white arrow). Very often the cuticular coatings outside the phellem are maintained, but at the same time the original narrow cavities are widened as a result of the sideways growth of the periderm, the result being large phellem areas between islands of cuticular substance (Fig. 7a). However, in cases where a large and vigorous periderm is formed the thick cuticular islands scale off or are bent outwards.

Several successive periderms may arise and a rhytidome be formed. Such areas are found in branches the greater part of which are covered by the thick coating. The innermost phellogen arise in the phloem thus cutting off extra xylary fibre cells and sclerified inner cortex cells. Fig. 8 may show a special case. Here the branch apparently has been wounded and the rhytidome accumulation is very strong on both sides of the wound which reaches more than half way into the xylem. Perhaps this case may be explained as a wound periderm formation. However, in some cases the periderm areas seem to crack and no signs of injury of the branch is found.

A vigorous rhytidome accumulation covering large parts of the older branches replaces the transpiring green cortex and may thereby bring about a reduction of the transpiring part of the plant body.

### Cortex

According to CABRERA (1961) the cortical parenchyma is nearly  $100 \mu$  thick in branches which are 2 mm in diameter. It consists of ten layers of cells. The two or

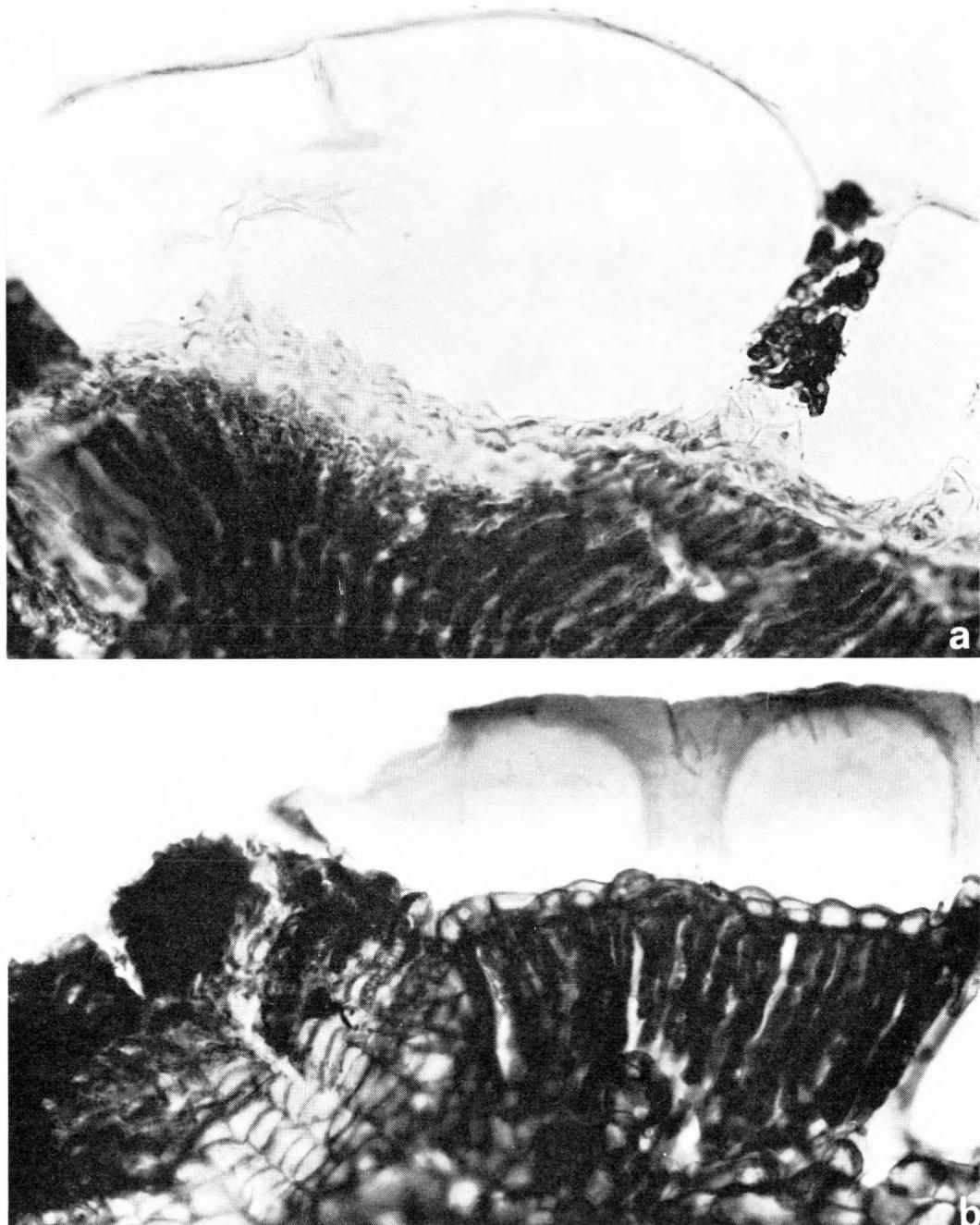


Fig. 6. *Montlea aphylla*. a. Periclinal divisions in epiderm cells initiate phellem formation and cause the cuticular layer to crack. One stomatal cavity in the cuticular layer filled with cells from an imperfect fungus. Fan-shaped arrangement of palisade tissue. — b. A phellem area (on the left) has filled out a crack in the cuticular layer which is found undisturbed side by side with the phellem. Two vesicles clearly shown by lighter colour (quadruple staining).  $\times 320$ .

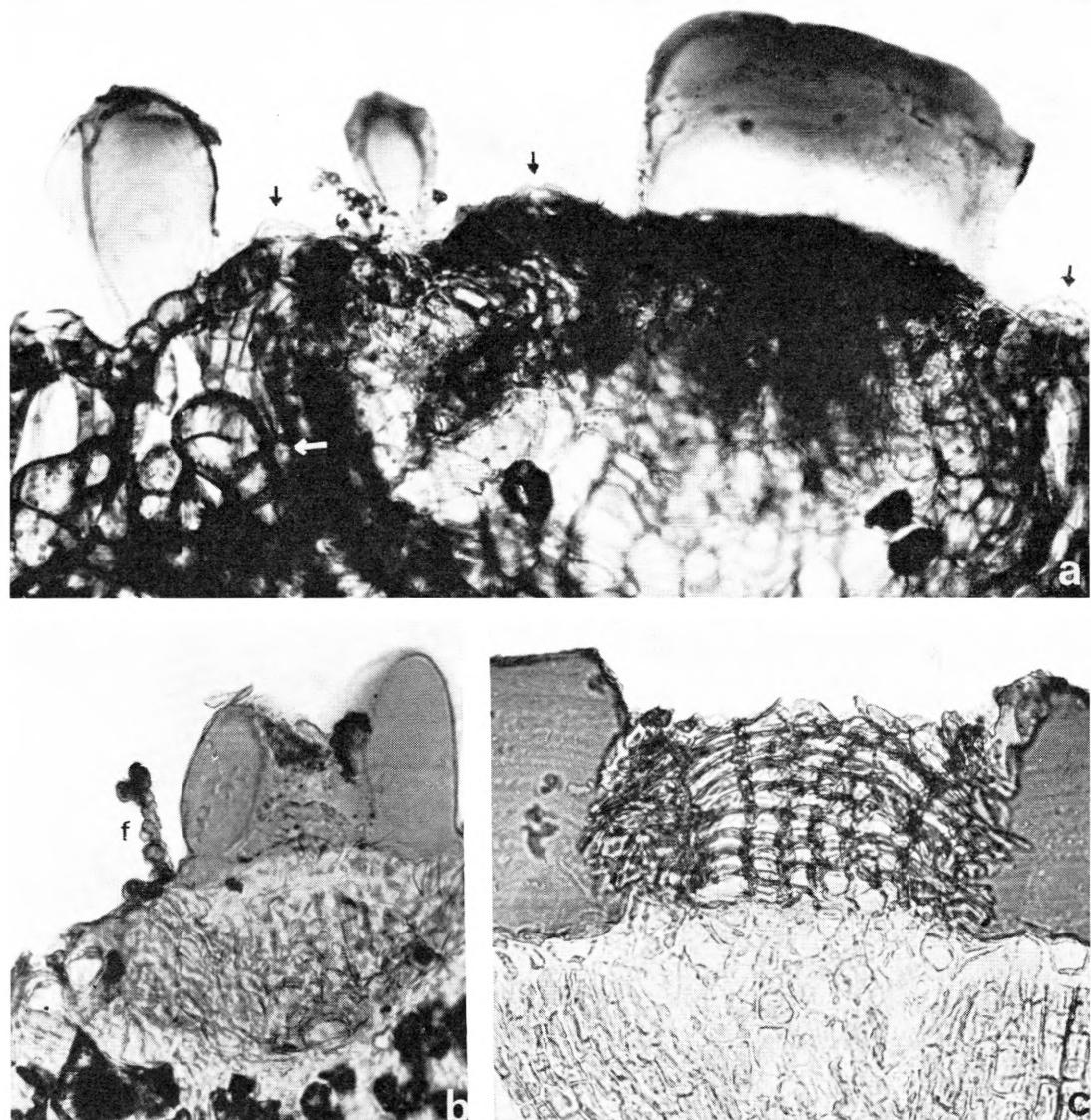


Fig. 7. *Monitea aphylla*. a. Three remaining fragments of cuticular coating separated from one another by developing phellem. Irregular cell masses perhaps phellogen (white arrow) grow into substomatal air chambers, guard cells (on the extreme left) or outer ledges of guard cells are still seen at three points (black arrows). Quadruple staining. — b. Phellem formation beneath cuticular layer. Small row of fungal cells (f) and on the left two guard cells and rest of substomatal chamber (black). Sudan IV. — c. Phellem formation in crack in cuticular coating. Below a kind of phellogen filling space in palisade tissue. Sudan IV stains cuticular layer and phellem.  $\times 320$ .

three external layers have elongated and very compact cells, the internal layers have isodiametric cells with intercellular spaces.

This is in accordance with our observations although in our material it is possible

to follow a development from a young stage where the cortex is 100–150  $\mu$  thick (cp. Fig. 2a) to older stages where a thickness of 250–280  $\mu$  can be measured. This growth is caused by radial cell elongation of the outer layers, which develop into a palisade tissue and an increase in number of cell layers. The internal layers get very wide intercellular spaces and develop into a kind of spongy parenchyma. The cells here contain not so many chloroplasts but they accumulate much more starch than the palisade cells do.

### Stele

The stele has a clear demarcation towards the cortex, a cylindrical belt consisting of 2–5 layers of fibres. CABRERA (1961) mentions that the pericycle has several layers of cells and some bundles of sclerenchymatous fibres and that the phloem is continuous, 60–70  $\mu$  thick. In our material there is mostly a fairly continuous cylinder of fibres. In one-year-old branchlets, however, there are broader interruptions of parenchymatous living cells. In older branchlets such interruptions are usually one cell broad. They form connections between the photosynthetic tissues and the phloem.

The secondary xylem was first studied by CHRISTIANI (1948) who compared *M. aphylla* and *M. schikendantzii*, both West Argentinian species, the latter being taller and foliate. In spite of this he found such great similarities between the structure of the xylem that he was unable to distinguish the wood of the two species clearly enough. However, according to Plate I, Figs. 1–2 in CHRISTIANI's paper the vessels are significantly wider in *M. schikendantzii*, the foliate species. Here the average vessel diameter is 24  $\mu$  (tangential direction) and 31  $\mu$  (radial direction) while in *M. aphylla* the corresponding values according to CHRISTIANI are 20  $\mu$  and 23  $\mu$ .

As appears from the cross section shown in Fig. 8 the wood in *M. aphylla* is very uniform. There are no wide vessels. Growth rings may sometimes be difficult to detect. The difference between late and early wood is usually very small but the wood is locally slightly ring-porous.

The number of xylem rays is great, every third or fourth cell row being a ray. The rays are 1–2(–3) cells broad and often very high. Most of them are primary. CHRISTIANI measured the height expressed in cells to 9–20 (–32–40) but we have occasionally counted about 80 cells. The height of the ray cells is greater than the breadth, those found near the phloem are regularly provided with crystals (Fig. 4b), the same being the case with the cells in the phloem rays. The axial parenchyma is very poorly developed if present at all.

The primary xylem vessels are helical. Those in the secondary xylem have a very delicate spiral striation in their walls. CHRISTIANI found particularly large quantities of small pores. The perforation is simple. The majority of the cells in the areas between the rays are fibres with thick walls.

The pith is broad (Fig. 8). Its cells bordering the xylem have thick lignified walls.



Fig. 8. *Monttea aphylla*. Rhytidome formation with deep crack in the phellem reaching far into the xylem. The undisturbed original surface with cuticular layer, epiderm, cortex with palisade tissue is seen on the left. Xylem without wide vessels.  $\times 64$ .

### 3. *Bulnesia retama* (Gill. & Hook.) Griseb.

Material: a. Prov. San Juan, between Uspallata and Barreal (Böcher, Hjerting & Rahn No. 2228, Fig. 9b), b. Prov. San Juan (Hawkes, Hjerting & Rahn No. 3330), c. Prov. Mendoza 25–30 km north of Mendoza (Böcher, Hjerting & Rahn No. 2100, Fig. 1).

*Bulnesia retama* (Zygophyllaceae) is a 1–3 m tall shrub and a characteristic element in the Monte vegetation of Western Argentina. It is distributed between lat. 27° and 35° south and between parallels 65° and 70°W. According to RECORD & HESS (1943: 555) it sometimes develops into a short and stout tree, which may be about 5–8 m high. The slender branchlets, leafless most of the time, are crowded together in broom-like masses (Fig. 1 and Plate XIX in MORELLO (1958)).

Young plants and branchlets bear compound leaves. These are in the young branchlets very small and with isolateral structure. In the young plants, however, the leaves are larger and dorsiventral. The stems are greyish-green as a result of a covering of unicellular hairs which bend near the base and become upright (Fig. 9a, 12c). In older branchlets the hairs are shed.

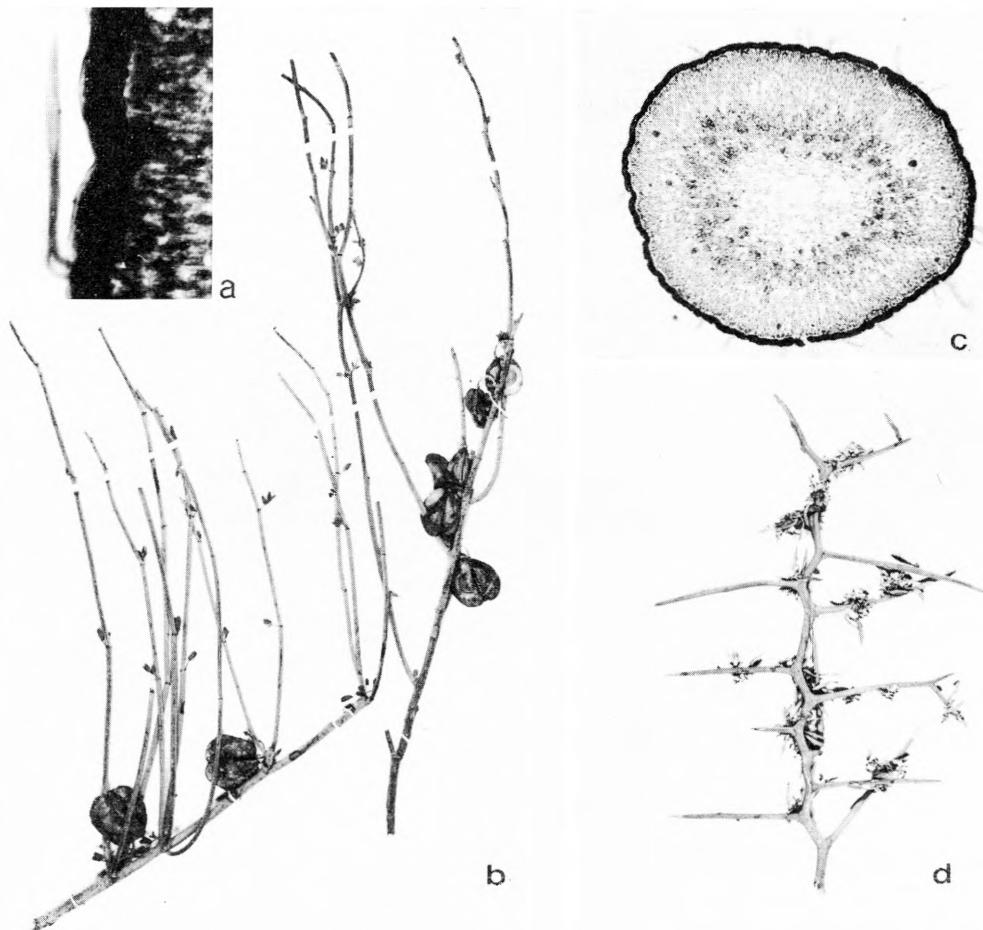


Fig. 9. a-c. *Bulnesia retama*, d. *Bredemeyera colletioides*. a. Hair and dark multiple epiderm. b. Young branchlet with small leaves, flowers and fruits (Böcher, Hjerting, Rahn No. 2100). c. Cross section of young branchlet showing cutinized epiderm (dark) and many non-cutinized hairs. — d. Flowering and fruiting specimen (Böcher, Hjerting & Rahn, No. 2228). a  $\times 100$ , b and d  $\times 1/3$ , c  $\times 50$ .

### Epidermis

The protoderm cells are almost isodiametric and polygonal in surface view. Very early the cells divide, resulting in the formation of a multiple epidermis consisting of an outer layer of radially elongated cells and 1–2 inner layers of shorter cells. The original polygonal cell pattern is outlined in the thick cuticular layer. From paradermal views (Fig. 10b) it appears that each protoderm cell is divided by anticlinal walls into 2–4 outer cells which are radially elongated, and by a periclinal wall cutting off a cell which often is further divided by another periclinal wall, the result being one to two cell layers resembling a hypoderm (Fig. 10c, Plate IXa). In not too young branchlets the cells in these layers are in the process of getting rather thick

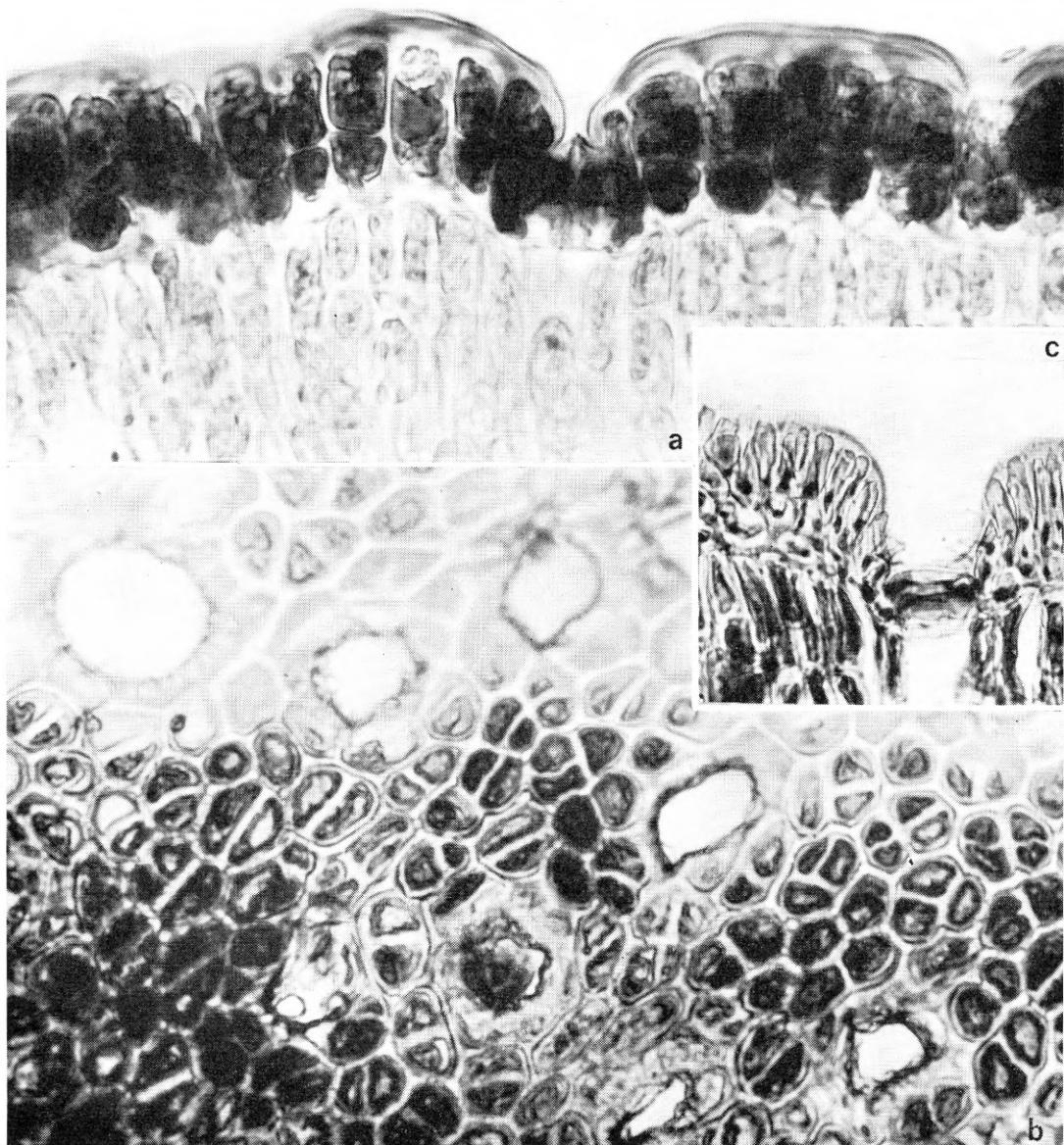


Fig. 10. *Bulnesia retama*. a. Cross section of stem. Young stage in the development of the multiple epiderm, showing periclinal walls and dark substances in the cells. One stomatal pit and one hair-pit, staining with Sudan IV. — b. Paradermal section through cutinized layer (upper part) and epidermal cells (lower part), showing several stomatal pits (roundish holes) and families of two to four cells each group originating from the same protoderm cell. — c. Longitudinal section of mature multiple epiderm in which the outer cells are divided by anticlinal walls resulting in the formation of a palisade-epiderm. a  $\times 625$ , b  $\times 800$ , c  $\times 320$ .

walls. The stomata have sunk below the surface. During the development of the multiple epidermis the stomatal pits get deeper. The cuticle extends half way between the guard cells and can be traced in the substomatal air chambers. The unicellular hairs issue from deep pits. They are without cuticle and very narrow at the base, which borders the outermost cortical palisade cells.

Young cells in the multiple epiderm contain dark substances the chemical nature of which remained unclarified but which might be phlobaphens (Fig. 10 a).

In the younger branchlets the cutinization only affects the outer thick walls and wedges in the outer parts of the anticlinal walls. Later the walls in the outer hypoderm-like layer are also cutinized.

In polarized light the cutinized walls show birefringence but this double refraction disappears in slides where wax has been removed. In such slides the hairs appear bright while all the multiple epiderm cells are dark (Fig. 12 b-c).

Wax crystallites are sometimes extruded. They occur in small colonies and never seem to cover larger areas (Fig. 12b).

The outer thick walls are often traversed by numerous thin strands, which issue from the cell lumina and taper towards the surface becoming undoubtedly sub-lightmicroscopical at their distal ends. In a few cases, however, it was possible to trace them from tops of cells with tapering lumina right up to the cuticle. In protoderm cells these delicate structures appear to be half as long as in the elongated cells which develop from the protoderm cells (Plate Xa-c). The position and structure suggest that they are ectodesms (see p. 38) and perhaps wax channels involved with interposition of wax in the thick outer walls and local extrusion of wax through the cuticle. The guard cells are provided with conspicuous outer ledges (Plate IXa) and in older guard cells it is possible to observe some short inner ledges (Plate IXb). The outer and inner guard cell walls are very thick. After treatment with hot alkali the ledges disappear and the thick walls appear clearly composed by 3-4 (outer thick wall) or about 8 (inner thick wall) cellulose-lamellae, the interjacent pectic substances being dissolved.

The later development of the epidermis is closely connected with the diameter growth of the branchlet. With increasing girth the elongated cells become somewhat broader and shorter and the stomatal pits and hair pits are widened; the former which in the young epidermis are nearly cylindrical (Fig. 10c, Plate IXa) become bowl-shaped (Fig. 11a, Plate IXb).

The most striking feature, perhaps, is the way in which the girth is increased. The elongated outermost cells are divided by walls which are periclinal or oblique. In the latter case a cell is formed which is able to grow in between the other cells which constitute the girth (Plate Xc on the right).

A subsequent stage may be the formation of fissures in the cuticle and the cutinized cell walls outside such enlarging cells and a filling up with new small cells inside the places of rupture. This process is illustrated in Fig. 11b-e and Plate Xd.

The subdivision of the original radially elongated outer cells leads to the for-

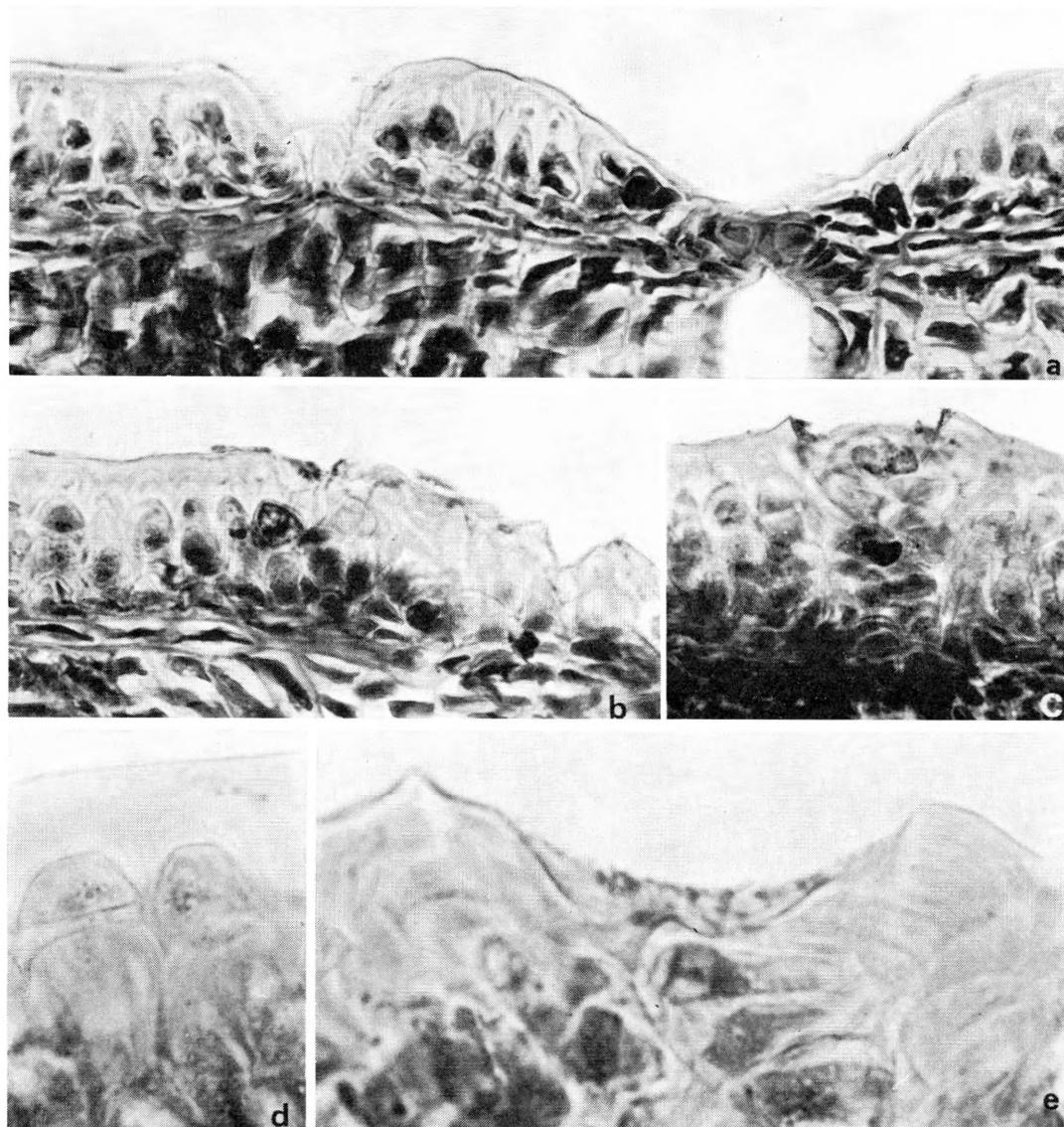


Fig. 11. *Bulnesia retama*. Cross sections of parts of older branches. — a. One hair pit (on the left) and one stomatal pit which by the diameter growth has been considerably widened and now are flat bowlshaped. Cortex cells much broader, no longer more a palisade tissue. — b. Two ruptures and many dead cells in outermost layer. — c. Filling up with small new cells inside place of rupture. — d. Small dead or dying cells in outermost layer. — e. Rupture and new small cells beneath. In the depression possibly wax. a-c  $\times 320$ , d-e  $\times 800$ .

mation of cell rows in which the distal cells usually become short and  $\pm$  hemispherical (Fig. 11 d); they seem to produce much cutinized wall substance and at the same time to withdraw, leaving a number of strata in the outer walls (Plate Xe). Many of the

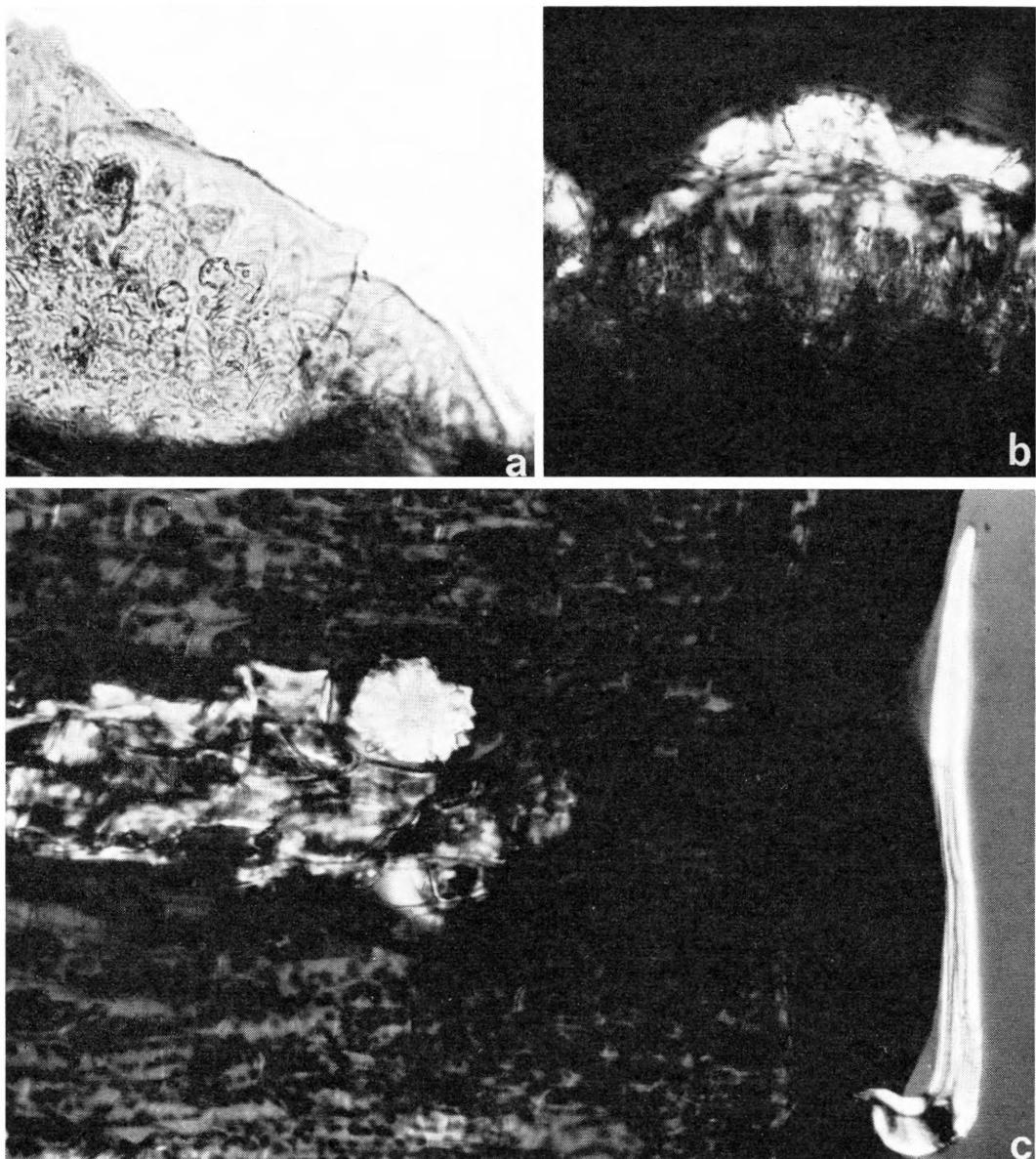


Fig. 12. *Bulnesia retama*. — a. An irregular phellem formed below multiple epiderm which ruptures and peels off. On the extreme right the phellem cells are uncovered. — b. Herbarium material. Cross section of multiple epiderm in polarized light. Wax deposits outside epiderm and cutinized parts of outer cell walls are birefringent. — c. Material after removal of wax in polarized light. Crystal druse and cells which are transformed into sclereids show up. In the epidermis all cell walls are dark except the hair. a and c  $\times 320$ , b  $\times 512$ .

small distal cells finally die and may, together with large parts of the cutinized outer walls, peel off. In herbarium sheets this peeling is evident and some microscopical

observations highly favour the view that at least small parts of the outer walls are also shed under natural conditions.

#### Periderm

In older parts of the branches scattered brownish cork areas are found, surrounded by more extensive green areas which are covered by the multiple epidermis. In young branchlets the formation of phellem is restricted to the immediate surroundings of lenticels. Later a rather loose irregular phellem tissue spreads from the lenticel-areas. Evidently the inner cells in the multiple epidermis work as a kind of phellogen and produce many cells with suberized walls. The phellem which is produced cuts off the multiple epidermis which sooner or later scales off (Fig. 12a). It seems as if the inner epidermal cells possess some cambial qualities. Usually however, they only give rise to few living cells which either substitute peripheral degenerating cells or serve the dilatation growth by being inserted between other cells in the girth.

#### Cortex

Almost isodiametric cells in the youngest parts stretch radially and may also divide, the result being the formation of a palisade tissue which in somewhat older stems consists of 5–6 cell layers. Between the cell rows there are very narrow inter-cellular spaces, only inside the stomata do they extend into larger chambers (Figs. 10c, 11a, Plate IX). Inside the typical palisade cells which are rich in chloroplasts long chlorenchyma cells occur as well as groups of elongate large parenchyma cells without chloroplasts often together with one or a few idioblasts containing crystal druses (Fig. 12c). A sclerification of the large cells takes place at an early stage, the result being the formation of radially stretched groups of sclerenchyma which include one or some few cells with druses. In old stems the sclerenchymateous groups seem to expand to the outer part of the cortex, there replacing green cells. The sclerenchyma cells attain great sizes and their walls show very many clear strata.

The sclerification can be traced in young stems by using polarized light. At an early stage the cell walls show up brightly under a polarizing microscope (Fig. 12c). Later they react with lignin – stains.

#### Stele

Extraxillary (pericyclic) fibre strands occur in connection with primary vascular bundles. Very early the parenchymatous cells between the fibre strands are transformed into sclereids, the result being the formation of a kind of connective tissue consisting mainly of sclereids with scattered fibres. This layer of thick-walled cells may be 5–8 cells thick (Fig. 13).

The wood anatomy of the genus *Bulnesia* was studied previously by BURGENSTEIN (1912) and COZZO (1948). The latter author compares five species of the genus *Bulnesia*, *B. retama* included. The microphotos published in Plates I–II in COZZO's paper indicate that *B. retama* has comparatively few but much higher xylem rays.

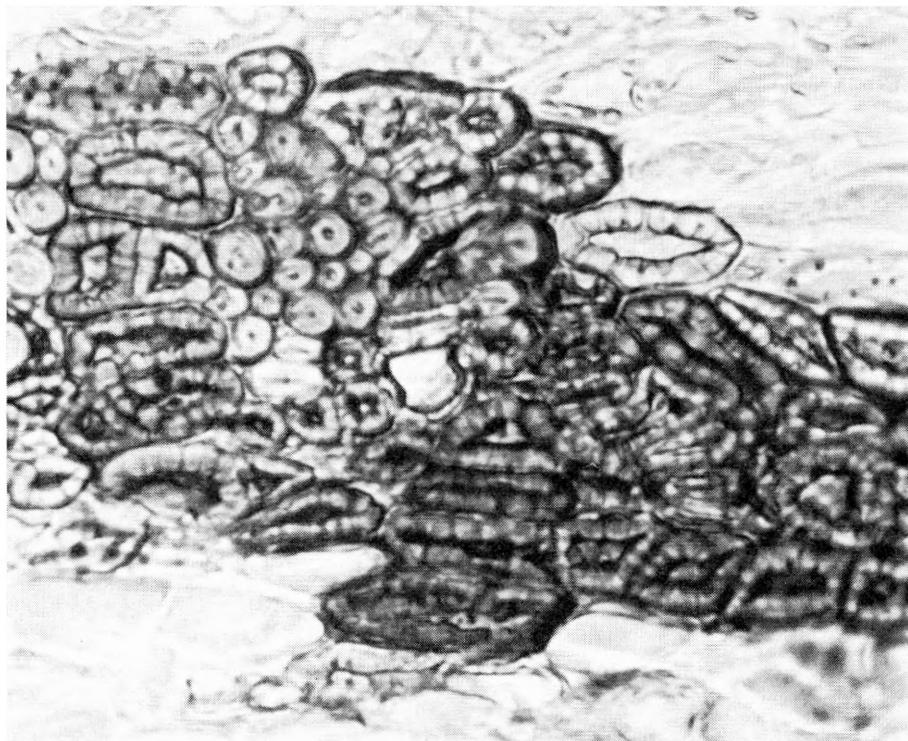


Fig. 13. *Bulnesia retama*. Cross section of branchlet. Mixed tissue composed by phloem fibres and connecting sclereids forming a separating layer between the cortex and the conducting elements in the phloem.  $\times 630$ .

At the first annual ring they are 2–3, sometimes 4–6 cells broad. The vessels are diffusely arranged but in narrow annual rings they tend to be placed circularly. In our material (Fig. 14) this is also the case. The arrangement of the groups of vessels, however, is very peculiar. The groups are not confined to single annual rings, but may continue through two (or three) rings. The narrow groups follow the direction of the rays or they cross the rays obliquely. In the stem seen on Fig. 14 they tend to curve to one side.

The proportion of libriform fibres in *B. retama* is very high. According to Cozzo's photographs the proportion is much lower in the foliate species and here the tracheary cells are also arranged more circularly and follow the annual rings.

In *B. retama* there are, according to Cozzo, on an average 38 vessels pr. mm<sup>2</sup> whereas in the other species the mean numbers pr. mm<sup>2</sup> are 53, 77, 104, and 142. This reduction of tracheary elements in the xylem of *B. retama* may have some connection with the apophyllous life-form of this species. It is curious to find a many layered cortical palisade tissue and no cortical bundles. Water conduction from the vessels to the palisade cells and food-conduction from these cells to the phloem, therefore, must go in the cortex from cell to cell. The pericyclic sclerenchymatous layer

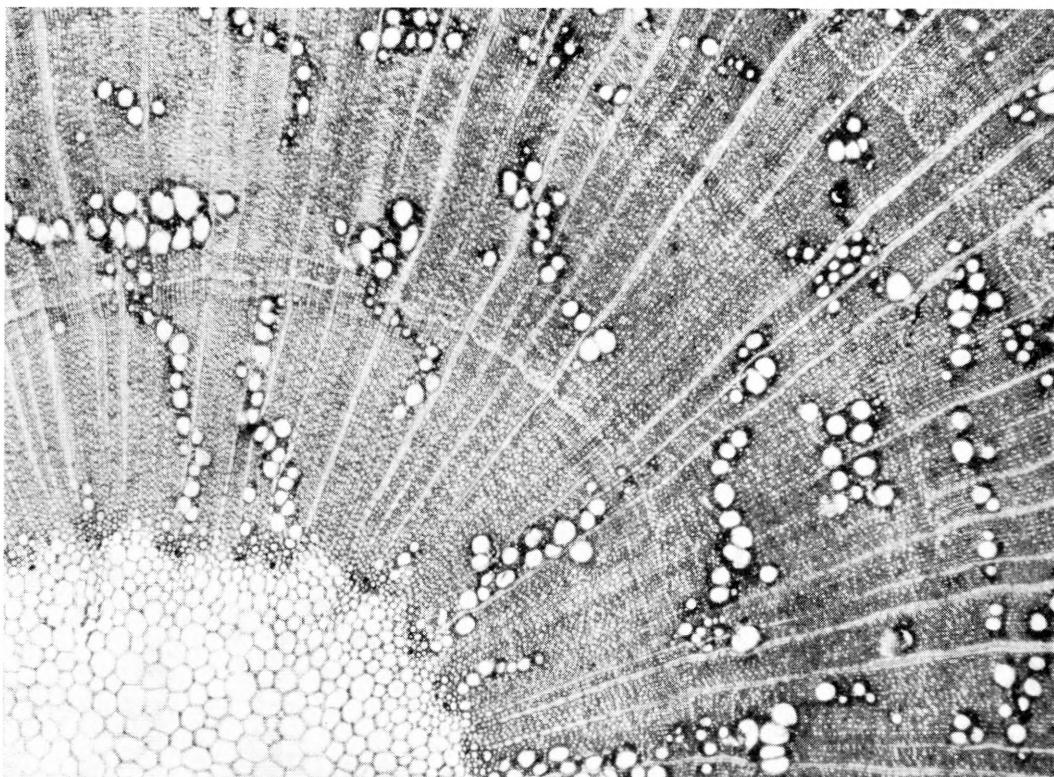


Fig. 14. *Bulnesia retama*. Cross section of xylem showing irregular groups of vessels, some growth layers, on the left some indistinct narrow ones suggest periods of stagnation.  $\times 50$ .

(Fig. 13) is not completely continuous. It contains scattered passage-ways of non-lignified cells, arranged in one row only. While water may pass thick and lignified cell walls, the translocation of food-stuffs to the phloem, probably proceeds through living cells forming pathways through the sclerenchyma cp. further p. 35.

#### 4. *Bredemeyera colletioides* (Phil.) Chod.

Material: Prov. San Juan, Pachaco 89 km west of the town San Juan. Altitude 1200 m (Böcher, Hjerting & Rahn No. 2228).

*Bredemeyera colletioides* (*Polygalaceae*) is a shrub which can reach a height of 1.8 m with trunks which may reach 4–5 cm in diameter. The relative main axes zig-zag, and at each turn a perpendicular branchlet issues (Fig. 9d). At the angle between the axes and the branchlets a deep and very narrow fissure is found on the upper and lower side of the branchlet. The fissure is covered by the epidermis which is folded inwards. Sometimes the two fissures merge into one which can be traced

all the way round the base of the branchlet. The branchlets terminate in spines and bear lateral inflorescences. Before the petals are shed the capsules elongate and almost ripen. They contain two seeds which are covered by a wisp of long hairs. The species occurs in the western provinces of Argentina from Tucuman to northern Neuquén, having its main distribution in areas dominated by Monte vegetation. It is also known from Chile.

### Epidermis

As in the preceding species a multiple epidermis develops and the guard cells sink below the surface of the epidermis. SCHWABE (1947) interprets the innermost layer as a hypodermis, but the ontogeny shows that a separate hypodermal layer does not exist. The protoderm cells are radially elongated with a thick outer wall (Fig. 15). The guard-cell mother cells are differentiated at an early stage by being broader and shorter than the other epidermal cells. The cells adjacent to the guard-cell mother cells (the subsidiary cells) become particularly long and expand in their outer part, the result being a sinking down of the mother cell in a small depression which is surrounded by the expanded portions of the adjacent cells (Fig. 15a–b). After the division into guard cells (Fig. 15c–d) the latter sink further down as a result of periclinal divisions in the other epidermal cells and radial growth of the new cells (Fig. 15e–g). The cells in the multiple epidermis remain arranged in radial rows. While, however, normal epidermal cells form rows of 2(–4) cells, the rows formed by the adjacent subsidiary cells contain 5(4–7) cells. As the guard cells are always connected with the innermost cells in these rows they are finally placed very far from the surface at the bottom of a deep pitcher. The pitcher with the guard cells forms a most interesting type of stomatal apparatus. This was already emphasized by SCHWABE (1947: 66). The outermost cells in the rows forming the pitcher elongate and expand, thereby forming an entrance which is narrowed and becomes protruded as a mouth (Fig. 16, 17b). As the normal epidermal cells form rows of a few cells only, the bottoms of the stomatal pitchers sink down and become surrounded by cortical palisade cells. Inside the guard cells there are large substomatal air-chambers (Fig. 17b, Plate XIb).

A striking feature is the frequent displacement of the narrow entrance in relation to the position of the stomatal pore. In very many cases the pitchers curve. Therefore, in such cases, the entrance to the pitchers cannot be seen in sections where the guard cells are cut transversely (Plate XIb, XVb).

Another very interesting feature is the structure of the outer ledge of the guard cells. This ledge has a rather normal appearance in young guard cells (Fig. 15), but in final stages it forms a thin diaphragm which covers the majority of the front cavity (Plate XIb, d, Plate XVd–e, Plate XVIa–c).

In young stomata the ledges are clearly formed by the guard cells only, however, the subsidiary cells may possibly in ripe stomata contribute to the final development of the ledges into the diaphragm, see e.g. Plate XVIb).

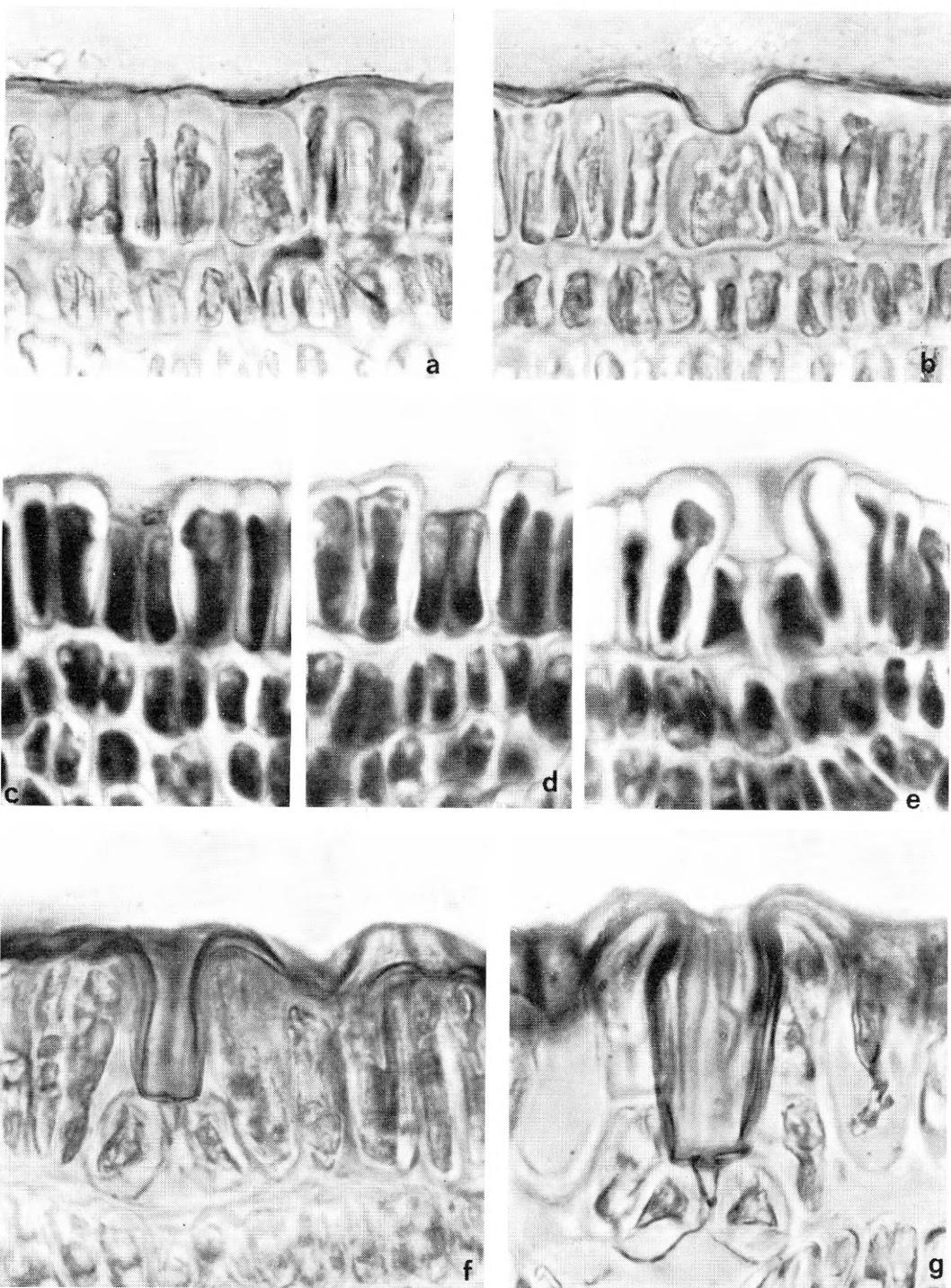


Fig. 15. *Bredemeyera colletioides*. Development of multiple epiderm and stomatal pitchers. a–b, f–g stained with Sudan IV, c–e with Lightgreen-Safranin. — a. Protoderm undivided, shallow depression at guard-cell mother cell. — b. Depression at guard-cell mother cell deeper, the two adjacent cells overtopping and partly overarching mother cell. — c–d. Mother cell divided. — e. Wall thickening and stretching of upper part of subsidiary cells, guard cells shorter and broader; initiation of outer ledges. — f. Stomatal pitcher formed, maximum stretching of epiderm cells. — g. Division of elongated cells, pitcher mouth and front cavity developing.  $\times 880$ .



Fig. 16. *Bredemeyera colletioides*. Longitudinal section through two mature stomatal pitchers, that on the right slightly curved. Row of six subsidiary cells forming the pitcher. 2–4 cells in the rows between the pitchers.  $\times 800$ .

In mature stomata the diaphragm always has a central opening, which is circular or elliptic (Plate XIII–XIV). But the margin of the opening is sometimes somewhat fibrous or is provided with some small, warty wax excrescences.

The outer and inner walls of the guard cells are very thick, but in the area where the pore narrows most they carry ridges, which in transverse sections appear as two opposite noses. These ridges are situated just outside or a little inside the place where the cytoplasmatic parts come closest to the pore.

Beneath the cuticle the walls of the cells in the multiple epidermis are in the process of becoming cutinized. The mature multiple epidermis appears, with Sudan IV red in all layers, even the inner walls bordering the cortex have a thin lamella which is red. The thick walls covering the stomatal pitchers are cutinized as are the ledges (diaphragm) and the outer walls of the guard cells adjacent to the pore (Plate XVI b–c). The walls inside the pore are covered by a cuticle and appear sometimes to be crispate (Plate XVI a).

A similar folding of the inner walls and cuticle was beautifully demonstrated in guard cells of *Helleborus* by HUBER et al. (1956) using the electron microscope. According to HUBER et al. this folding cannot be a result of shrivelling. However, in *Bredemeyera* it was found only in material which had been fixed, imbedded and stained. Perhaps such shrivelling is therefore due to a dehydration of some of the

wall compounds, e.g. pectic substances, see p. 15. In material treated with hot alkali the thick inner and outer walls appear clearly stratified. Using phase contrast it is possible to distinguish about eight lamellae of cellulose on each side of the cell lumen which after this treatment swells and becomes elliptic when viewed transversely. The interjacent spaces in such walls appear empty but were probably originally filled with pectic substances. The outer ledges and the diaphragms as well as the cutinized parts of the guard cell walls disappear after treatment with hot alkali.

Of particular interest is the observation made by VOLKENS (1887) and FAHN & NINA DEMBO that the walls of the guard cells in desert plants continue to thicken after maturation. The cell lumen is finally reduced to such an extent that it does not seem possible that turgor pressure is capable of opening the stomatal apertures. This character is thought to be of adaptive value in the dry summer of the desert.

A comparison of young and old guard cells in *Bredemeyera colletioides* (Fig. 15g and Plate XVIa-c) clearly shows a reduced cell lumen in the mature cells. Furthermore the cutinized ridge at the pore is absent or very small in young guard cells. It therefore seems probable that the movements of the guard cells in older parts of the branchlets are reduced or sometimes even stopped.

The thick outer epidermal walls are very interesting; they appear stratified and are clearly traversed by very delicate channels or ectodesms (Plate XVa-b). Sometimes the cytoplasm of the outer cells taper or have a few narrow protrusions which continue in a fine channel in the wall (Plate XVa, lefthand cell). In most cases, however, the channels first become visible at some distance from the cell lumen where they radiate against the outer surface (Plate XVb). The system of channels in the walls is particularly clear in the long protruding outer walls at the entrance to the stomatal pitchers. Transverse sections of the entrance show that the tips of the outermost subsidiary cells all have about five channels which merge, forming a small nodule from which a number of very fine plasmatic strands continue in the direction towards the surface, see Fig. 18. The area in the outer walls of the normal epiderm cells where such strands occur (Plate XVa-b) is much wider. Corresponding to the nodule, there are here, at certain levels in the wall, plasmatic layers from which the delicate strands continue and which are mutually connected and connected with the cell lumen by fewer and perhaps slightly broader strands. The system of plasmatic strands, which are easy to observe at high magnification in the light microscope and particularly in the protruding walls at the pitcher entrances, represent presumably main channels from which much finer ± submicroscopical strands issue. This view was corroborated by a number of observations where diaphragming and the use of different filters made it possible to see a very fine, dense striation issuing from the main channels (see Plate XIIb-c).

Observations in the polarizing microscope added a number of important facts. If herbarium material was cut and the material mounted in glycerol the cutinized parts of the multiple epiderm appeared to be birefringent (Plate XIc). Furthermore, hair-like birefringent structures were found in great quantities on the walls of the

stomatal pitchers (Plate XIc, XIIe). Also the thin diaphragms formed as continuations of the outer ledges were birefringent (Plate XId). Finally a particularly bright shine occurred in the area of the middle lamella in some particularly broad cutinized wedges in the outer anticlinal walls (Plate XIe).

Using the red I plate the thick non-cutinized walls of the guard cells and the walls of the inner epiderm cells on both sides of the pitchers appeared blue, while the diaphragms and the thick cutinized outer walls of the outer epiderm cells were orange.

The bright birefringence of the non-cutinized parts of the guard cell walls was maintained in material treated with hot alkali and where the cutinized parts were dissolved. It also persisted in material which was fixed and during staining and mounting treated with tertiary butyl alcohol and xylene. On the other hand birefringence in the thin diaphragms disappeared in the fixed and stained slides. The inner parts of the walls in the outer epiderm layer and the parts of the walls bordering the cortex also showed birefringence. This persisting double refraction is probably due to cellulose, while most of the birefringence which disappears is caused by wax.

Wax seems to be interposed in the cutinized walls and extruded. On the surface of ordinary epiderm cells it occurs as small scale-like bodies outside the cuticle and perhaps also in the cuticle, but the wax-covering is hardly complete.

The hair-like wax protuberances (wax-hairs) form particularly dense coverings at the entrances to the stomatal pitchers. In most cases the wax-hairs from both sides meet and are wrapped up. Some very long ones placed on the border between the entrance and the pitcher cavity form a dense interlacing pattern, which must be able to slow down the air movement and have other functions as a kind of a closure of the pitcher (Plate XIIc-e).

The density of wax-hairs decreases with the distance from the entrance. In some cases, small hairs or warty bodies of wax even seem to reach the diaphragm and the front cavities.

The coincidental occurrence of many and long wax-hairs and the nodules in the cell walls behind is striking and suggests that the above-mentioned channel system is of importance for the displacement of wax precursors. In this connection it is interesting that the larger channels or nodules showed some birefringence (Plate XIc, XIIe).

The middle lamellae or central areas in some of the broadest outer anticlinal walls show up particularly brightly. However, the shining middle parts were not continuous, being traversed by thin dark strands which presumably are plasmodesms. In phase contrast the same walls were also delicately cross-striped. Outside such walls there were, on the surface, often small collections of bodies with the same degree of birefringence and dimensions corresponding to the breadth of the birefringent wall area (Plate XIe). As the birefringence also in this case suggests wax deposition the occurrence outside such walls of bodies with a similar type of double refraction seems to be of some interest. Perhaps wax precursors follow plasmodesms through the

cutinized anticlinal walls and ectodesms in the outer ones so that wax depositing occurs where these wax channels end, viz. in the middle lamellae and on the surface. However, if the middle lamellae are particularly broad (perhaps expanded) and filled up with wax, some of the wax may be extruded through fissures outside the anticlinal walls.

While it is clear that many anticlinal divisions occur in the young epidermis which consists of one cell layer only (Fig. 15), there is no evidence of any mitotic activity in older stems, where the epidermis is multiple and cutinized. How an increase in the girth takes place in old stems is therefore the question. Some facts, however, suggest that some late anticlinal divisions occur. Some of the multiple epidermal rows of 2–3 cells are particularly narrow and placed two side by side. The two peripheral sister cells have, in the cuticular layer, first their own strata, but the outer strata are common to both. Sometimes single, undivided, narrow cells are inserted between rows of 2–3 broad cells. These single ones taper towards the periphery. If they were able to increase their breadth and to widen abaxially, this would also contribute to the diameter growth.

There are many points of resemblance between *Bredemeyera colletioides* and *Anabasis articulata* (*Chenopodiaceae*) described by FAHN & NINA DEMBO (1964). The latter species deviates by having a thick water-storing parenchyma, but it has extremely reduced leaves and is clearly stem-photosynthetic. *Anabasis articulata* has also a multiple epidermis and the multiseriate subsidiary cells produce a deep cavity above the guard cells. The cells bordering the entrance to the cavity, together with their papillae, make the outer portion of the cavity narrower.

### Cortex

In young branchlets the cortex consists of 5–6 layers of photosynthetic cells (Fig. 17a). Later a differentiation takes place. The outer 3–4 (5) layers develop into palisade cells, those between the palisade cells and the pericycle into chlorenchyma and scattered cells which contain druse crystals (Fig. 17b, Plate XVIId). Except inside the guard cells the intercellular spaces are narrow. In the innermost cortical layer the cells are enlarged tangentially and form an almost continuous layer. Each cell may have connections to two rows of palisade cells and may serve as collecting cells for food-materials produced by the palisade cells.

### Stele

Young stems contain 2–3 layers of cells which have no chloroplasts and develop into an extraxylary cylinder of fibres which is probably pericyclic. As in *Bulnesia* there are passage areas of living cells connecting the innermost cortical layer with the phloem. Such passages are often found outside phloem rays (Plate XVIId).

As already mentioned by SCHWABE (1947) there are no wide vessels in the xylem. In the protoxylem the vessels have helical thickenings. The vessels of the secondary xylem have simple perforations.

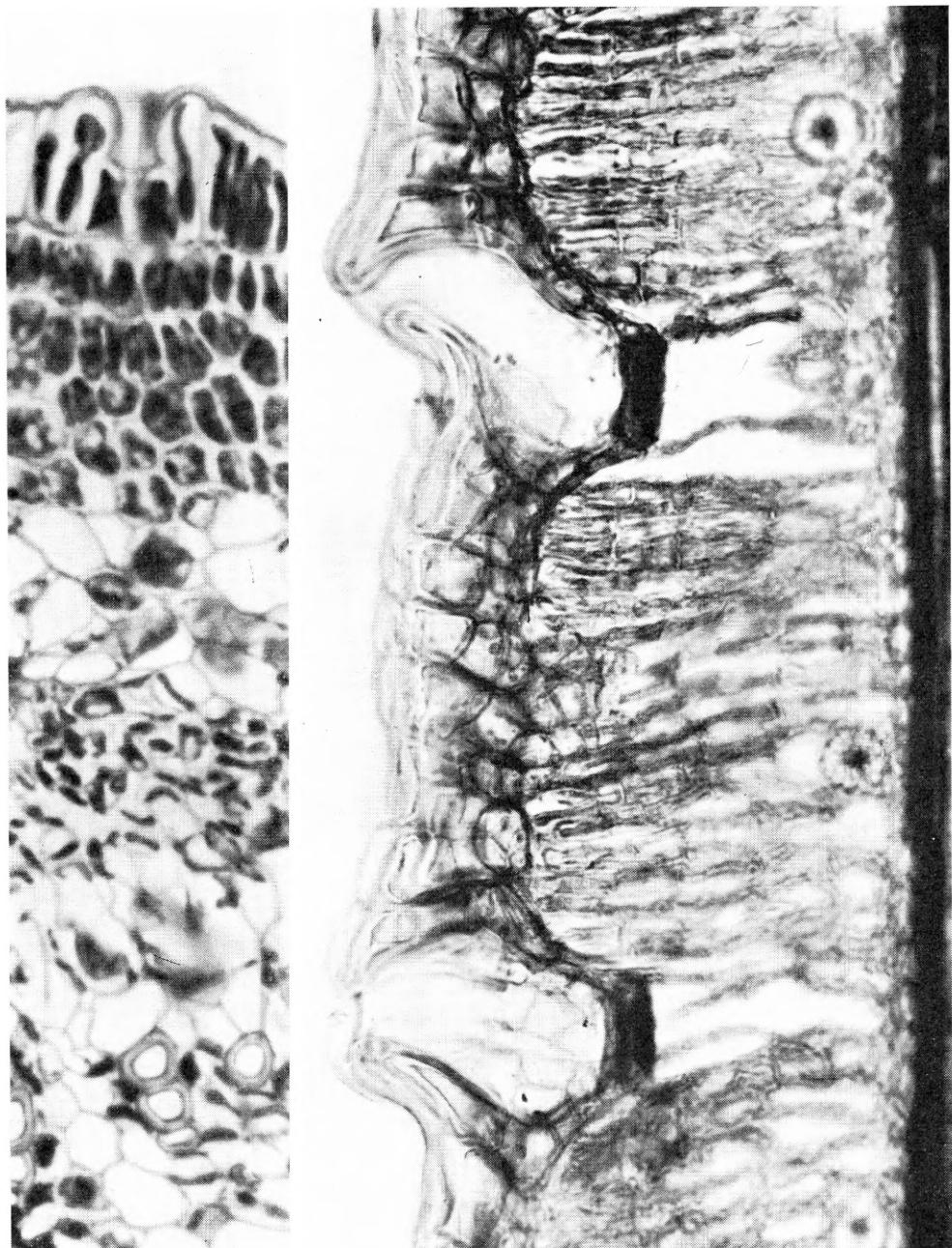


Fig. 17. *Bredemeyera colletioides*. On the left: Part of cross section of young stem with epidermis, 4–5 rows of palisade initials with many anticlinal divisions, large cells which develop into fibres, protophloem, initials of metaxylem and protoxylem.  $\times 470$ .

On the right: Longitudinal section of older stem with mature multiple epiderm, palisade cells in cortex, crystal druses and fibres (black). Two stomatal pitchers cut, the uppermost one curving very much.  $\times 320$ .

The axial xylem parenchyma is poorly developed but mainly paratracheal. In the centre of the branchlets the parenchyma of the pith gets thick walls. The xylem rays are 1–(2) cells broad, cp. Plate XVI d.

## 5. Discussion

### *Structure of outer epidermal wall*

FREY-WYSSLING (1959: 56) and FREY-WYSSLING & MÜHLETHALER (1965: 313) discuss the nature of the cuticular layer and conclude that it is situated outside the primary wall; it is not a part of the wall but a secretion between the cuticle and the primary wall. Of particular interest is the opinion that the cuticular layer can be compared with the polysaccharides deposited as a mucilage layer on the epiderm of aquatic plants, which on terrestrial plants, however, are strongly mixed with or replaced by cutin substances.

The studies in *Monttea aphylla* referred to above corroborate with this view, but in *Monttea* the cuticular layer has reached an unusually great thickness. This makes it possible to see details which are not known from cuticular layers in other plants; but just because of the exceptional dimensions of the layer it is hardly justifiable or at least very difficult on the basis of observations in *Monttea* to make any generalization with regard to the structure of cuticular layers in xerophytes.

There is a strong resemblance between mucilaginous epidermis walls and the epidermis walls found in *Monttea*. The cellulose mucilage formed in seed coats (e.g. in *Lepidium sativum*) is birefringent and gives a picture in a polarizing microscope which is highly reminiscent of our pictures of walls in which wax has been removed (e.g. Plate IV a). The radiating shining lines in the *Lepidium* mucilage according to FREY-WYSSLING (1959: 155) are due to the layering of the cellulose fibrils, which are turned during the swelling and become orientated perpendicular to the surface of the seed.

Another important similarity is the presence of wall lamellae which are separated by matrix which expands. In walls with cellulose mucilages the system matrix + cellulose fibrils as stated by FREY-WYSSLING & MÜHLETHALER (1965) can, according to the quantity, capacity for hydration and state of hydration, produce soft slimes, form mucilages and walls with different degrees of plasticity and elasticity.

The process which in *Monttea* resembles a swelling is not immediately comprehensible and ought to be studied in more detail. The tubular corrosion cavities which mainly were found outside the transverse walls may be due to the presence of hemi-cellulose or pectin. But these substances seem to occur together with cellulose and not to constitute a matrix between the carbohydrate lamellae. The expansion in *Monttea* may be caused by a migration of large quantities of substances found together with those having lipid character or by the liquid wax and cutin precursors themselves. The inward bulging of the protoplasts in young very active cells (Fig. 3a), the

occasional occurrence of Sudan IV-positive islands in the epiderm (Fig. 3c-d), the clear lamellation and the perforation of the outer walls indicate that the cell walls in the active phase are split up into thin porous lamellae, the intervening spaces being filled with matrix, and that the amount of matrix sometimes is so great that the surface of the protoplasts become concave.

If the outer walls are not exposed to higher pressure from a larger amount of expanding material they may be maintained, the very delicate pores or channels giving enough passages for the secretion. In this connection it is interesting to refer to the investigations of LAMBERTZ (1954: 164) who did not find such microchannels or ectodesms in the outer walls of secretory cells. Such walls, he says, are extremely thin and it is therefore difficult to distinguish small pores for possible ectodesms from granular coagulated cytoplasma. Perhaps the explanation is that such delicate structures are only present as long as the wall lamellae are not decomposed as a result of stretching.

In *Bulnesia* and *Bredemeyera* delicate channels in the outer walls are easy to demonstrate (Plate X, XV). As mentioned these structures are probably not always identical with true ectodesms (see SCHUMACHER 1942, 1957, LAMBERTZ 1954, SCHNEPF 1959, SCOTT et al. 1958), they are wider, being probably often main channels from which ectodesms issue. The channels seem to deviate from true ectodesms in many ways. First, the fine channels found by us were very conspicuous after fixation with alcohol only. SCHUMACHER and LAMBERTZ had to use Gilson fixation and staining with pyoktanin to make them observable. Second, according to LAMBERTZ, it was not possible to detect ectodesms in heavily cutinized walls, where they were considered to be obscured by the cutinization process. In our material there seem to be few or no clearly observable microchannels in the heavily cutinized outer wall layers. On the other hand the channels pass cutinized inner wall layers and go right out to the outer layers and may continue as very thin strands, but in any case they seem to stop before the cuticle. This is accordance with the results of SCOTT & al. (1958), SCHIEFERSTEIN & LOOMIS (1959), and HALL (1967).

The plasmatic nodules or layers observed in the outer walls of *Bredemeyera* (Plate XIVe) are of particular interest. It is here sometimes difficult to distinguish or demarcate a cuticle from the cuticular layer, but it is evident that the wall layers placed slightly outside the nodules or plasmatic layer stain more intensively purple with the quadruple staining whereas the inner parts in the multiple epidermis are paler. The delicate plasmodesmal structures which radiate from the nodules or plasmatic layers towards the periphery stop or become submicroscopical where the layering in the wall is getting indistinct and the purplish colour becomes deeper.

The nodule shown in Fig. 18c appears empty while perhaps some plasmatic substance is left in the channels. It is striking here that these wider channels found by us in *Bredemeyera* appear to be double. By successful fixation and addition of oxalic acid or nitric acid it was possible for LAMBERTZ to demonstrate that the true ectodesms were built as two parallel threads. Later this double structure also seems to be observable in the electron microscope (SCHUMACHER 1957, SCHNEPF 1959: fig. 9-10).

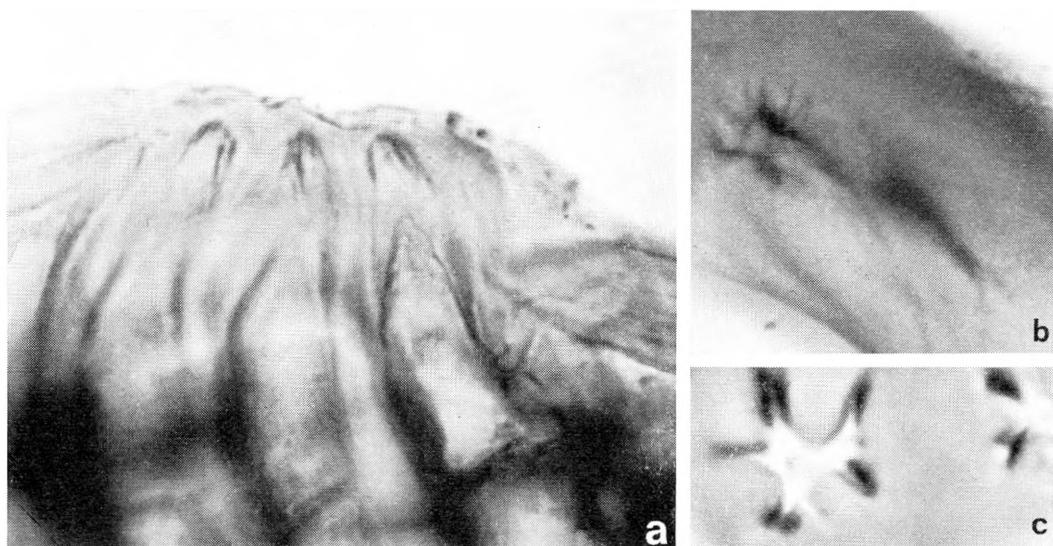


Fig. 18. *Bredemeyera colletioides*. — a. Cells forming the entrance to the pitcher showing tapering cell lumina and strands leading to apical nodule. — b. Apical nodule from which a number of very fine strands radiate towards the surface at the entrance. — c. Cross section of apical nodule showing twin strands leading to the cell lumen. a  $\times 800$ , b-c  $\times 3200$ .

LAMBERTZ demonstrated that ectodesms were best developed in young cells. In *Bulnesia* and *Bredemeyera* it is evident that the protoplasmic part of the outer epiderm cells is reduced with increasing age of the epiderm and recedes as new wall layers are added by apposition. During this process fewer and perhaps sometimes no microchannels are formed. In the latter situation the cytoplasmatic connections from the cell to the plasmatic nodules and layers in the outer wall would be broken. In any case the nodules or plasmatic layers are probably remains of a peripheral part of the cytoplasm with structures resembling ectodesms, a part which for some reason was cut off by the next secondary wall layers (cp. Plate XV). This favours the view that the plasmodesmal structures in thick outer walls are of particular importance in the young stage or during the apposition growth.

SCHIEFERSTEIN & LOOMIS (1959) and HALL (1967) discuss the presence in the outer walls of microchannels through which wax might migrate before it was extruded through the cuticle.

In *Bulnesia* and *Bredemeyera* we may perhaps be allowed to suppose that the channels mainly function during the period of enlargement of the outer surface, where new cutin has to be inserted in the expanding cuticle and a polymerization of cutin and deposition of wax must take place in the deeper wall layers when the cutinization of the multiple epiderm takes place. On the other hand, the possibility exists that e.g. the production of wax hairs in stomatal pitchers could be increased during periods with particularly dry conditions, resulting in a partial closure of the

opening and a cutting down of the transpiration. If so, we may assume a function of the channels also in later stages.

The process of cutinization and wax depositing is probably slow when compared with the secretion which we assume takes place in *Monttea aphylla*. In this species there are no microchannels in the cuticular layer. The whole organization of the outer walls in this species is strikingly different from that of the two other species in which channels in the outer walls are found. Nevertheless we find it justifiable to speak about cuticular layers in all three species. This attitude was also influenced by the paper of SITTE & RENNER (1963), who in the upper leaf surface of *Ficus elastica* found a deviating type of cuticular layer where cellulose is only found in the inner lamellae. The two authors therefore rightly modify the definition of cuticular layer so that all cutin-containing layers should be classified as cuticular layers, regardless of whether they contain cellulose or not. According to our observations it might further be justified to include under the definition such cuticular layers as are intensively secreted and have the cellulose arranged as thin dome-shaped lamellae.

#### *Life-form*

Usually comparative anatomy is closely connected with taxonomy. Ideas about the interrelation of various taxa and evolutionary lines within certain groups are often supported through comparative anatomical studies. But comparative methods have also proved to be very useful in ecological anatomical investigations. In our case we find some very striking similarities between the three apophyllous species. Mainly, on the basis of their anatomy it is possible to refer them to the same type. If apophylls constitute a life-form, our three species belong to a subtype of this life-form. Let us call this subtype terete apophylls.

SLADE (1951) has, for the New Zealand brooms (e.g. *Carmichaelia*, *Corallo-spartium*, *Notospartium*, *Chordospartium*), described two important morphological evolutionary lines, both arising from the terete subgenus *Kirkiella*. One morphological trend is a flattening in the stems, another a development towards a shallow grooving and further to a deep furrowing of the stems. Nothing is said about the possible ecological background for these two lines, but it seems likely that different selective forces have affected a terete ancestral type and that in some kind of environment a backward evolution took place towards a flattened leaf-like structure, while in other environments the evolution became a progressive furrowing and sinking down of the stomata in the furrows.

These points of view might be generalized. As stems usually are  $\pm$  round, the ancestors for apophyllous species in the various taxonomic groups had probably more or less terete stems. They were also probably foliate but with the character of shedding their leaves early or at least at the height of the summer. While some of the morphological evolutionary lines led to deviations from terete structure, this was maintained in others. Adaptation to very dry conditions may lead to the furrowed

type in some groups but not in others. According to SLADE (1952), the occurrence of cortical fibre bands is of fundamental importance for the trend leading to furrowed stems. Even species with smooth stems have alternating longitudinal areas with and without stomata. The epidermal strips devoid of stomata are underlaid with bands of cortical fibres. Successive developmental stages show that the long stomatal areas are the forerunners of stomatal furrows. In this connection it is interesting to note that none of the three terete xeromorphic apophyllous species dealt with in the present paper have any fibre bands in the cortex. In *Bulnesia retama* some cortex cells develop into groups of sclereids but there are no subepidermal fibres which would impede development of stomata in the epidermis outside.

The type with furrowed stems is developed in several families. There is a striking similarity between stems of the Leguminous *Corallospartium crassicaule* from New Zealand, the Mediterranean *Retama raetam* (EVENARI 1938, Fig. 6) and the Verbenaceous *Neosparton aphyllum* from South America (see Fig. in CABRERA 1961). Here the sinking of the stomata is connected with the furrowing. Obviously the sinking down of the stomatal apertures is a character which is of great adaptive value. In the three species which we have studied, the formation of large chambers outside the front cavities is due to two widely different processes: (1) a development of a multiple epidermis (2) a secretion of a very thick cuticular layer. In all three species there are two front cavities outside the aperture and this double front cavity system is, in the case of *Bredemeyera colletioides*, very conspicuous. The complicated stomatal pitchers with their wax hairs and the diaphragms with their wax covering in this species would probably never have come to existence if the protection by sinking down of the stomata was not of fundamental importance for the water economy of the plants and therefore of great adaptive importance.

Species of the family *Restionaceae* (CUTLER 1966) although being herbs, have xeromorphic photosynthetic stems and may belong to the terete type or to an independent type. The stomata are here in some species sunken but in many species not. However, here the substomatal air chambers have a special coating of protective, thick-walled, modified palisade cells. The protective cells form the wall in a short tube or cavity which becomes closed at the inner end, but it is open to the green cortex cells by special pores. The protective cells have a cuticle on the surface exposed to the atmosphere. In this way the substomatal cavities here are transformed to structures which protect against water-loss.

A number of other similarities between the three species presented here may be mentioned. Thus, in the xylem there are relatively few and narrow vessels and a high proportion of libriform fibres. Other, and probably more significant similarities, are found in the cortex.

In all three species external cortex cells are elongate and rich in chloroplasts and form a many layered typical palisade tissue.

No leaf trace bundles are found. All conduction of water as well as food translocation proceeds from cell to cell in the photosynthetic tissues. Soluble carbohydrates

reach the phloem through narrow passages in the extraxylary fibre- or fibre-sclereid cylinder which occurs outside the phloem in all three species.

The cortex in the *Restionaceae* has no traces either. Here the palisade cells are separated from the sclerenchyma cylinder with the bundles by a cylinder of parenchymatous cells. Only the smallest peripheral bundles approach the parenchymatous cylinder and may have connection with the chlorenchyma (cp. Figs. 1–3 in CUTLER 1966).

There is a striking difference between this organization and that found in some other stem assimilating plants in which a cortical venation system is developed. In the articulated succulent *Chenopodiaceae* (FAHN & ARZEE 1959) a cortical network is connected with leaf strands or with leaf strands and stelar strands. In the non-succulent Leguminous brooms of New Zealand the cortical venation pattern is derived from a leaf trace system. Leaf traces may here occupy the cortical ridges and are here separated from the photosynthetic cortex cells by one layer of colourless cells which may act as a physiological sheath or endodermis (see in SLADE 1952, Fig. 3).

The most important dissimilarities concern, as already mentioned, the development of the cuticular complex and the occurrence of periclinal divisions in a protoderm leading to a multiple and highly cutinized epidermis in *Bulnesia* and *Bredemeyera*. Trichomes were only found in *Bulnesia retama*. As they are unicellular and non-cutinized (Fig. 12c) they may perhaps be concerned with water absorption from the atmosphere (cp. the classical studies by VOLKENS 1887: 31–33). On the other hand trichomes may just represent family characters which are kept because they are neutral, having no negative adaptive value. Quite similar hairs were found in *Nitraria retusa* (also to *Zygophyllaceae*) by VOLKENS and are not considered by him to be water absorbing.

If we finally ask whether the three species studied, as regards xeromorphic anatomical characters, are particularly well-equipped or possess xeromorphic features which are more specialized or advanced than in most other xerophytes, the answer should probably be positive. The cuticular complexes found are particularly thick, the stomatal apertures have double front cavities, the green assimilatory cells are all arranged with very short distances to the tracheary elements in the stele and the intercellular spaces are narrow. However, it is not our intention here to penetrate into the physiological side of the problems. Xeromorphic characters ought always to be looked upon as genetically fixed ecotypical characters which mainly occur and are particularly well-developed in plants which are connected with dry habitats. This definition is neutral. A xeromorphic character might as well reduce the loss of water as play a part in insulating the green cells from excessive heat or reduce the light intensity. But frequently it will serve several different functions at the same time.

However, the eco-physiological side ought certainly not to be forgotten. It is definitely more difficult to tackle but important results might be reached if teamwork was organized between biochemists, physiologists, anatomists and ecologists.

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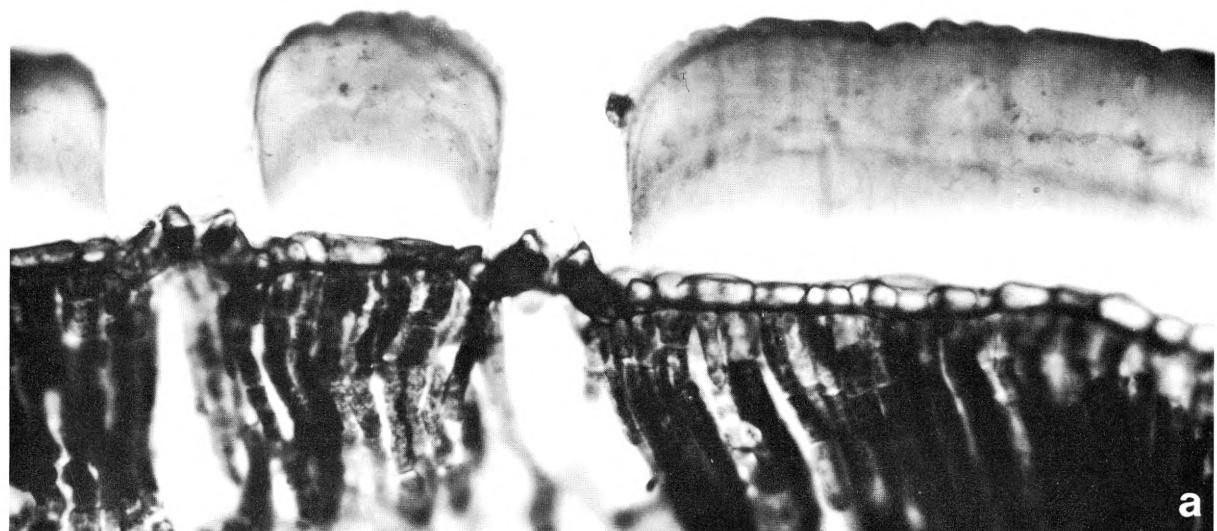
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PLATES

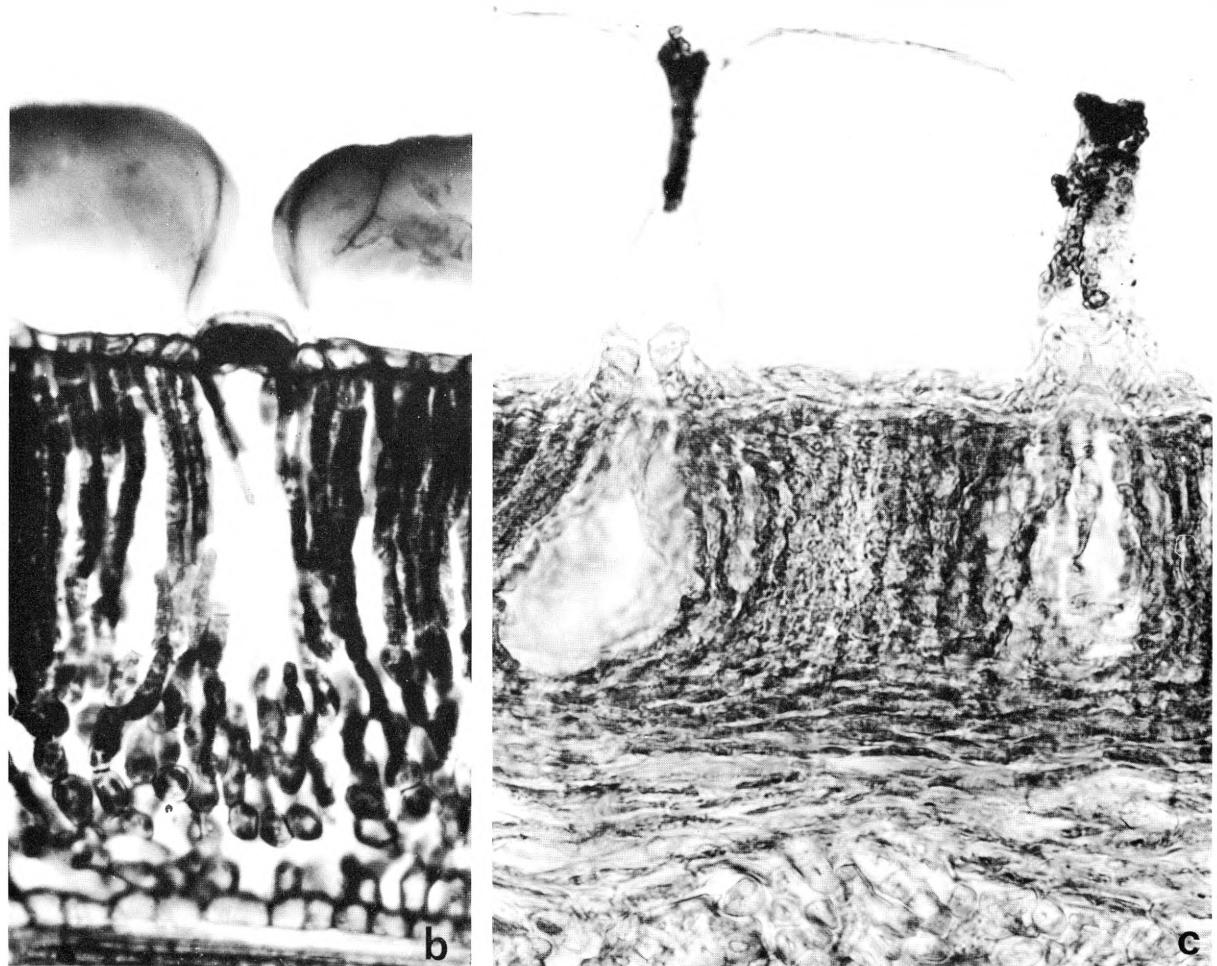
PLATE I *Monttea aphylla*

a and c transverse sections, b longitudinal section of epidermis and cortex. a-b Johansen's quadruple staining, c Lightgreen-Safranin staining. a-c  $\times 320$ .

- a. Two stomatal cavities. Cuticular coating with 1-2 clear layers both parallel with the surface which has a number of shallow furrows.
- b. One stomatal cavity, showing four differently coloured parts of the guard cell. The outer layer which corresponds to the cuticularized outer ledge is light purplish, next follows a green line (outer thick part of the wall), a light green area (cell lumen + wall) and finally a dark bluish violet part, which is the very thick inner wall of the guard cell. The other epidermis cells are green, the outer part of the cuticular coating dark purplish and the inner part light purplish. – In the cortex: layers of palisade cells and a spongy parenchyma, finally a dense parenchymatous layer and extraxylary fiber.
- c. The same, but fibres cut transversely. Pear-shaped substomatal air chamber and plugs in the cuticular cavities formed by an imperfect fungus.



a



b

c

PLATE II *Monttea aphylla*

a-f transverse sections of epidermal cells, in d including whole cuticular coating. Stainings with Sudan IV (a-b), PAS (periodine-Schiff, c-d), Nile-blue (e-f). a-c, e-f $\times$ 1950, d $\times$ 800.

- a. Cells in active stage. Middle part of outer wall with several thin lamellae. Peripheral parts not split into lamellae and joining anticlinal walls which seem to fork.
- b. Middle cell active with lamellated outer wall. On each side cells with firm walls and ridges as relics of basal parts of dome-shaped cellulose lamellae.
- c. Dome-shaped vesicle limited by thin cellulose lamellae, two are clearly seen on the right; on the left the lamellae are  $\pm$  dissolved.
- d. The same as c, but a large vesicle has almost reached the surface of the cuticular layer and its outer edges stained with PAS.
- e-f. Active epiderm cells, the outer walls viewed slightly obliquely; in e the surface appears as a network from which a number of short dark threads radiate. Thick anticlinal wall with "forking". - f. Same as e but pores in network smaller and may be shaped as small protruding tubules, leftmost cell with five distinct lamellae.

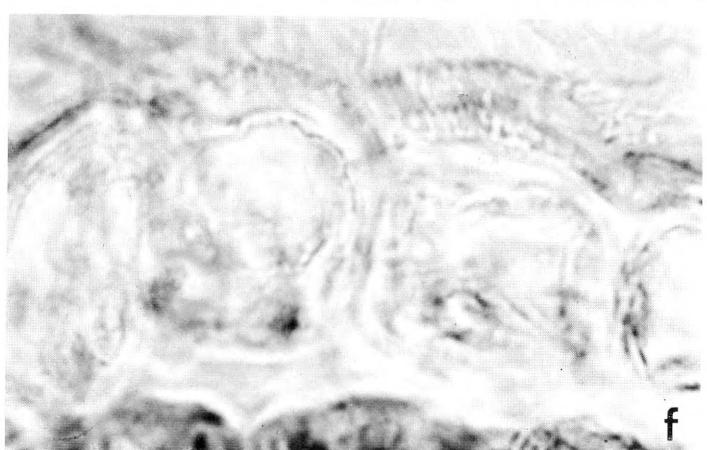
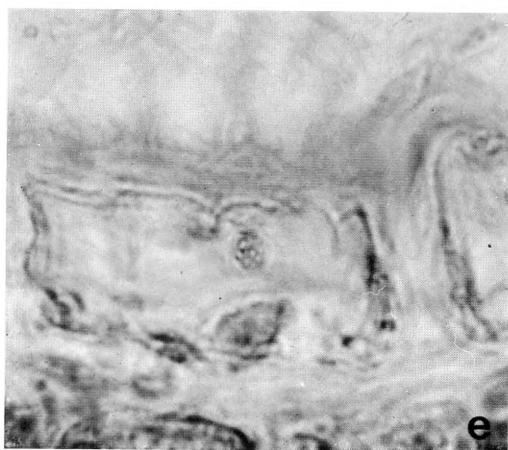
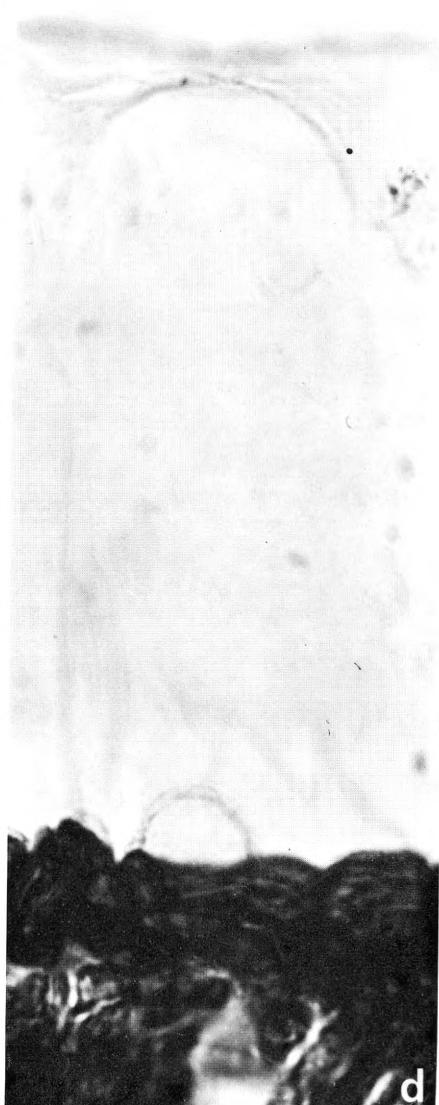
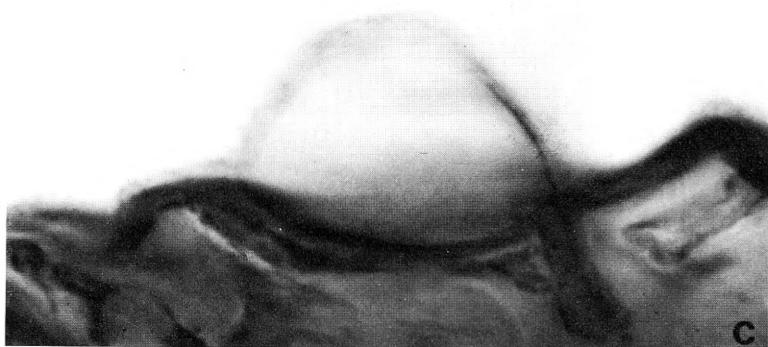


PLATE III *Monttea aphylla*

a-f transverse sections of epidermal cells, in d and f only inner part of the cuticular coating visible. a and c in polarized light, a stained with PAS, b-d Johansen's quadruple staining, e staining with Nile-blue, e-f staining with Ruthenium red. - a-b $\times$ 320. c-d $\times$ 800, e-f $\times$ 1950.

- a. Birefringence of whole vesicles probably due to wax. Outer edge stained with PAS (arrow), a very fine radial (anticlinal) striation to be seen dimly.
- b. Similar area showing paler vesicles and dark purplish outer part of cuticular coating. Note: cell of an imperfect fungus in the front cavity of the stoma.
- c. The usual aspect of birefringence after removal of wax, showing two shining lines outside each anticlinal wall. Most active cells have concave walls towards cuticular covering.
- d. Stomatal apparatus and cavity in cuticular layer with small group of fungal cells (on the right). Note dark staining of thick walls in guard cells and subsidiary cells.
- e. Actively secreting cell; on the right a thick anticlinal wall and adjacent parts of outer periclinal walls. The very thin middle part of the outer wall has a number of small pores and outside the middle area some structures in the cuticular layer which possibly has been secreted by the cell.
- f. One actively excreting cell the outer wall of which is very blurred and seems to be decomposed into small translucent bodies. Outside righthand anticlinal wall (dark red with Ruthenium red) small bodies and vesicles arranged perpendicular to the surface (cp. Plate V, b).

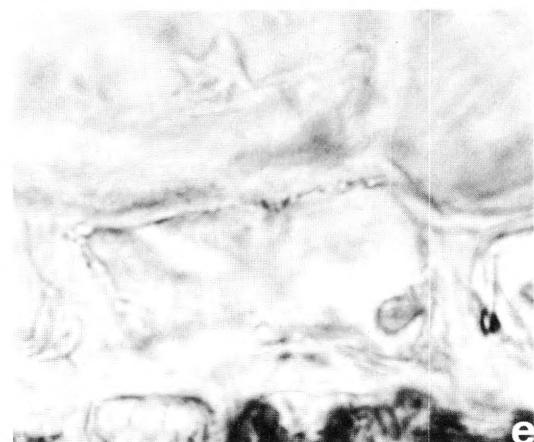
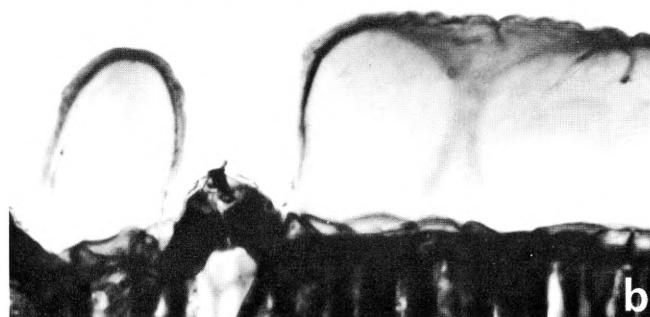
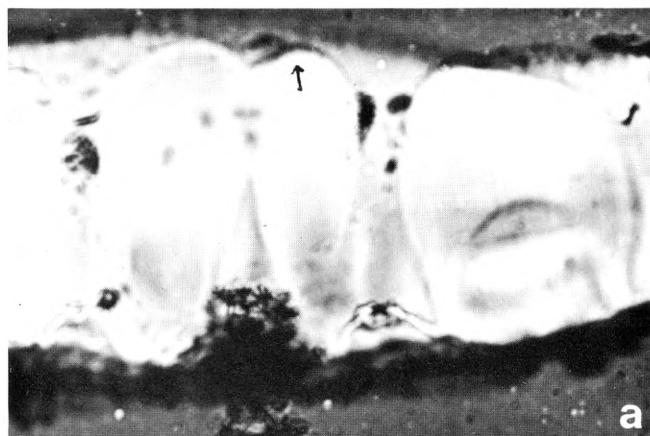


PLATE IV *Monttea aphylla*

a-c transverse sections of epidermal cells with cuticular coating as shown in polarized light (a and c) and with phase-contrast (b). b-c the same area.  $\times 320$ .

a. Arched area of cuticular coating between two stomatal cavities, one of which is seen on the right. The bright perpendicular lines represent two merging vesicle boundaries of two adjacent cells.

Immediately above the antielinal walls the lines divide into two which issue from the corners along the grooves (cf. Fig. 3b).

b-c. Similar area as in Fig. a as observed with phase contrast (b) and in polarized light (c). With phase contrast the outermost layer is bright, while it appears dark in all other cases. There are pairs of dark lines in the peripheral part (Fig. b). These lines are weakly birefringent (Fig. c), whereas the inner lines show up brightly and are clearly paired (arrow).

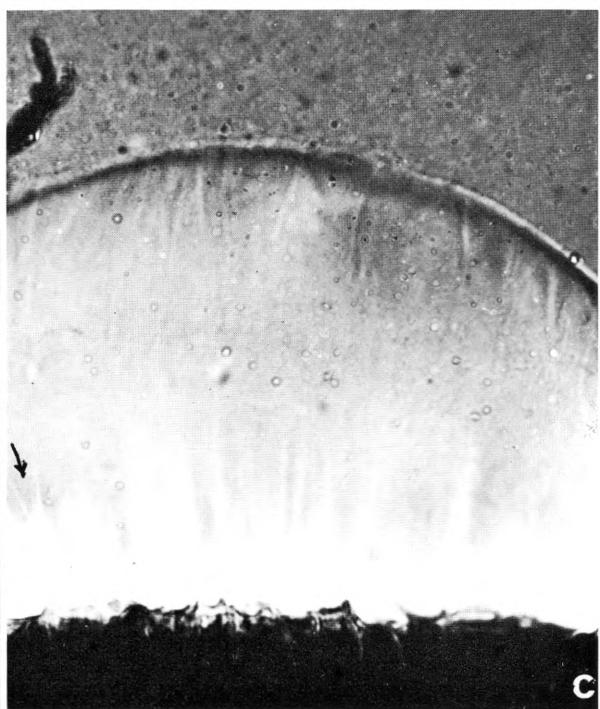
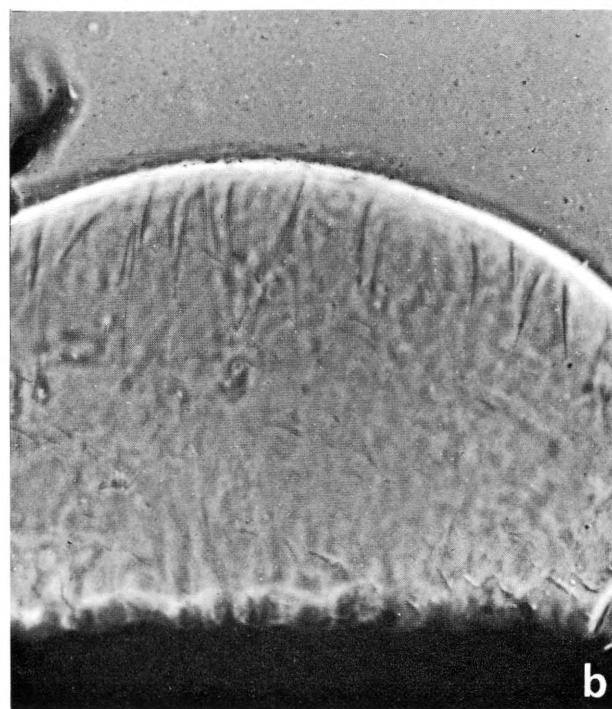


PLATE V *Monttea aphylla*

a-c transverse sections of epidermis and outer part of cortex. Phase contrast and staining with Lightgreen-Safranin.  $\times 800$  (a-b),  $\times 625$  (c).

- a. ¶ Contours of vesicles provided with great quantities of small granules. Large vesical on the left and three smaller ones on the right. Older vesical boundaries on the right just visible (arrow).
- b. Line with small granules outside anticlinal wall. The line corresponds to a border area between two vesicles which here nearly have reached a low depression in the surface.
- c. Area near cuticular stomatal cavity (the stoma is just outside the picture on the right but the subsidiary cells are seen, cp. Plate VIII e-f). Some of the epidermis cells have been divided by periclinal walls and a number of cells with chloroplasts have been formed and fill out a depression in the cuticular layer. The picture illustrates how the initiation of the phellogen takes place.

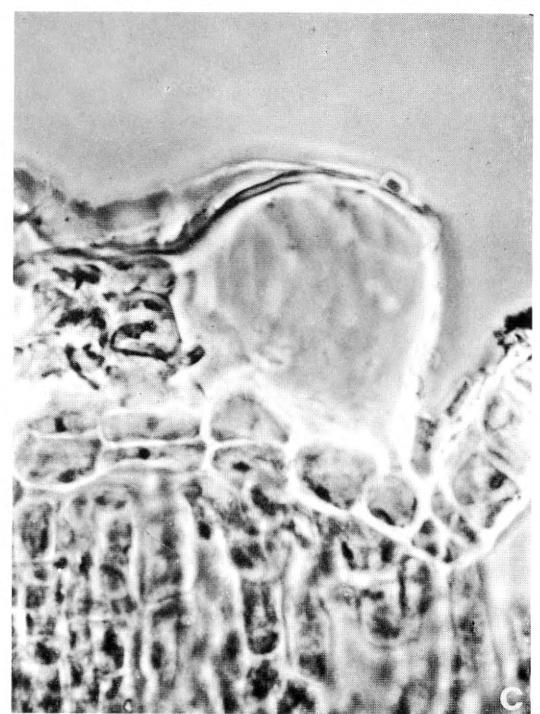
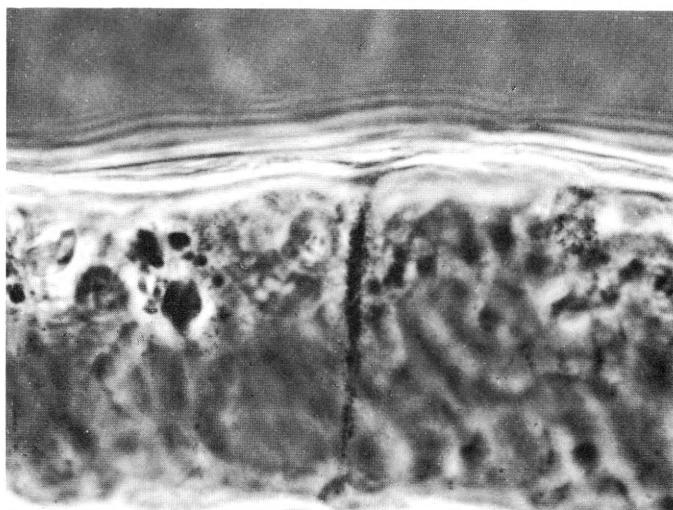
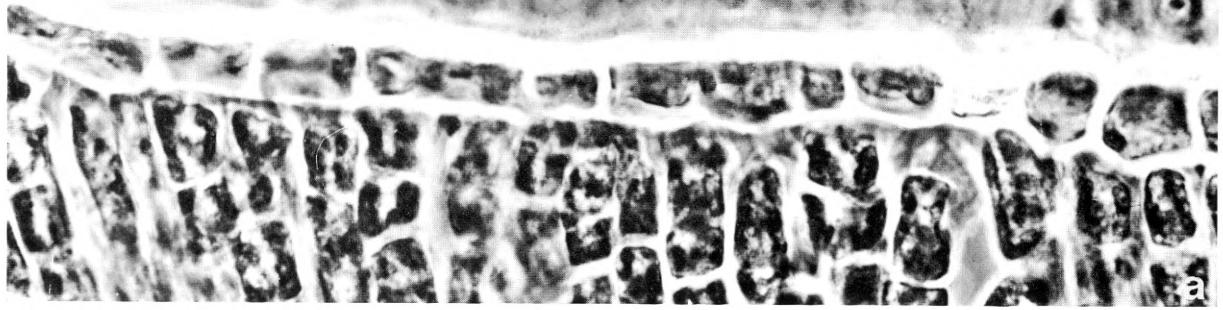
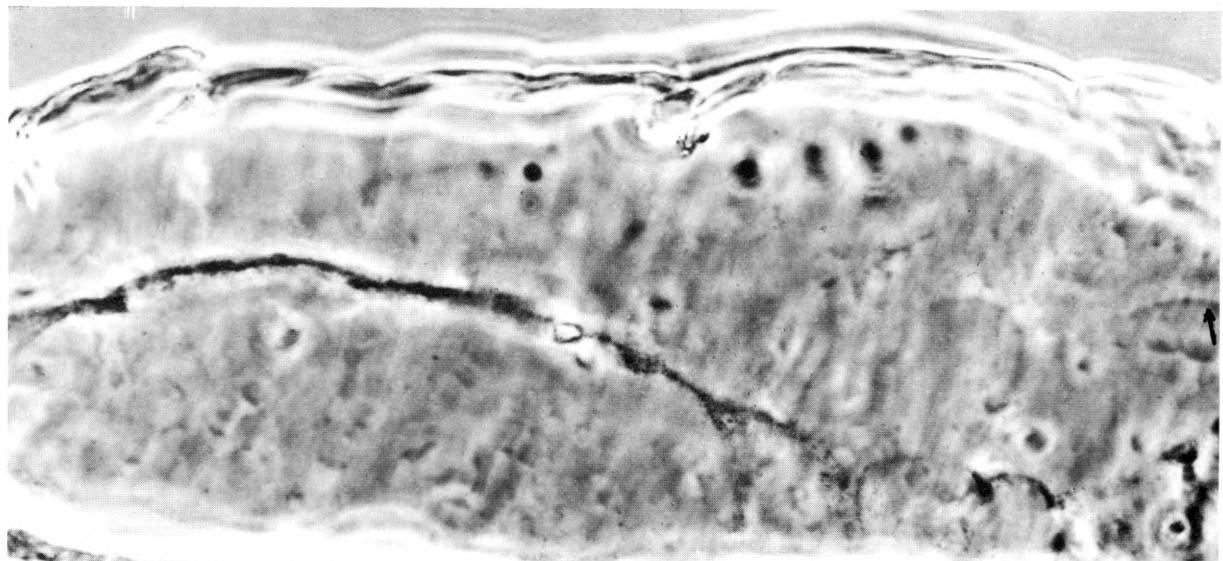


PLATE VI *Monttea aphylla*

a-e transverse sections of cuticular coating, b after staining with methylene blue, a, c-e after treatment with ammonium oxalate followed by 4% NaOH. a and c stained with Nile-blue, d-e with PAS. c-e phase contrast. a $\times$ 264, b-c  $\times$ 320, d-e  $\times$ 800.

- a. Corrosion channels in continuation of anticlinal walls; sometimes two parallel channels situated in two adjacent dome-shaped vesicle-membranes (arrows).
- b. Dome-shaped vesicle membranes stained with methylene blue. Most of them represent one cell only, on the extreme right, however, one semicircle covers at least two cells.
- c. The contents of the vesicles stain dark blue while the corrosion channels appear bright and shining. The cuticular coating loosens from the epidermis (except on the right).
- d. Corrosion channels dark, very numerous, many situated in and upon dome-shaped vesicle membrane. Cuticular coating completely loosened from epidermis.
- e. Corrosion channels very numerous, the longer ones expand abaxially.

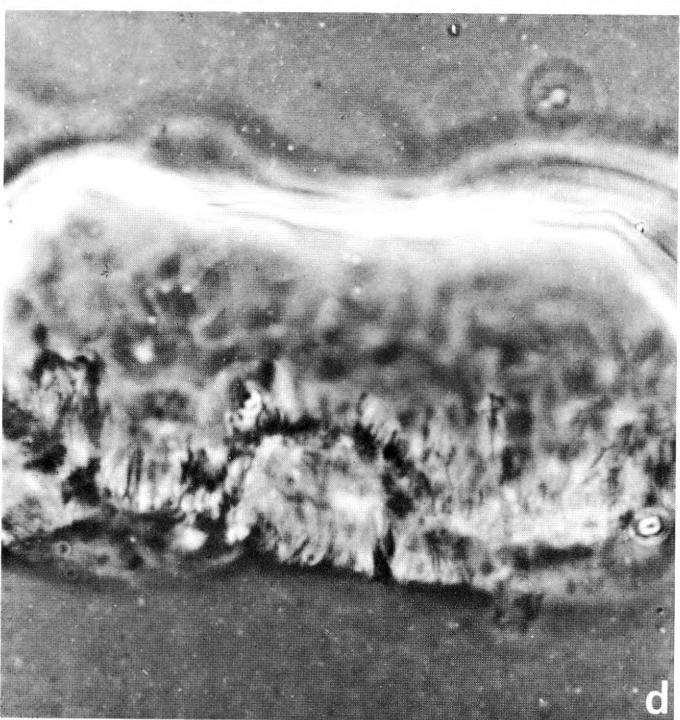
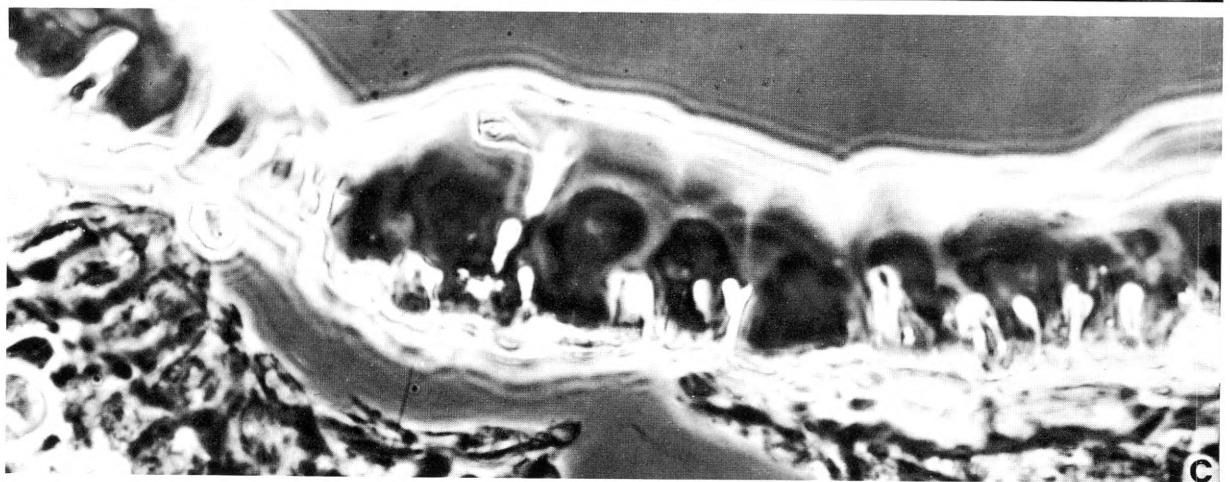
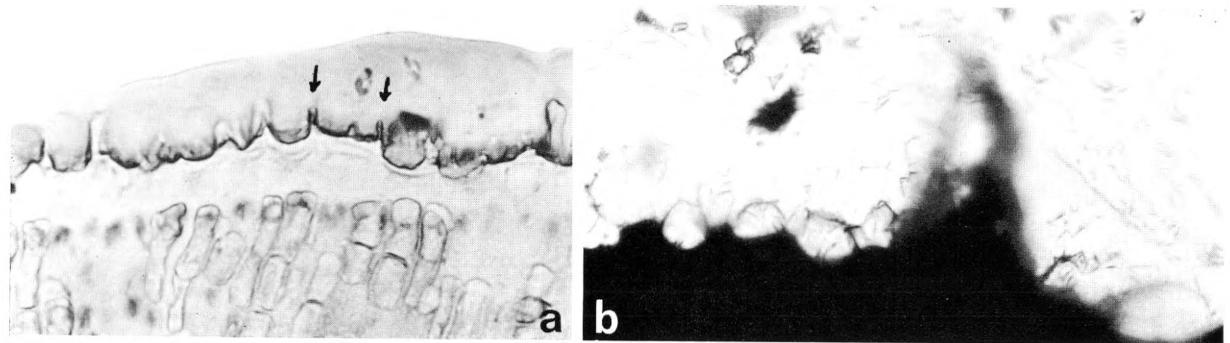
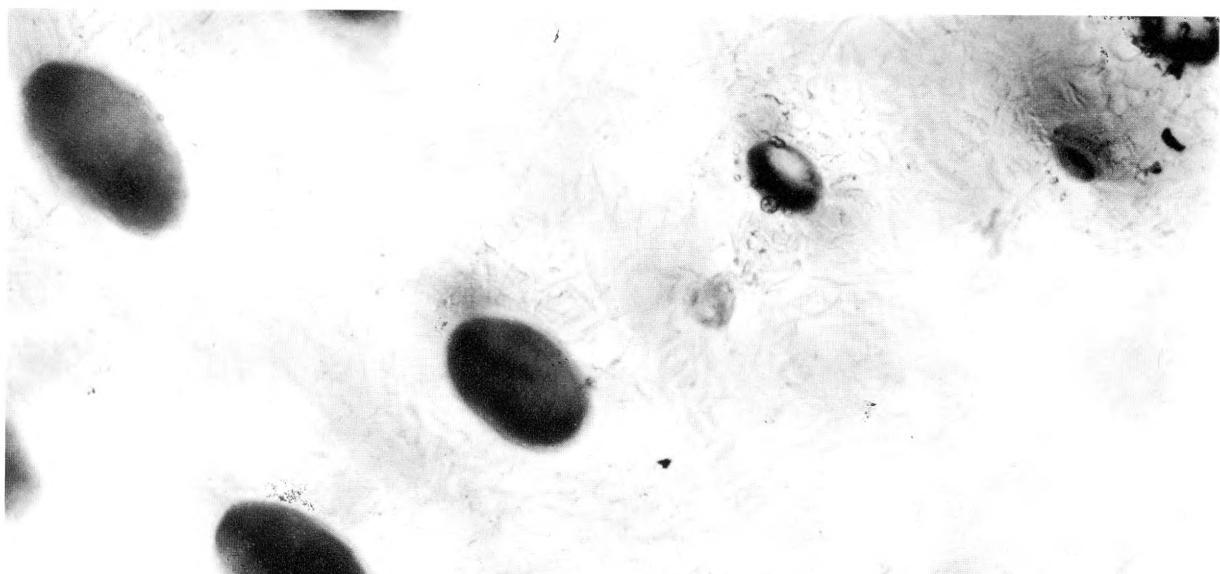


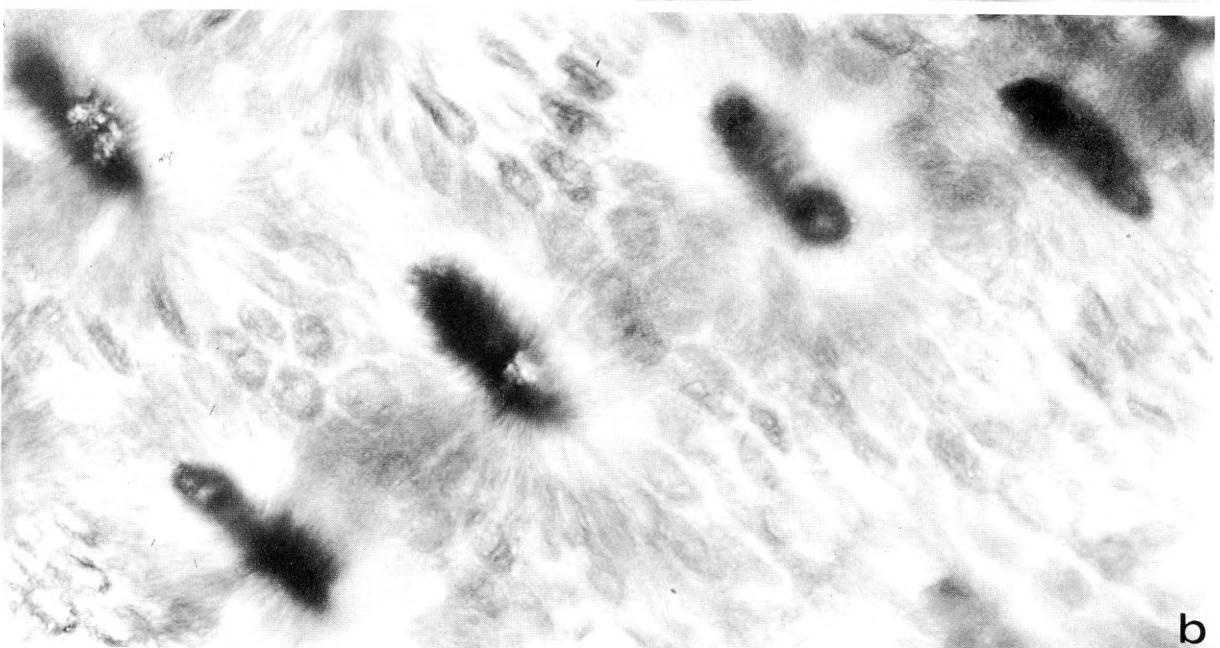
PLATE VII *Monttea aphylla*

a-c  $\times 320$ .

- a. Cuticular coating seen from outside. The cuticle is provided with a system of shallow grooves. The elliptic entrances to the stomatal cavities are very different in size but all orientated with their major axis perpendicular to the axis of the stem.
- b. The same but paradermal view at lower focussing. The cuticle lining the stomatal cavities is finely striated. The contours of epidermal cells beneath the cuticular coating are seen.
- c. Transverse section of epidermis stained with Sudan IV and NaOH. Cuticular coating shrivelled, cuticle of guard cells and subsidiary cells maintained. Note gaps in cuticle immediately inside stomatal pore.



a



b



c

PLATE VIII *Monttea aphylla*

a longitudinal b-f transversal sections through epidermis with stomata. a-e stained with Lightgreen-Safranin, f. with Sudan IV (+ NaOH). a-f  $\times 800$ .

- a. Very young stage near tip of branchlet, note short epidermal cells and small cuticular coating.
- b. Epidermis in leaf.
- c-d. Young branch, in d very active excreting cells forming a thick coating. The stem forms here a ridge which by later growth is smoothed out. At arrow "fork" formed of remains of the outer wall. At the asterisk two thin lamellae covering two less active cells.
- e. Stomatal apparatus.
- f. Stomatal apparatus; cuticle stained with Sudan IV. Note outer ledges partly dissolved by NaOH, cp Plate VIIc.

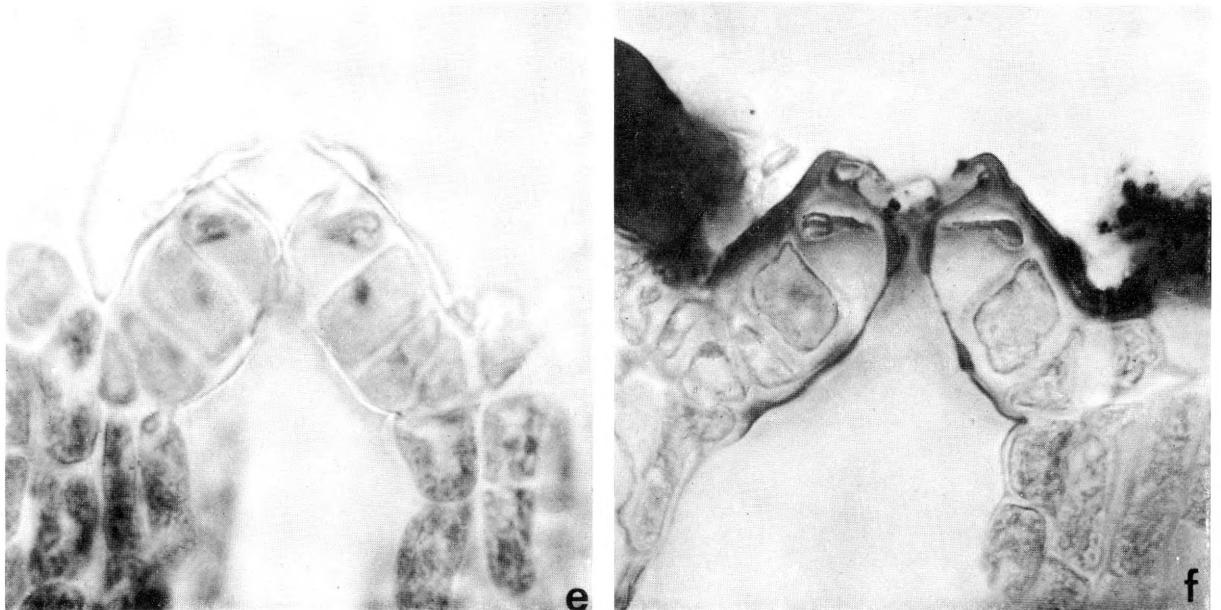
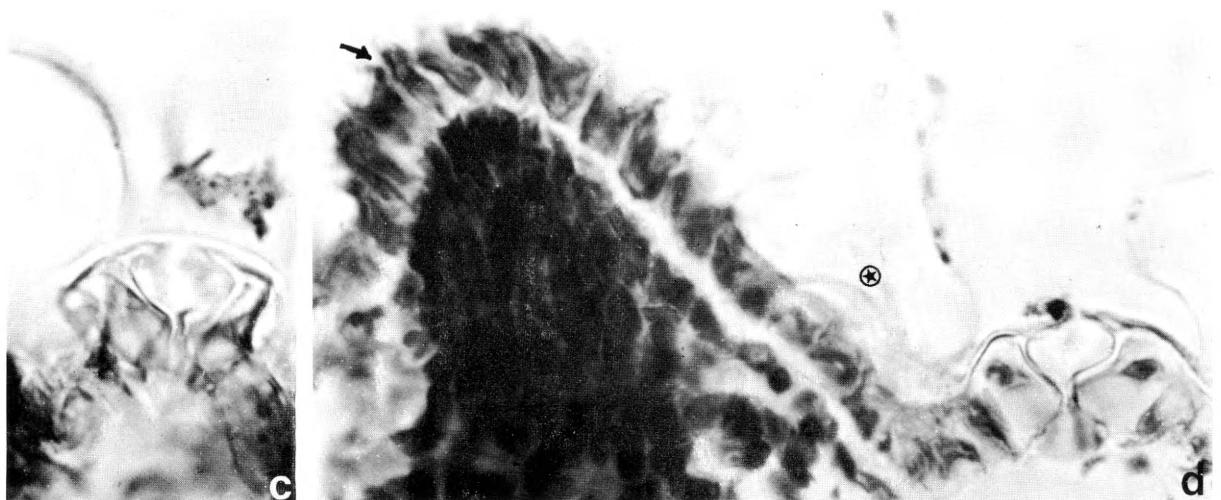
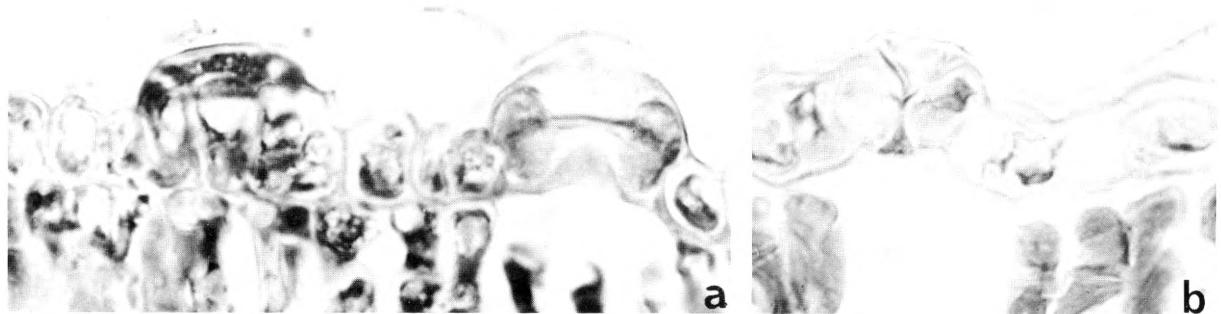
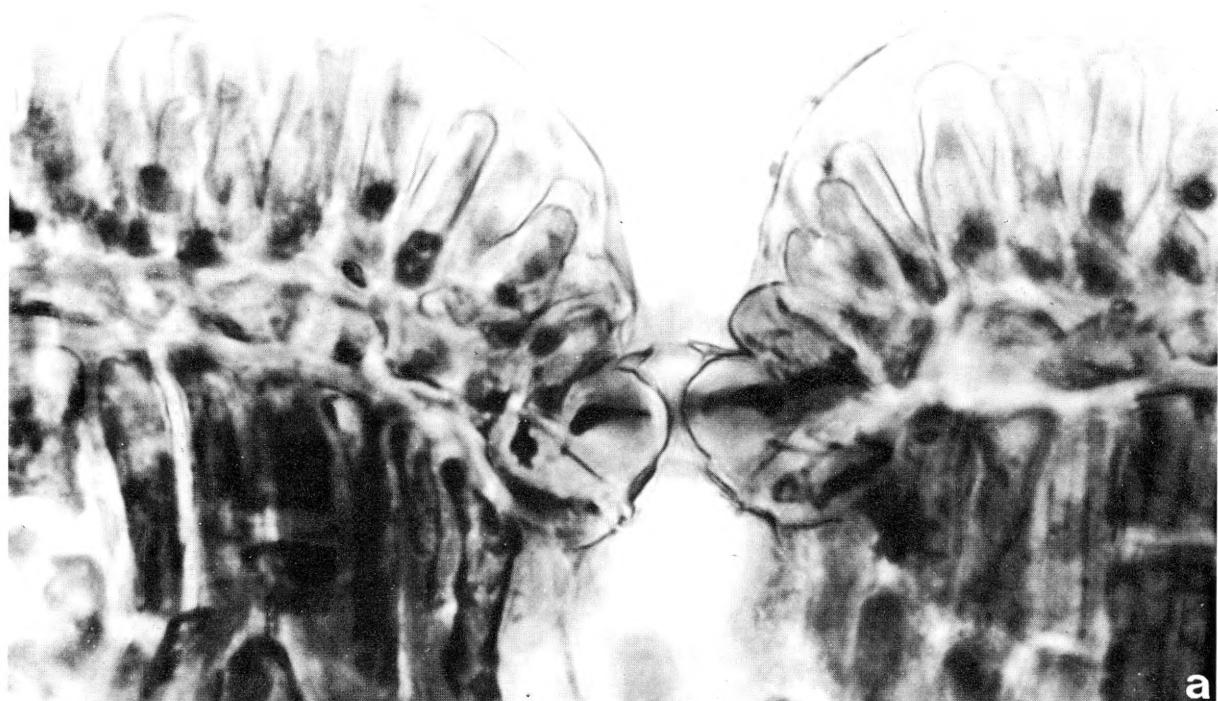


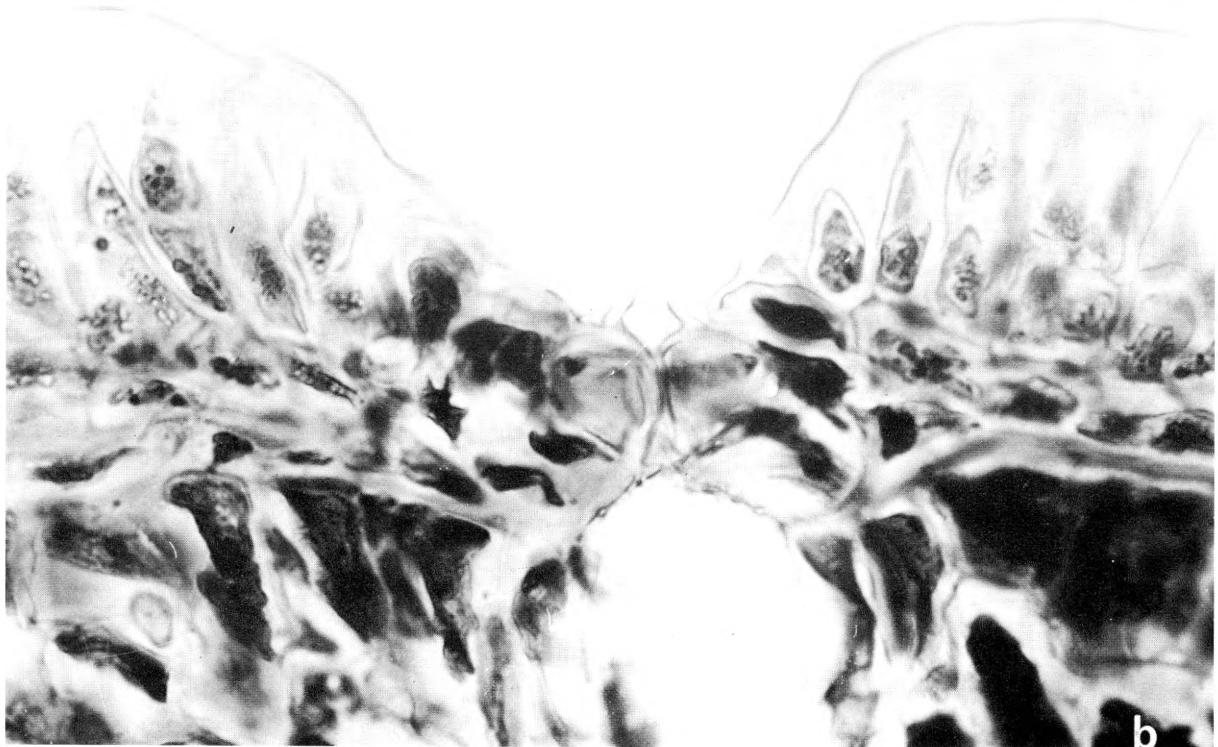
PLATE IX *Bulnesia retama*

Transverse sections of branchlet at stomatal pits.  $\times 800$ .

- a. Young branchlet. In the multiple epiderm there is an outermost layer of narrow elongate cells forming a palisade-epiderm. Below one layer resembling a hypoderm. Front cavity limited by rather long outer ledges.
- b. Older branch. Cells in outer palisade epiderm divided by periclinal walls. Outermost cells withdrawn with pointed tips towards thick stratified cuticular layer, from which wedges are pushed deeply between the cells. Pit above stoma widened, guard cells also with inner ledges. Palisade cells in cortex broader at their abaxial ends or divided by periclinal walls.



a



b

PLATE X *Bulnesia retama*

a-d. Behaviour of outermost epiderm cells. a, protoderm cells, still undivided, b-c, young cells in outermost layer of multiple epiderm, d, old stage showing ruptures in thick cuticular layer, e, cell row; old stage. a stained with Lightgreen-Safranin, b-c, Johansen's quadruple staining. a-d  $\times 1950$ , e  $\times 1024$ .

- a. Many short plasmatic threads (ectodesms?) issuing from outer part of protoderm cell. Probably remain of wax deposit outside the cuticle.
- b. Two pairs of sister cells, each pair originating from one protoderm cell. Cuticular layers broader, ectodesmal structures longer. Cuticle distinct.
- c. The same as b but showing whole cells and on the right one cell divided by an oblique wall, the lower cell probably being able to grow up against the surface, thereby increasing the girth.
- d. After rupture of thick cuticular layer, one cell (probably of the type shown on the right in Fig. c) reaching the place of rupture and starting here to form new outer wall layers. Empty cells on both sides. The increase in thickness of the cuticular layer is considerable (in a about  $8 \mu$ , in b  $15-20 \mu$ , in d a little more).
- e. Cell row in multiple epiderm, the outer cell small. In the cuticular area outside there are four distinct layers. In the top of two of the layers marks after a few strands.

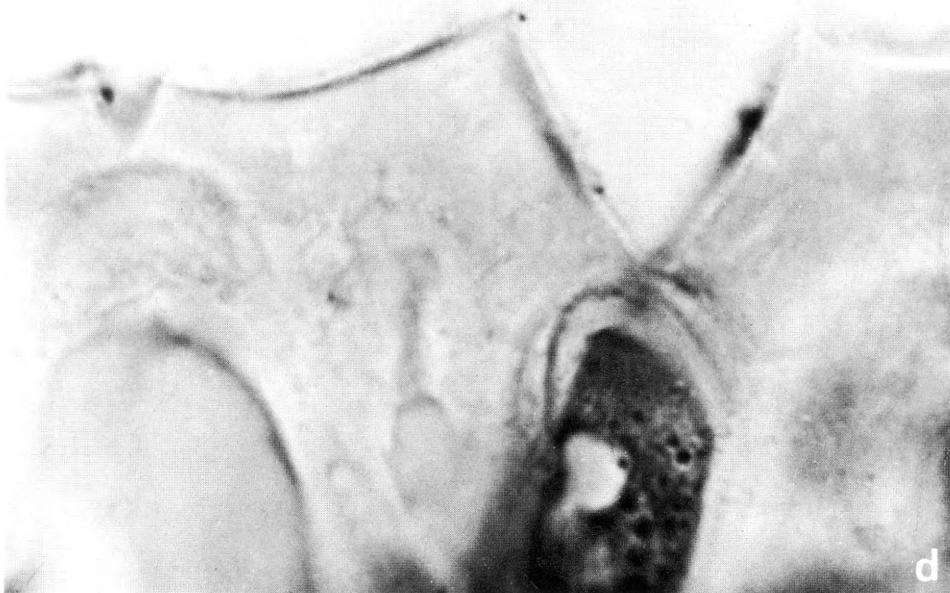


a



b

c



d



e

PLATE XI *Bredemeyera colletioides*

Stomatal apparatus and outer part of multiple epiderm.

a. Johansen's quadruple staining, b Sudan IV, c-e in polarized light, a  $\times 550$ , b-c  $\times 800$ , d-e  $\times 1280$ .

- a. Curved stomatal pitcher. Many lamellae in cuticular layer on the right. Plasmatic nodule near the tip of protruding part of cell covering the pitcher cavity.
- b. Section through central pore in stoma covered with diaphragm. The pitcher is curved as in Fig. a and the very delicate channels leading to the nodule are seen in cross-section as dark points (two in each cell). Heavy cutinization of outer walls and cutinized wedges between outer epiderm cells. Rows of cortical palisade cells.
- c. Entrance to stomatal pitcher showing birefringency of outer cutinized part and hair-like structures ("wax-hairs"). Near the tips of the protruding parts of the cells forming the entrance are two channels, which appear dark on the left where the wall is shining but show up on the right where the surrounding wall is dark.
- d. Guard cells and diaphragm in polarized light.
- e. Part of thick outer wall and wedges. In the broad wedge the middle part is birefringent but appears to be transversed by plasmodesmata. Small shining bodies on the surface and two small merging shining areas on the transition between the inner wall rich in cellulose and the outer cutinized part.

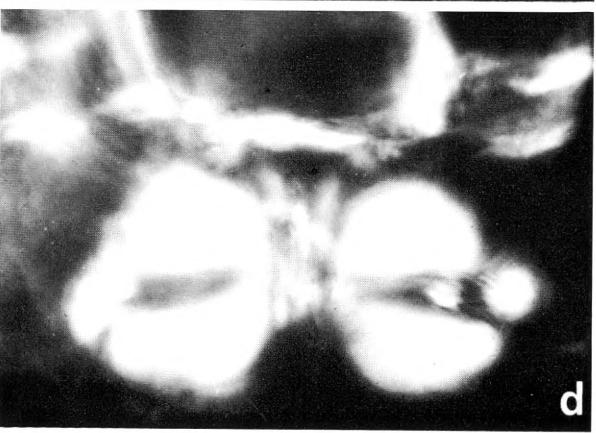
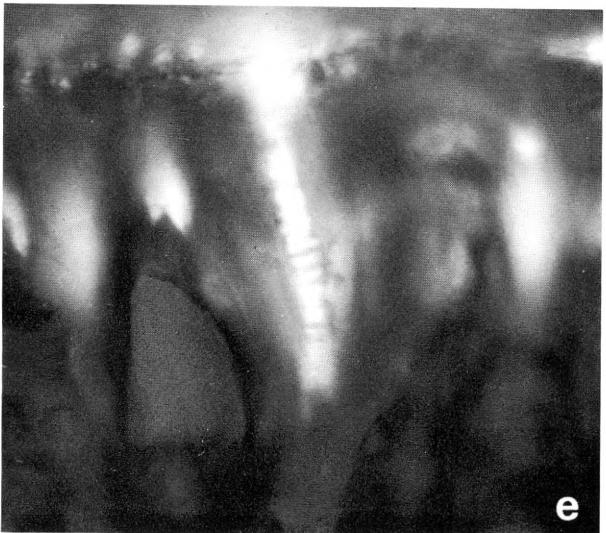
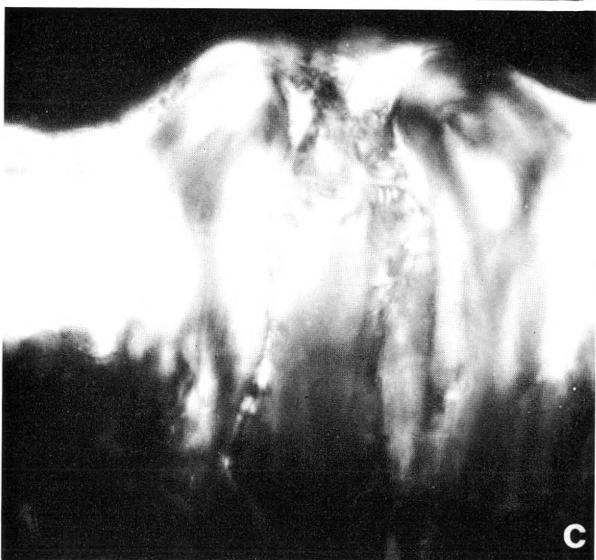
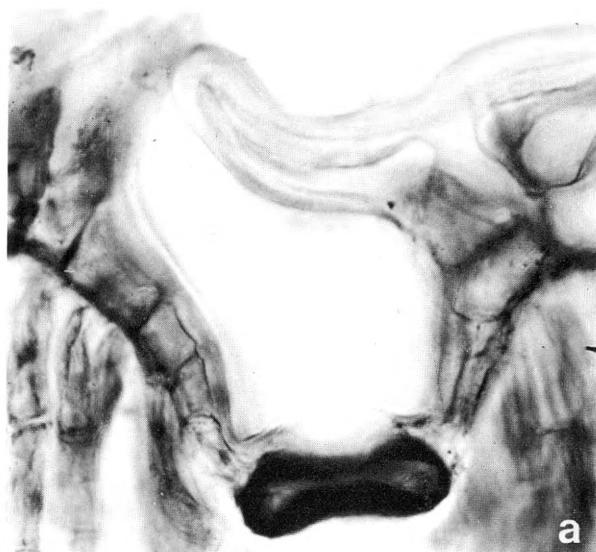


PLATE XII *Bredemeyera colletioides*

Entrance of stomatal pitchers.

a Johansen's quadruple staining, b-e no staining, glycerol mounted slides made from herbarium material, e in polarized light. a  $\times 433$ , b-d  $\times 1950$ , e  $\times 1280$ .

- a. Stomatal pitcher (longitudinal section) which is slightly curved.
- b. Tip of protruding part of subsidiary cell forming entrance to pitcher. On the left dense covering of "wax hairs". In the wall the plasmatic nodule and several very delicate strands issuing from it.
- c. The entrance and outer part of stomatal pitcher showing wax hairs and "wax bridge" on the transition to the pitcher cavity. In the protruding cell wall several very fine strands (ectodesms). Fan-shaped arrangement of the strands above dark area in anticlinal wall.
- d. Entrance of stomatal pitcher in which all "wax hairs" are concentrated at the entrance and stop at the "wax bridge" which in this case appears to be particularly dense.
- e. Entrance and outermost part of stomatal pitcher. At arrows birefringence of two very delicate channels

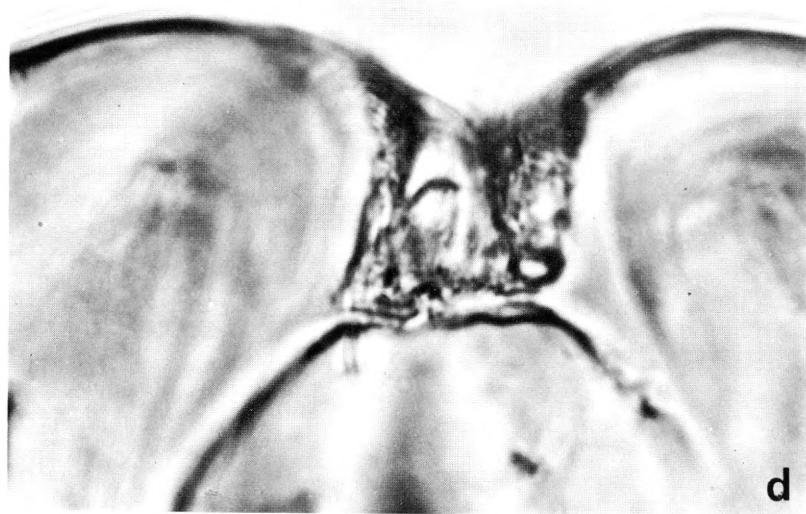
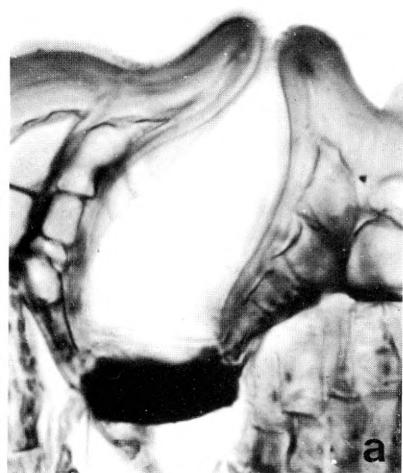


PLATE XIII *Bredemeyera colletioides*

Transverse sections of stomatal pitchers and surface view of guard cells.  $\times 1280$ .

a-b. The same stoma.

a. Plane of diaphragm sharp. Diaphragm with elliptic opening.

b. Central pore between guard cells sharp.

c and d. Transverse sections of outer part of two different pitchers. In pitcher c the stomatal aperture is straight under the opening (dark area in the middle, cp. Plate XIV a-b for continuation at lower focussing). Pitcher d is curved and the stomatal aperture displaced in relation to the outer part of the pitcher (dark round area below, for continuation, see Plate XIV c-d).

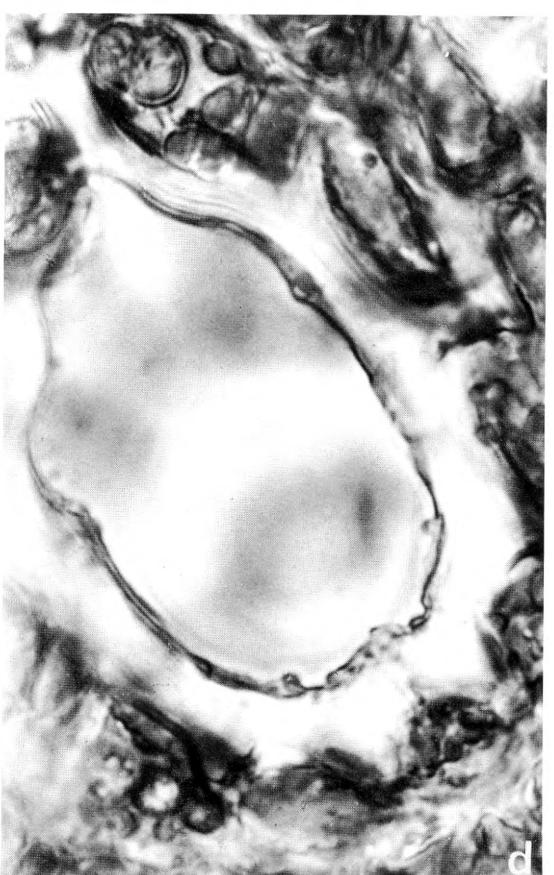
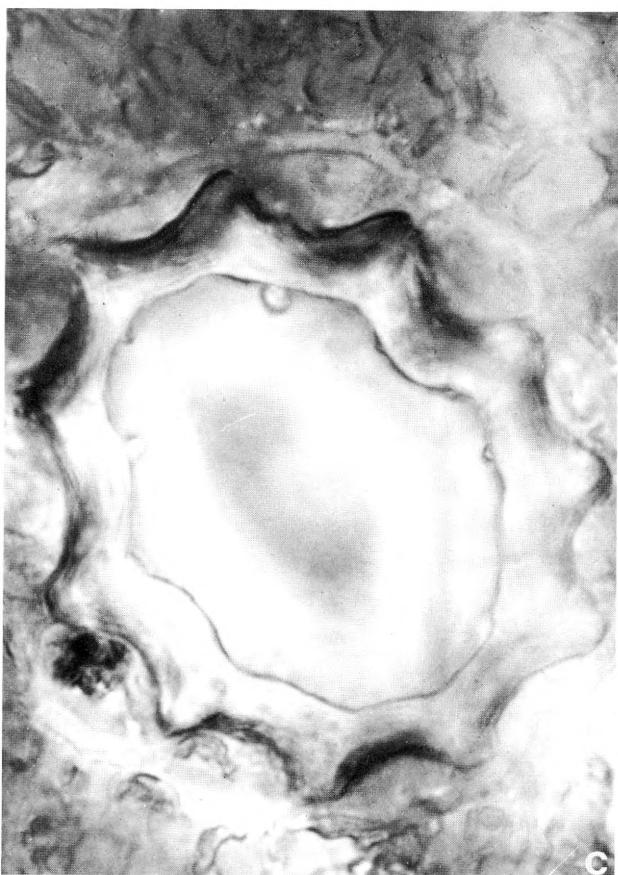
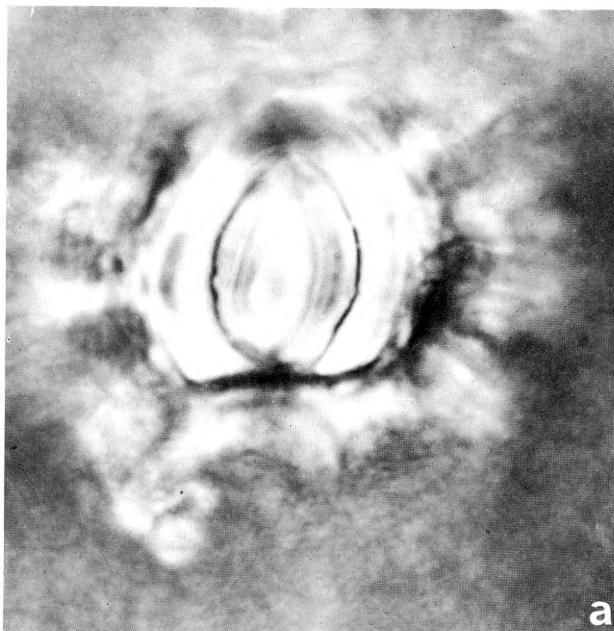
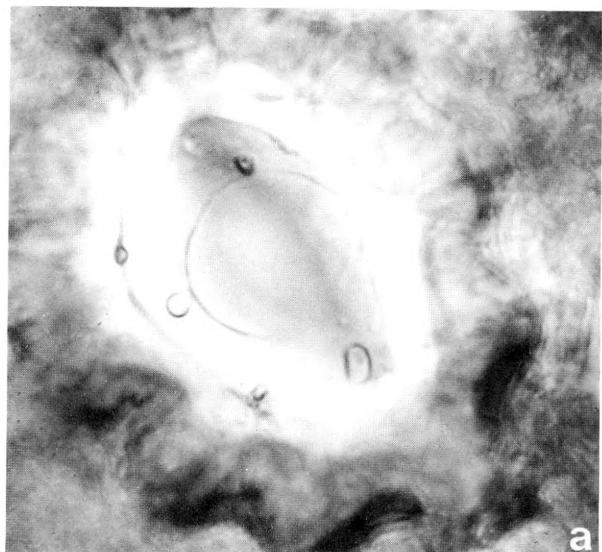


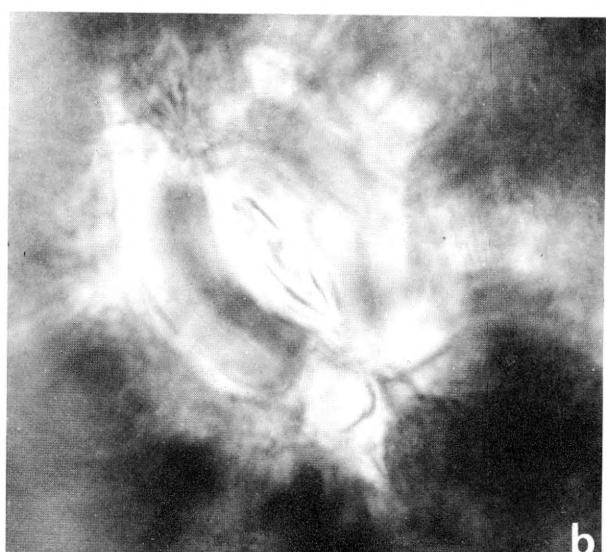
PLATE XIV *Bredemeyera colletioides*

a-d surface views of diaphragm and guard cells. e longitudinal section through mouth of pitcher, f transverse section of mouth of pitcher.  
a-d, f  $\times 1280$ , e  $\times 1950$ .

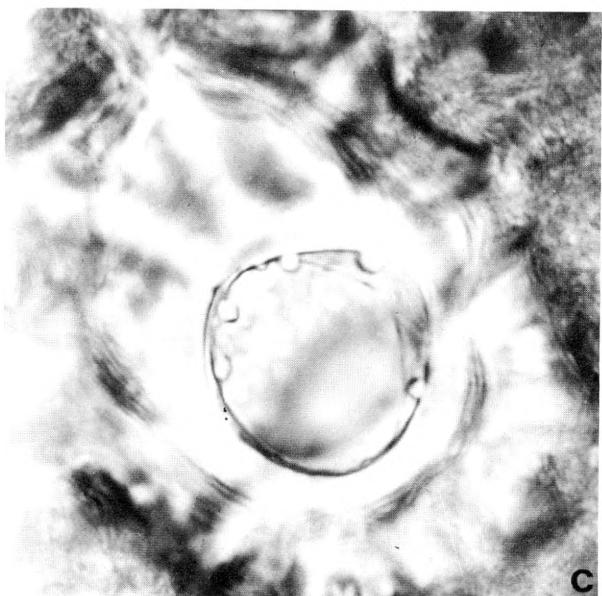
- a-b. The same stoma. — a. Plane of diaphragm sharp with circular opening — b. Plane of central pore between guard cells sharp.
- c-d. The same stoma. — c. Eccentric circular opening in diaphragm. Five small rounded teeth and some delicate threads (probably wax) at the margin of the opening. — d. Central pore seen obliquely below opening in diaphragm.
- e. Upper parts of four uppermost subsidiary cells cut, showing plasmatic nodules, channels and delicate strands (ectodesms?) radiating towards the periphery.
- f. Mouth of pitcher seen from inside. Five connections to cell lumens cut. On the left the connecting channels merge and form nodules.



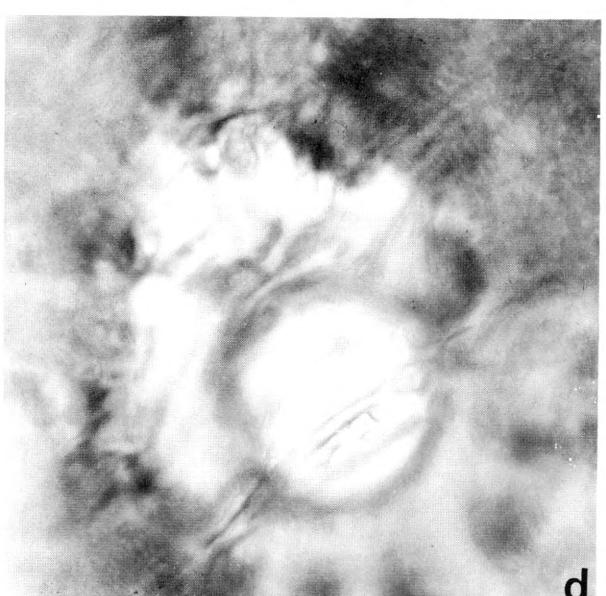
a



b



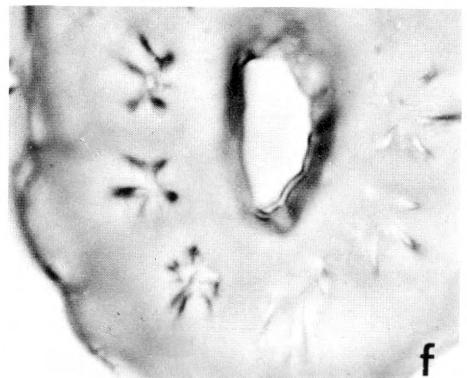
c



d



e



f

PLATE XV *Bredemeyera colletioides*

Sections through multiple epiderm. a-b outermost cells with thick cuticular layer, c area with three stomatal pitchers, d-e longitudinal sections of guard cells. — All stained with Johansen's quadruple stain. — a  $\times 1950$ , b  $\times 1342$ , c  $\times 320$ , d-e  $\times 537$ .

- a. Clear layering in cuticular layer, in the lefthand cell one delicate channel connecting cell-lumen with area which is filled with radiating dark structures (ectodesms?).
- b. Cell showing two plasmatic platelets from which very delicate strands radiate towards the periphery.
- c. The two stomatal pitchers on the left are cut through the guard cells, in the second from the left the diaphragm formed by the outer ledges is seen. On the right protruding mouth of a pitcher (with five plasmatic nodules).
- d-e. d. Section through central opening diaphragm. e. Section through the diaphragm.

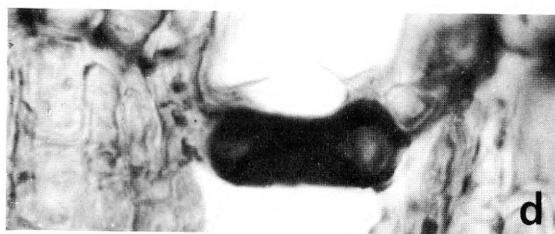
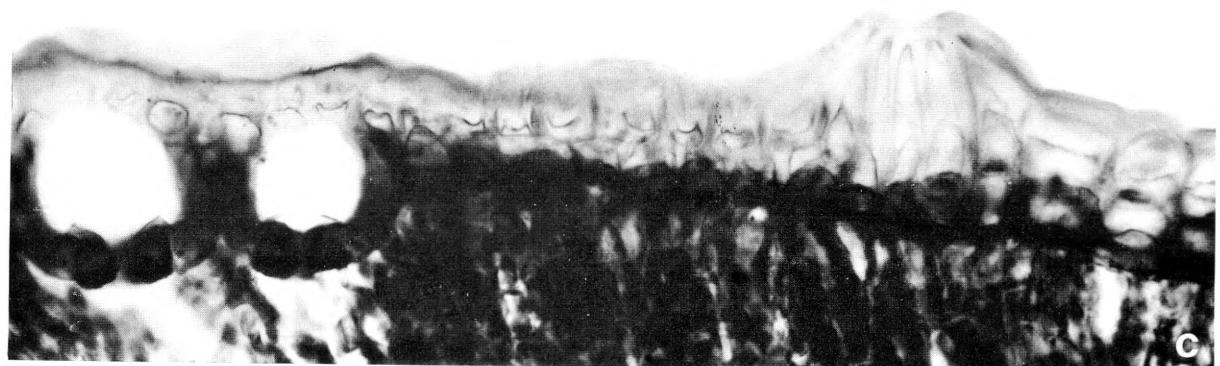
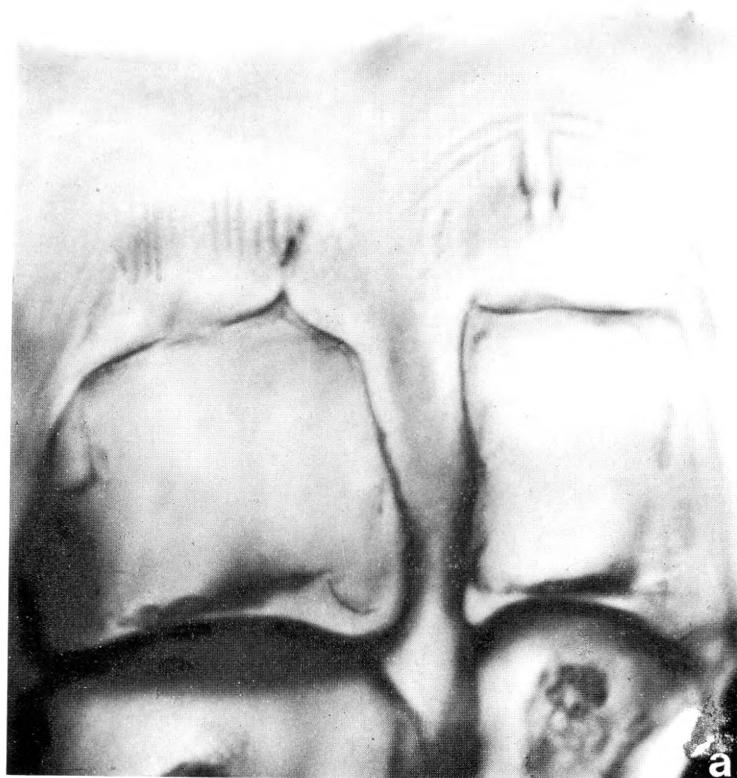
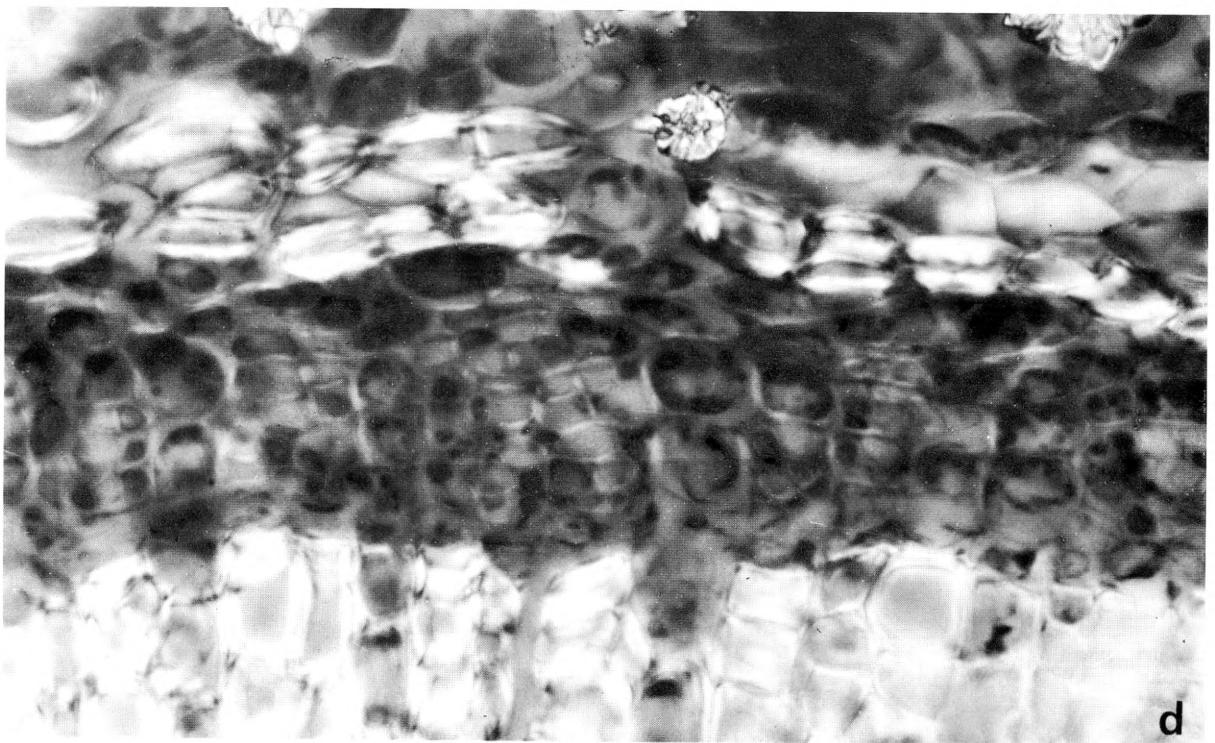
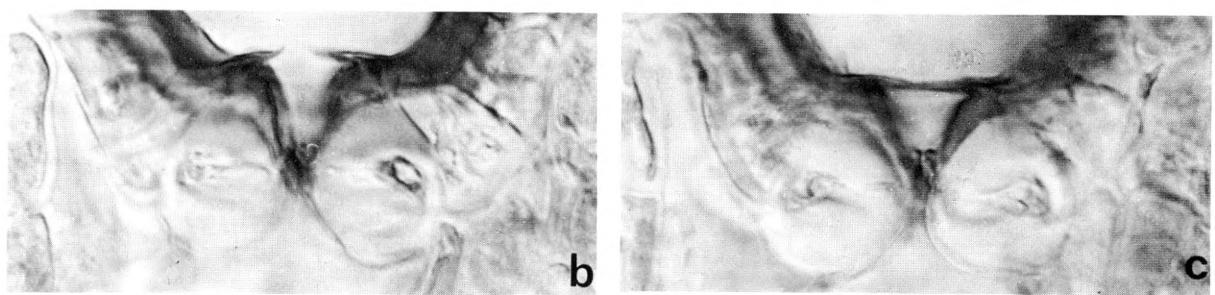


PLATE XVI *Bredemeyera colletioides*

a-c transverse sections of guard cells. — d. transverse section of extraxylary fibre band, phloem, cambium and xylem. a-c stained with Sudan IV, d as seen in polarized light. a  $\times 1950$ , b-d  $\times 800$ .

- a. Diaphragm covering large part of front cavity. Walls of central pore heavily cutinized, inside the central pore the surface is folded and covered with a cuticle.
- b-c. Stoma at two different focussings showing opening in the diaphragm (b) and heavy cutinization of front cavity.
- d. Crystal druses in inner part of cortex, extraxylary fibre band (pericyclic, with passage of living parenchymatous cells in the middle), phloem and poorly developed cambium, xylem with many rays.





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TYGE CHRISTENSEN

# VAUCHERIA COLLECTIONS FROM VAUCHER'S REGION

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### Synopsis

Modern taxonomy in the algal genus *Vaucheria* goes back to the basic but somewhat controversial work published by VAUCHER in 1803. This author distinguishes eleven species, ten of which are typified by illustrations and descriptions of plants from the Geneva region. The present paper gives an account of recent *Vaucheria* collections from the same region. The information gathered is intended to serve as a clue to the taxonomy of VAUCHER, at the same time adding to general knowledge of the species.

## Aims of Investigation

The present paper has two purposes. One is to improve knowledge of the Central European species of *Vaucheria* by studying their morphology and their occurrence in nature within a restricted area. The other is to solve some problems as to the identity of species established by VAUCHER (1803), by choosing for such study the region round Geneva where VAUCHER's observations were made.

For these two purposes the algae have been dealt with mainly as they appear when collected in nature. As some species may occur in running water, in stagnant water as well as on soil, this approach gives a good deal of variation even in a material that is genetically homogeneous or nearly so. More details of such variation mean a more precise concept of the species in question and knowledge of how the plants may appear in nature in this region is a prerequisite for a true understanding of VAUCHER's descriptions. On the other hand, the phenotypical variation may obscure smaller genotypical differences. Such differences are to be studied by growing related plants under equal culture conditions. For that purpose, however, strains from other parts of the world should be included along with plants from the Geneva region, which leads beyond the scope of the work undertaken here.

## Material and Methods

Collections were made on 19–20 June 1954, 17–22 April 1957, 11 Sept. 1963 (only a few samples), 26 Oct. 1963, 2 April 1965 and 14–15 Feb. 1967. All the samples are from the area shown in Fig. 1.

In dealing with the material each species in each sample has been given a number of its own, and each drawing has been designated by a letter added to this number. These numbers and letters have been used in labelling the illustrations instead of an ordinary system of consecutive letters, because they enable the reader to see immediately whether two drawings of a given species show plants from the same collection or from different collections. "cr. c." after this designation indicates that the drawing in question shows material from a crude culture.

A magnification of  $100\times$  has been used throughout except in Fig. 17. This makes it possible to read all dimensions from the figures by means of a centimeter rule, rendering superfluous the large number of measurements which would otherwise be

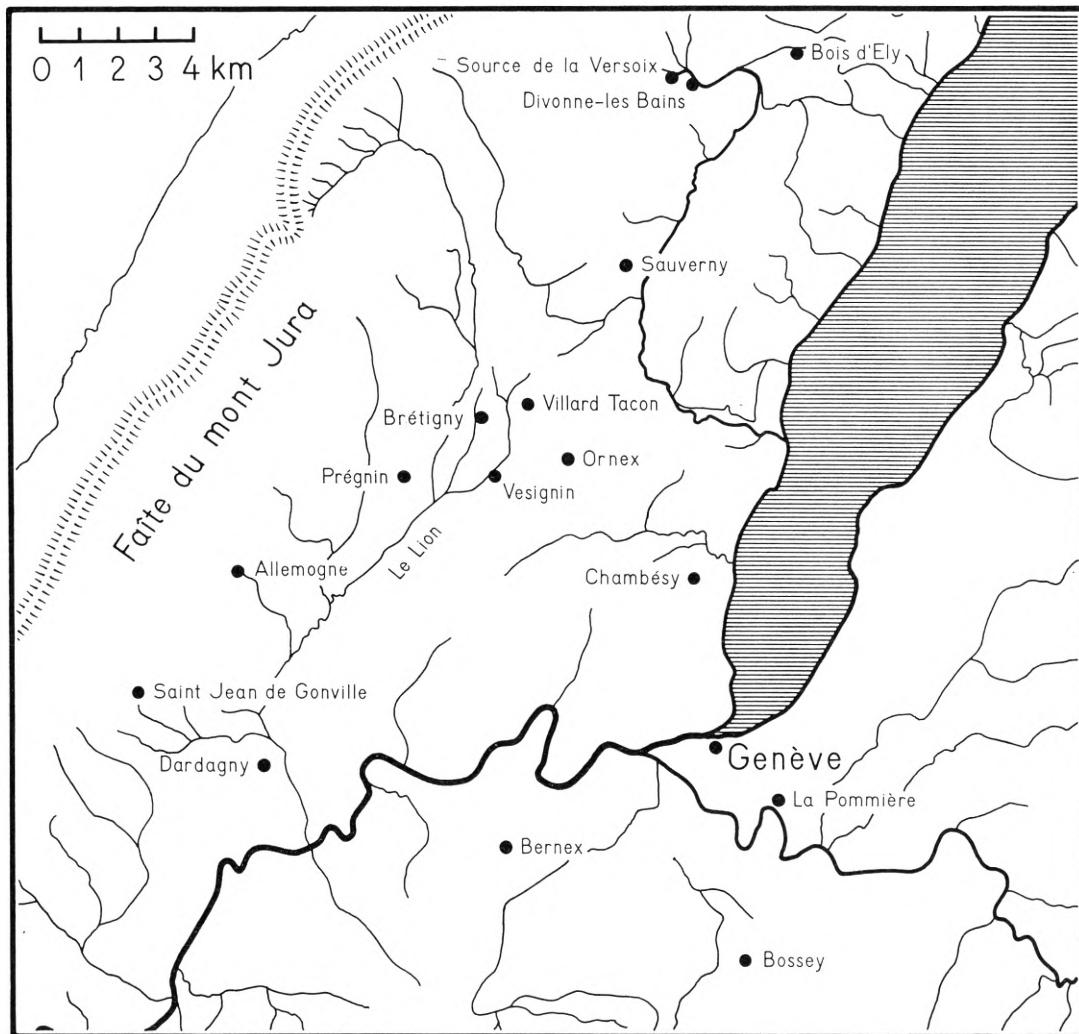


Fig. 1. Map showing the area of collecting and the places mentioned in the text.

given in the text. In all cases drawings were made from material kept in glycerol, which means that the dimensions are slightly smaller than in living plants.

The illustrations are mainly line drawings made with a uniform thickness of lines. In the case of thick-walled oospores, however, the thickness has mostly been especially accounted for, and the same applies to various other cases of remarkably thick-walled structures. Such walls often swell in glycerol and, consequently, may have been rendered thicker than they are in living material. Strongly gelatinized oogonial walls have been omitted, the outline of the oospore being shown instead. Shading in Fig. 17 is arbitrary and has also been applied to parts that were dead and empty at the time of collection.

### Comments on the Individual Species

The material falls into eleven distinct taxonomic entities, referred to in the following by the letters *A* to *K*. Their sequence has been chosen to allow for the most convenient system of cross references, with no regard to natural affinities.

*A.* (Figs. 3–5). *Vaucheria canalicularis* (L.) T. CHRISTENSEN 1968, *Confervula canalicularis* L. 1753, *Vaucheria disperma* DC. 1801c, *Ectosperma ovata* VAUCH. 1803, *Ectosperma cespitosa* VAUCH. 1803, *Vaucheria cespitosa* (Vauch.) DC. in LAM. et DC. 1805, *Vaucheria geminata* var. *caespitosa* STOCKM. 1890, *Vaucheria geminata* sensu GÖTZ 1897, non vel partim modo *Vaucheria geminata* (Vauch.) DC. in LAM. et DC. 1805, *Vaucheria woroniniana* HEERING 1907.

This is the species first studied by VAUCHER in its sexual condition, and undoubtedly also that first studied with aplanospores. VAUCHER found plants with aplanospores in the autumn of 1799, and in the course of the following winter carried out a veritable culture experiment with them, collecting the spores in December, observing their germination in February, and in April finding that the new-formed filaments bore spores similar to those collected in nature. A report on these observations was first presented at a meeting in Geneva on 17 April 1800, and later printed in Paris (VAUCHER, 1801). The alga with aplanospores was referred preliminarily to *Confervula fontinalis* L. taken as a collective species. In his final account VAUCHER (1803) named it *Ectosperma ovata*.

Before presenting his observations on the plants with asexual spores, VAUCHER also found filaments with sexual organs. He saw both antheridia and oogonia, and correctly interpreted them as male and female organs. Unfortunately he also considered the aplanospores to be the result of a fertilisation process, taking some sporangium initials for the male organs. Besides, his sexual plants were found in the cascades at the source of the Versoix River (Fig. 2), while the asexually reproducing material had been collected in muddy ditches. So VAUCHER was lead to regard his two finds as representing two different species. An illustration and a brief description of the sexual plant were included in his first report (VAUCHER, 1801).

In the summer of 1800 VAUCHER made some germination experiments with spores from the Versoix River source, and afterwards wrote a report dealing exclusively with this plant. This report, dated 8 Aug. (VAUCHER, manuscript 1800) and a plate in water colours were sent to "l'Institut" in Paris. They were presented on 8 Sept., 1800 (cf. Institut de France, Académie des Sciences, 1912) at a meeting of the "Classe des Sciences Physiques et Mathématiques", which for some years after the revolution replaced the Academy of Sciences, and they are still kept in the archives of the Academy.

The second report by VAUCHER was never published as such, but VAUCHER's former pupil A. P. DE CANDOLLE, then a student in Paris, wrote a brief summary of it for a monthly abstract journal (CANDOLLE, 1801b). On the same occasion DE CAN-

DOLLE epitomized VAUCHER's first report (CANDOLLE, 1801a), the summary being accompanied by a reproduction of some of the illustrations made for this report, including that of the plant from the Versoix River source.

Shortly afterwards DE CANDOLLE published a paper of his own, suggesting a subdivision of the genus *Confervaria* and introducing among others the generic name *Vaucheria*. One of the species referred to this new genus was VAUCHER's plant from the Versoix River source, now named *Vaucheria disperma* by DE CANDOLLE. As had been the case with VAUCHER's first report, the contents of DE CANDOLLE's paper were first summarized in the abstract journal (CANDOLLE, 1801c), later published in full (CANDOLLE, 1802). The short Latin diagnosis is given in both publications. For a detailed description and an illustration of the species reference is made in the first case to the summaries by DE CANDOLLE (1801a and b), in the latter to the paper by VAUCHER (1801), published in between.

VAUCHER, in his final comprehensive account (1803) modestly refused to accept the generic name *Vaucheria*, and instead called the genus by the new name *Ectosperma*. For the plant from the Versoix River source he introduced the epithet *cespitosa*. The illustrations and part of the text are taken from his unpublished second report (VAUCHER, manuscript 1800). Besides, there is a reference to the description in his first report (1801), whereas no mention is made of the specific name suggested by DE CANDOLLE (1801c).

In the third edition of LAMARCK's Flore Française (1805), DE CANDOLLE accepted the specific name preferred by VAUCHER, but combined it with the generic name *Vaucheria*. The epithet *disperma* was added as a synonym.

WALZ in his monograph (1866) discarded most of VAUCHER's species, among these *E. cespitosa* and *V. geminata*, but uncautiously used some of the epithets for species independently described by himself. Thus the epithet *geminata* was applied to a "new species" which was, at least in part, *Vaucheria cespitosa* (Vauch.) DC. This started some confusion which, through a sequence of errors in reading and observation, lead to a merging of *V. cespitosa* (Vauch.) DC. into *V. geminata* (Vauch.) DC., along with the synonym *V. disperma* only remembered by few authors. STOCKMAYER (1890) pointed out some important differences between the two entities but accepted them as varieties of the same species because of a wrong interpretation of the galls correctly interpreted by VAUCHER. GöTZ (1897) realized that there were two independent species but applied the epithet *geminata* to the wrong entity, and finally HEERING (1907), correcting this, introduced the new epithet *woroniniana* for the species erroneously called *geminata* by GöTZ.

The specific identity between *Vaucheria disperma/cespitosa* on one side and *A. Vaucheria canalicularis* on the other appears both from VAUCHER's description and from his observations on the ecology. The arrangement of the oogonia on the fruiting branch of *V. disperma* is that of either *A* or perhaps *C* and—although VAUCHER's figure is not very detailed—can hardly fit with any other species. In the 1803 illustration all sets of fruiting organs are shown in a terminal position on long shoots. This



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Fig. 2. Source of the Versoix River springing from several outflows at the bottom of a wooded slope.

is common in both *A* and *C* when growing in dense tufts, while in all others terminal fruiting is something exceptional. The tufted growth described by VAUCHER and referred to by the specific name *cespitosa* is a regular phenomenon in *A* when the plant grows at the edge of swiftly running water (it was also referred to by the name given to it by DILLENIUS, 1741). Something similar may be found in *C* though more rarely.

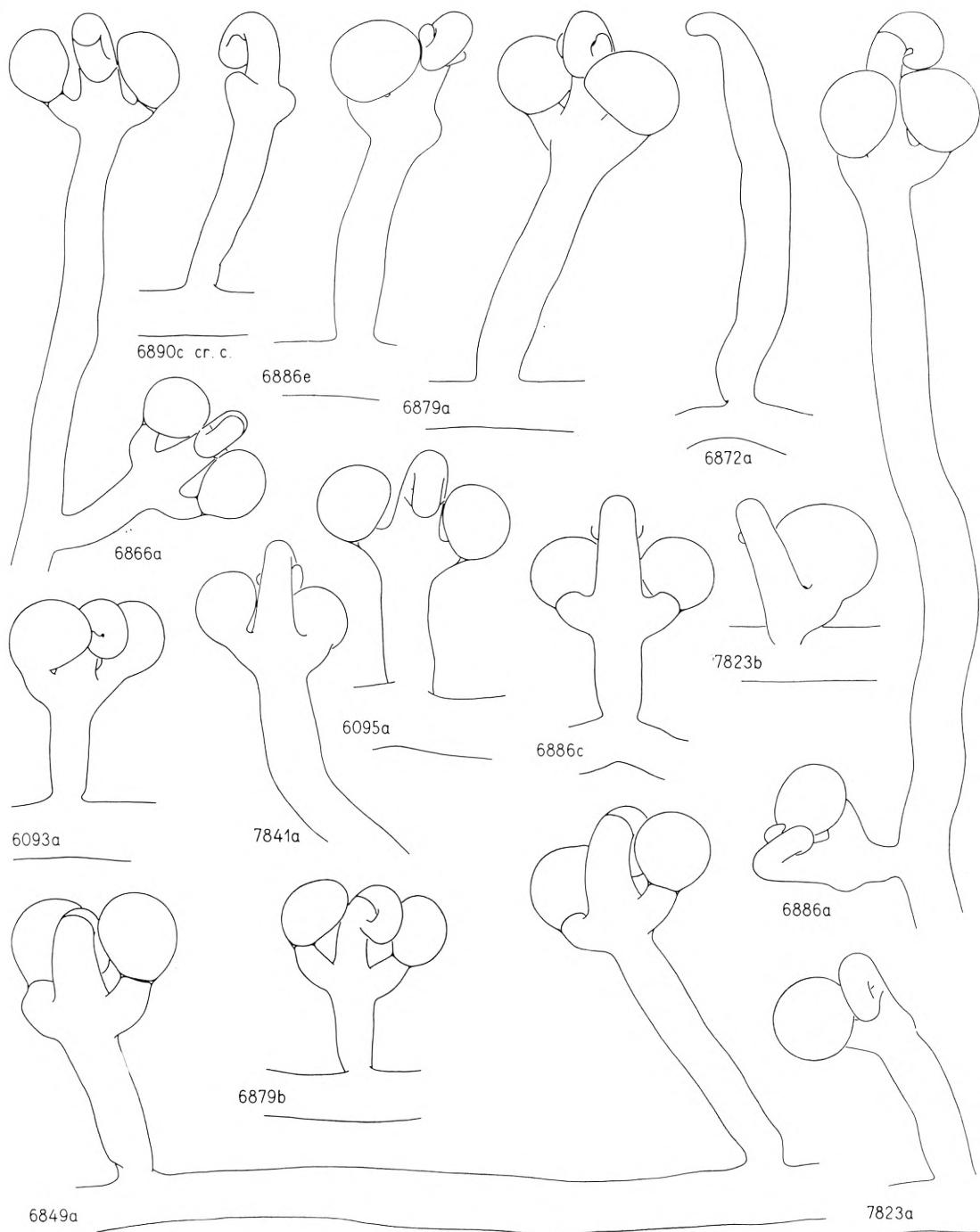


Fig. 3. A; *Vaucheria canalicularis*, sexual organs.  $\times 100$ .

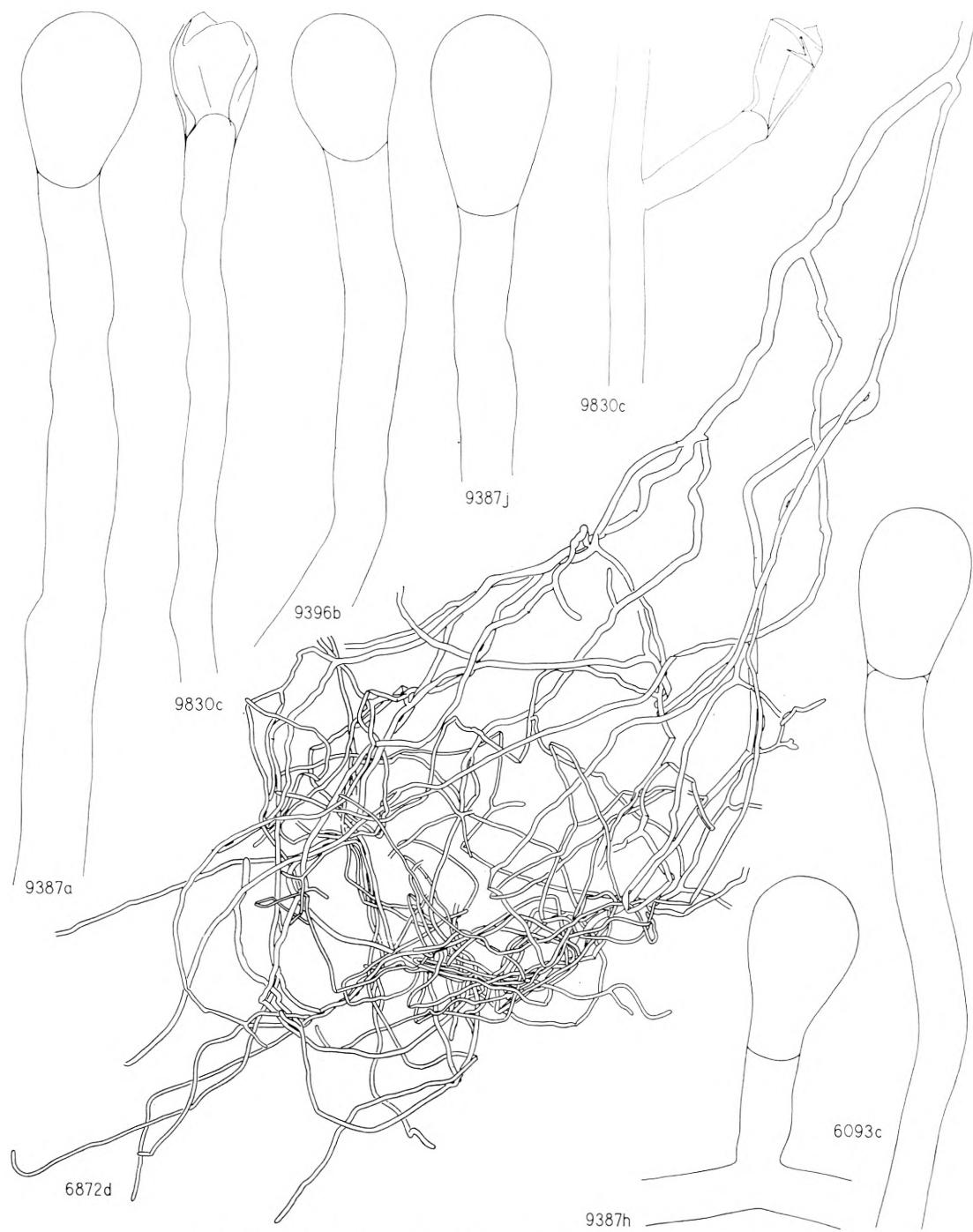


Fig. 4. A; *Vaucheria canicularis*, rhizoids and aplanosporangia.  $\times 100$ .

However, since *C* is covered by VAUCHER'S *Ectosperma cruciata*, said to be much the thinnest of the species with two oogonia per antheridium, *A* must be the plant covered by his *cespitsosa*, previously named *Vaucheria disperma* by DE CANDOLLE. As to the ecology, VAUCHER says that *Ectosperma cespitsosa* is abundant in all the sources at the foot of the Jura Mountains and that it is the only species he has found in them. Today *A* is dominant in the same places. *C*, *E* and *J* have also been found in such places by the present author, but they do not occur with such regularity nor in such abundance as *A*, and their appearance in nature is different from that described by VAUCHER for *Ectosperma cespitsosa*. VAUCHER found that *E. cespitsosa* abounded in the source of the Versoix River and first studied it here. Today, in most seasons *A* is very abundant a little below the source, where the stream receives more light. The source itself is perhaps more shaded than in the days of VAUCHER (cf. Fig. 2), but *A* has been found there at all visits though less plentiful, and no other species has been noticed except for a little of *E*.

Thus there is ample evidence that *Vaucheria disperma* is identical with *A*. It may be added that this species is very common and very conspicuous in the aquatic and semiaquatic habitats of the Geneva region. So it must inevitably be among the species dealt with by VAUCHER and it seems natural that this was the species first observed by him as to sexual as well as asexual reproductive organs before he turned his eye to other species.

Nearly half the author's collections are from ditches. VAUCHER collected his material of asexually reproducing plants in ditches (the author has it from the Versoix River source as well) but does not mention the sexual *E. cespitsosa* from such places. It seems improbable that he never found sexual stages in these environments. More likely he did not realize that such sexual plants represented the same species as his finds from the sources. Instead, he may have referred them to his *E. geminata*, cf. p. 12.

In the author's material a large majority of the samples with *V. canalicularis* also contain other species. As appears from Table 1 (p. 29) the forms most commonly found together with it are *V. cruciata*, *V. frigida* and *V. bursata*. Without exception, the stations are associated with running water. A little less than a third of the samples are from swift waters, where the plant is mostly found as densely tufted masses at the water's edge. A smaller fraction are from slow water courses or stagnant waters such as ponds with brooks running into them and ditches with little water left. In such places the species forms loose masses of relatively long filaments when growing submerged, and dense mats where there is very little water left, as on the bottom of ditches that are drying out. More than a third of the samples come from shady places at the border of streams and ditches. Unlike the lawn-like growth found in very shallow sheets of water on the bottom of ditches exposed to full day-light, the plants growing on soil above the water normally form an open tangle of creeping filaments. Finally three samples are from level ground with a terrestrial phanerogam vegetation but situated less than a meter from a freshwater course.



Fig. 5. A; *Vaucheria canicularis*, deformations caused by parasites. Smaller fungal sporangia not shown.  
x 100.

In 36 of the 51 samples sexual organs are found. 6 collections have both oospores and aplanospores, and 6 have only aplanospores. Most of the aplanospore-forming samples are from October, while the percentage of sexually reproducing plants is about the same at all seasons of collecting, except that most samples from February are sterile.

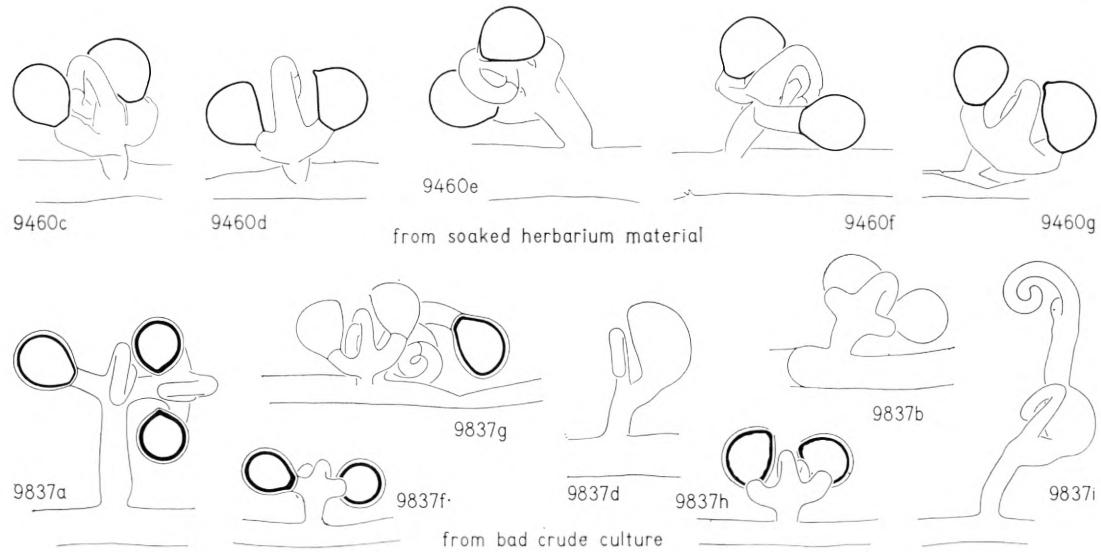
Gall formation caused by the rotatorian *Proales werneckeri* (Ehrb.) occurs in two samples, both collected in October and both with sexual organs and aplanosporangia as well. One of them was taken in the Versoix River at Divonne-les Bains. In this, most of the galls are relatively narrow with two openings at the top and sometimes one or more at the base (Fig. 5, 9387). In the other sample *V. canalicularis* is mingled with *V. frigida* and *V. bursata*, collected amongst moss on a stone in the brook that separates Switzerland and France near the road between Dardagny and St. Jean de Gonville. In this, the breadth of most galls is greater than the length and the more elongate types are vase-shaped (Fig. 5, 9400). The number of preformed openings is considerable, usually between 5 and 10 with 16 as the maximum number observed.

In three samples there are growth disturbances connected with attacks by the phycomycete *Zygorhizidium vaucheriae* Rieth. None of the samples were submerged at the time of collection. One was taken in April on the muddy bank of a brook in the wood northnorthwest of Bernex, one in June on the steep side of the lode carrying water from the former Marsh of Bossey, and one (Fig. 5, 9396 a) in October at the source of Allemogne, away from the large basin in a corner where just a little ground water was oozing out. The Bernex sample contains more *V. cruciata* than *V. canalicularis*, but only the latter species is infected by the fungus. In all cases the short contorted laterals are rather scattered compared with the situation found in attacked *V. cruciata*. The morphology of the fungus agrees well with the description given by RIETH (1967).

*B.* (Fig. 6). *Vaucheria geminata* (VAUCH.) DC. in LAM. et DC. 1805, *Ectosperma geminata* VAUCH. 1803, non *Vaucheria geminata* sensu GOTZ 1897.

*Ectosperma geminata* is said by VAUCHER to resemble *E. cespitosa*. The distinctive characters mentioned are that the oogonia are stalked and borne on special fruiting branches instead of forming terminal pairs on the main filaments, that the oospores are concave on one side, not rounded all over, and that the species forms dull green masses in ditches with stagnant water, not dark green tufts in running water.

The different shape of the oospores was probably often difficult to see in the primitive microscope at VAUCHER's disposal—it is not apparent from the illustrations, which, according to the introduction, were made by his wife. The other characters would serve to separate *B* together with stagnant water forms of *A* from swift water forms of *A*. Very probably such separation covers VAUCHER's species concept, which was apparently guided more by field characters than seems appropriate today. Tradition has attached VAUCHER's specific name with something like *B*. Though the identity is not certain the author sees no reason to change current usage of the name since,

Fig. 6. B; *Vaucheria geminata*.  $\times 100$ .

in any case, *B* may fall under VAUCHER's concept of *E. geminata*, while other names are available for *A*.

The only good material of *B* at the author's disposal is a herbarium specimen kept at the Conservatoire botanique de Genève. It was collected on 24 Feb., 1867 in "fossés pleins d'eau" at la Pommière, a place now occupied by gardens and houses. In addition, a few similar looking filaments have been found in an old crude culture. The culture was in a rather bad condition and most fruiting organs of this species were aborted. Illustrations of this plant, therefore, are given with considerable reservation. The sample in question was collected on 14 Feb. 1967 in a meadow south of Brétigny, growing in grass close to an ice-covered pool in a place obviously much trodden by cattle in the summer.

*C.* (Fig. 7). *Vaucheria cruciata* (VAUCH.) DC. in LAM. et DC. 1805, *Ectosperma cruciata* VAUCH. 1803, *Vaucheria debaryana* Wor. 1880.

According to VAUCHER, this species grows in the same places as *V. geminata*. In its general appearance, too, he finds it very similar to this species, and therefore will not exclude the possibility that it is only a variety of it. As distinctive features he mentions that the filaments of *V. cruciata* are much thinner, that all dimensions of its fruiting organs are about half those found in *V. geminata* and that the antheridium is shaped like a cross. Later authors have failed to refind the peculiar type of antheridium indicated by VAUCHER, and therefore have mostly regarded *V. cruciata* as a species inquirenda, but the agreement between *C* and *V. cruciata* in size and general appearance as well as in habitat make their identity obvious. VAUCHER's description of the antheridium certainly does not apply, but the structures in question are delicate and

give little contrast, so VAUCHER cannot have seen them very clearly through his primitive microscope. He also describes the antheridia of the Corniculatae as being straight at the beginning and coiled after fertilization (1803, p. 17), and draws the emptied antheridium of *V. canalicularis* like those of the Corniculatae. When seeing *V. cruciata* best he has apparently been able to distinguish the striking feature of spouts issuing at right angles to the antheridium branch, and then perhaps has conjectured the terminal part of the antheridium to be of the standard type also erroneously attributed to *V. canalicularis*, only thinking it was hard to see because of the coiling.

The species is commonly associated with *V. canalicularis*, *V. bursata* and *V. frigida*, each of which occurs in about half the samples containing *V. cruciata*, cf. Table 1. In one sample only it is unaccompanied by other species of *Vaucheria*. This sample was taken in the rapids of a brook otherwise devoid of larger algae, and consisted of small cushion-like masses so heavily encrusted with lime that they felt hard and stone-like when collected. It is remarkable in consistently having only one oogonium on each fruiting branch. Otherwise two is the normal number; mingled with two-spored branches one-spored are of frequent occurrence, while branches with three are pretty rare.

More than half of the samples were taken on soil near running water; a smaller number were actually in the water, and a few were found on more or less level ground in places which are probably flooded by water now and then.

The majority of finds are from April, but the species has also been found in February, June and October. In February the plant was mostly sterile, otherwise nearly all samples are fruiting.

Growth disturbances caused by *Zygorhizidium* are found in one sample, taken in April in swiftly running water in a roadside ditch between Sauverny and the frontier station. Mostly, the contorted laterals form dense clusters separated by relatively long spells of normal looking filament. The primary sporangium found in the centre of such a cluster often reaches a considerable size, like that pictured by RIETH (1967) in his fig. 1g and others. The infected filaments are too dirty to allow a closer study of smaller sporangia sitting on their surface. The zygotes, however, stand out clearly and show a coating of veritable spines, longer and more pointed than those pictured by RIETH and those seen by the author in the parasite of *V. canalicularis*.

*D.* (Fig. 8). *Vaucheria terrestris* (VAUCH.) DC. in LAM. et DC. 1805, *Ectosperma terrestris* VAUCH. 1803, non *Vaucheria terrestris* sensu GOTZ 1897.

This species is said by VAUCHER to occur on moist soils during autumn and winter. This applies to *D*, and there is complete agreement between *D* and the description and figure of *E. terrestris* given by VAUCHER, so identity is quite obvious. From the author's observations the species appears rather uniform in morphology as well as ecology. At the same time, however, it is very closely allied to *E* as well as *F*. The features distinguishing it from these allies are pointed out in dealing with the species in question.

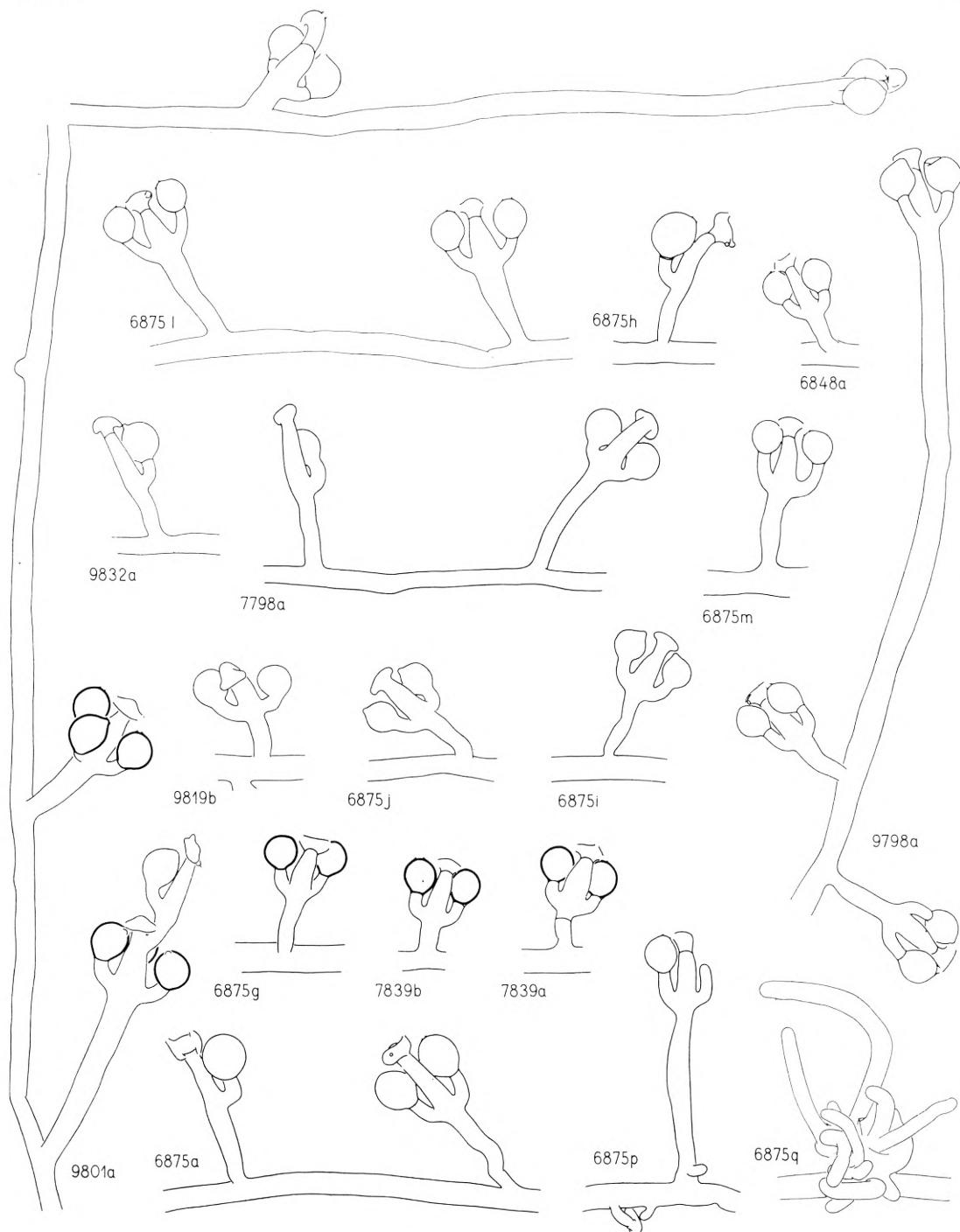


Fig. 7. C; *Vaucheria cruciata*. Lower corner right: deformations caused by *Zygorhizidium*.  $\times 100$ .

Nearly all that has been collected of *V. terrestris* was taken in October, growing on soil in fields or gardens, mostly mingled with *F*. A single find was made in February. Three finds from April may belong in the same species but may also be small representatives of *E*, and therefore have been registered as unidentified.

All samples obtained were fruiting at the time of collection.

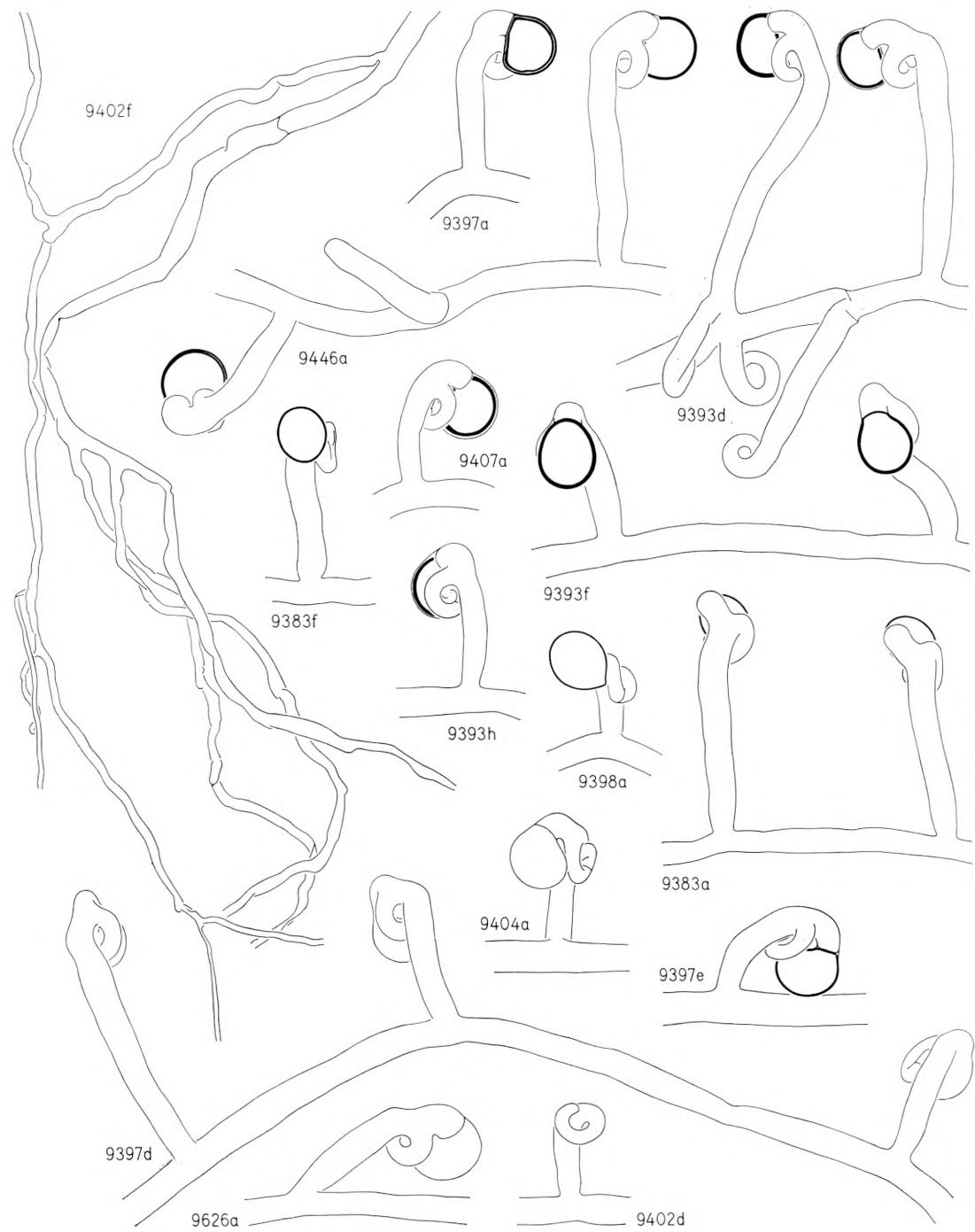
*E.* (Fig. 9). *Vaucheria frigida* (ROTH) C. AG. 1824, *Conferva frigida* ROTH 1797, non *Conferva frigida* sensu DILLWYN 1802, *Ectosperma hamata* VAUCH. 1803, *Vaucheria hamata* (VAUCH.) DC. in LAM. et DC. 1805, *Ectosperma multicornis* VAUCHER 1803, *Vaucheria terrestris* sensu GÖTZ 1897, non *Vaucheria terrestris* (VAUCH.) DC. in LAM. et DC. 1805. — Uncertainty as to the proper application of Art. 13 of the Code of Nomenclature makes it doubtful whether the name *frigida* or the later name *hamata* should be used (cf. CHRISTENSEN, 1968). Pending a clarification of this matter the author prefers to use the epithet *frigida* to avoid confusion of *V. hamata* (VAUCH.) DC. with *V. hamata* sensu GÖTZ.

*Ectosperma hamata*, according to VAUCHER, has oospores more rounded than those of *V. terrestris* but less so than the aplanospores of *V. canalicularis*. Otherwise, it resembles *V. terrestris* rather a lot in morphology but differs ecologically by growing and fruiting submerged on the bottom of ditches and by being characteristic of early spring. It is said to be rather common in the Geneva region. As *V. frigida* looks like a bigger *terrestris*, is common in VAUCHER's region, and sometimes submerged, the identity of VAUCHER's plant seems beyond discussion. It may be added that *V. frigida* has been found in the only locality mentioned by VAUCHER for *E. hamata*, namely the ditches in the Marsh of Bossey. Only this gives very little extra support, as the marsh has been drained and the ditches replaced by one deep lode, in which the plant is now to be found.

Proliferation of the fruiting branches often occurs. It is obvious, and generally agreed on, that VAUCHER's *Ectosperma multicornis*, characterized by having several antheridia on each fruiting branch, is nothing but a proliferating state of a plant that otherwise has only one. The species shown in VAUCHER's illustration must be *V. frigida*.

*V. frigida* has larger dimensions than *V. terrestris* in all respects, thicker tubes, thicker fruiting branches, less densely coiled antheridia and larger oospores. As a vague but rather general character it can be added that fruiting branches of *V. terrestris* often exhibit an elegant straightness in their lines, whereas those of *V. frigida* show a somewhat elephant-like plumpness, often with small irregular bends.

Even kept apart from *V. terrestris*, *V. frigida* is not absolutely uniform. In addition to plants that agree entirely with the Dillenian type material there are some, like 6898 and 7805 (Fig. 9), with thinner filaments and less elongate oogonia, and others that combine narrower filaments with greater distance between antheridium and oogonium and a more pointed oogonial beak. These aberrant forms seem to differ little from the rest as to their occurrence in nature, and are comprised with them in the following. One find very close to *V. terrestris* has been registered as unidentified,

Fig. 8. D; *Vaucheria terrestris*.  $\times 100$ .

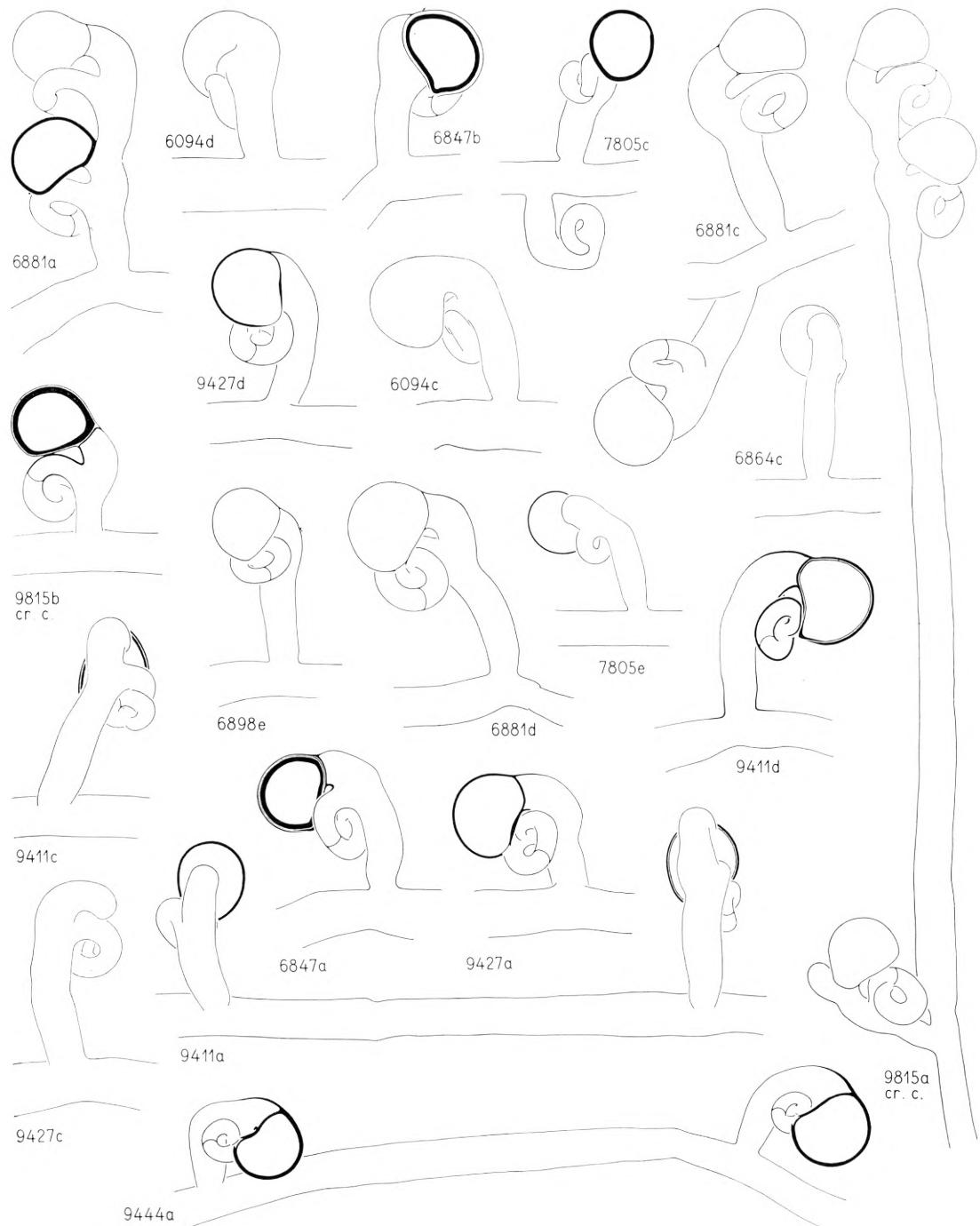
as were three finds of probable *V. terrestris* too similar to *V. frigida*. The necessity of such unsatisfactory procedure is an indication that *V. terrestris* and *V. frigida* are taxonomically very close to one another.

For VAUCHER it was natural to keep the two plants apart because he found them totally different as to their appearance in nature. While his *Ectosperma terrestris* was a representative of the Linnaean genus *Byssus*, forming a thin felty cover on soil, his *E. hamata* was a typical Linnaean *Conferva*, consisting of longer and straighter filaments that grew in the water. Therefore he had to explain why he placed the two in one genus, rather than why he did not put them into the same species. Today the ecological difference between them appears less well defined. *V. frigida* is amphibious. It may flourish and fruit under water but more frequently grows at the water's edge or just above the water. The prevailing habitat in the Geneva landscape of today is on soil along water-courses, where trees and shrubs provide a suitable combination of moisture, light and temperature, particularly in the spring. From this way of life there does not seem to be a great distance to that of *V. terrestris*, which thrives on arable land in late autumn and winter, when air and soil are moist and sunshine not too bright. Actually, the two are so close that it would be tempting to lump them into one, had it not been for the fact that *V. terrestris* is also very closely allied to the following species. Instead, a future splitting of *V. frigida* on the varietal level may perhaps clarify things.

Most of the author's material is from April and this, like that from June and October, is fruiting nearly throughout. In the material from February only two out of seven samples are fruiting.

F. (Fig. 10). *Vaucheria prona* T. CHRISTENSEN 1970, *Vaucheria hamata* sensu GÖTZ 1897, non *Vaucheria hamata* (VAUCH.) DC. in LAM. et DC. 1805.

This species looks like *V. terrestris* in most respects, differing mainly in the situation and number of the oogonia. In *V. terrestris* the stalk of the single oogonium starts as a bulge from the back of the antheridium stalk at the transition between the straight and the curved part. It grows out in a direction mostly little different from that of the straight part and then, itself, turns in the same direction as the curved part, lying above the latter. *V. prona* normally forms two oogonia per antheridium, and then is immediately recognizable by this character alone. Sometimes it forms only one, as is the case with all two-spored species, and such fruiting branches may resemble those of *V. terrestris* rather a lot. No matter if there are one or two per antheridium, however, the oogonia are initiated from the sides, not the backs, of the antheridium stalks. If only one oogonium is formed its stalk still does not ride on top of the antheridium stalk but projects side by side with it, both reaching about the same height above the vegetative filament. BLUM (1953), on the basis of herbarium studies, came to the conclusion that the two were identical. Undoubtedly they are very closely allied, but in the present author's material seemingly intermediate samples have turned out to be mixtures.

Fig. 9. E; *Vaucheria frigida*.  $\times 100$ .

As to ecology and appearance in nature the two species are very similar, except that *V. prona* appears to have a wider ecological range than *V. terrestris*. Their similarity when viewed by the naked eye must be the reason why VAUCHER did not realize the existence of a two-spored terrestrial species though it is quite common in his region. He normally distinguished species in the field, and his algal studies were made over a remarkably short period. So, after studying one or a couple of samples of *V. terrestris*—which he may well have had in his own garden—he probably preferred to go ahead looking for new forms rather than to bring home more samples of what he thought he knew and had enough drawings of.

Twenty of the author's 32 samples were taken in October, and a much larger proportion would have come from this season if the species had been collected wherever it could. Nearly all these twenty samples grew in fields or gardens, under maize, vine, beets, cabbage or weeds, or between grass or stubble in places not exposed to full sunlight. About half of them also contained *V. terrestris*, while only two contained other species of *Vaucheria*. Among the samples taken at other seasons—four in February, seven in April and one in June—only two came from fields or gardens. More were taken in woods or along hedges, and most in amphibious or even aquatic environments. While all the October samples had well developed fruiting organs, these were missing or badly developed in more than half of those from other times of the year.

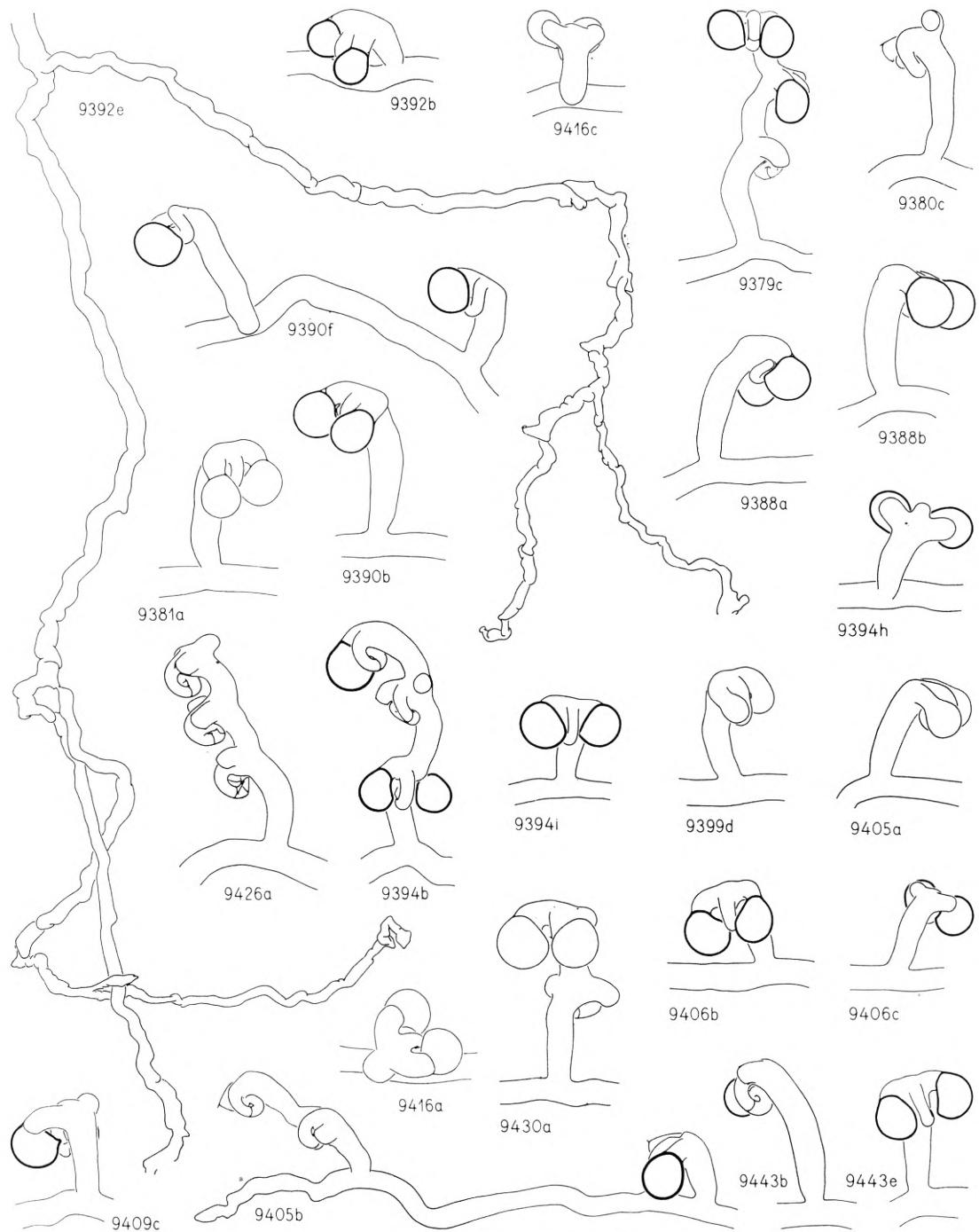
*G.* (Fig. 11). *Vaucheria pseudogeminata* P. DANG. 1939, *Vaucheria hamata* sensu WALZ 1866?, non *V. hamata* (VAUCH.) DC. in LAM. et DC. 1805.

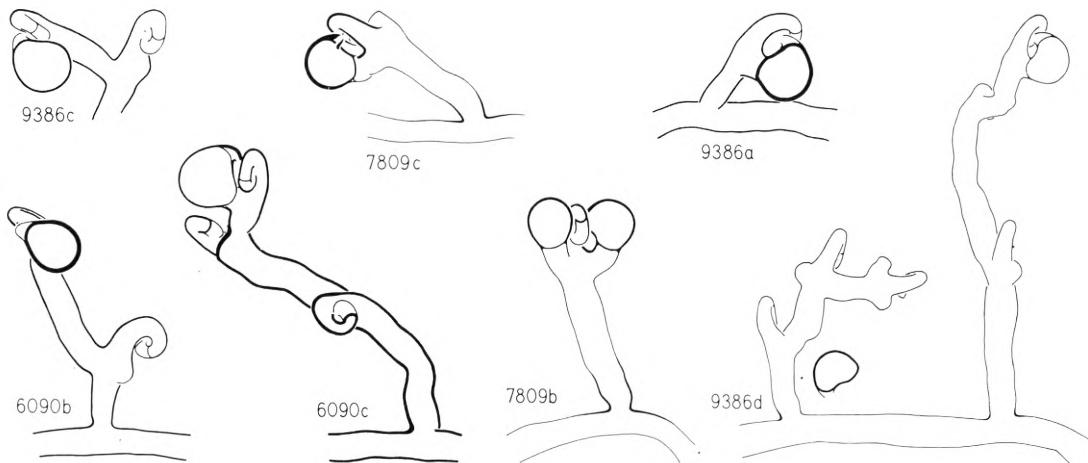
The material agrees very well with the description given by DANGEARD. VAUCHER obviously did not find this species, which is quite understandable since it is not very common, and since it is relatively small and normally grows mingled with larger species.

There are five samples in all. Three of them were taken in April. One grew by a woodland track, one along a path following a brook through a small wood, both mingled with *V. prona* as well as *V. cruciata*, the latter also with *V. frigida* and *V. canalicularis*. The third April sample came from the side of a ditch, mingled with *V. cruciata*, *V. canalicularis* and *V. bursata*. A sample from June also grew on the side of a ditch, mingled with *V. canalicularis*. The fifth sample was taken in October on a field between stubble and young lucerne, mingled with *V. terrestris* and *V. prona*. All samples were fruiting at the time of collecting.

*H.* (Figs. 12–13). *Vaucheria racemosa* (VAUCH.) DC. in LAM. et DC. 1805, *Ectosperma racemosa* VAUCH. 1803, non *Vaucheria racemosa* sensu GOTZ 1897, *Vaucheria walzii* ROTHERT 1896a, *Vaucheria uncinata* sensu GOTZ 1897, non *Vaucheria uncinata* KÜTZ. 1856.

GÖTZ (1897) designated this plant as *V. uncinata*, at the same time applying the name *V. racemosa* to *V. geminata* (Vauch.) DC. jointly with a plant probably referable to *V. verticillata* MENEGH. The true *V. uncinata*, however, is a very different plant, as pointed out by BLUM (1953), and has only one or two, rarely three oogonia on each fruiting branch. *V. verticillata* mostly has four, all arranged in a whirl around the

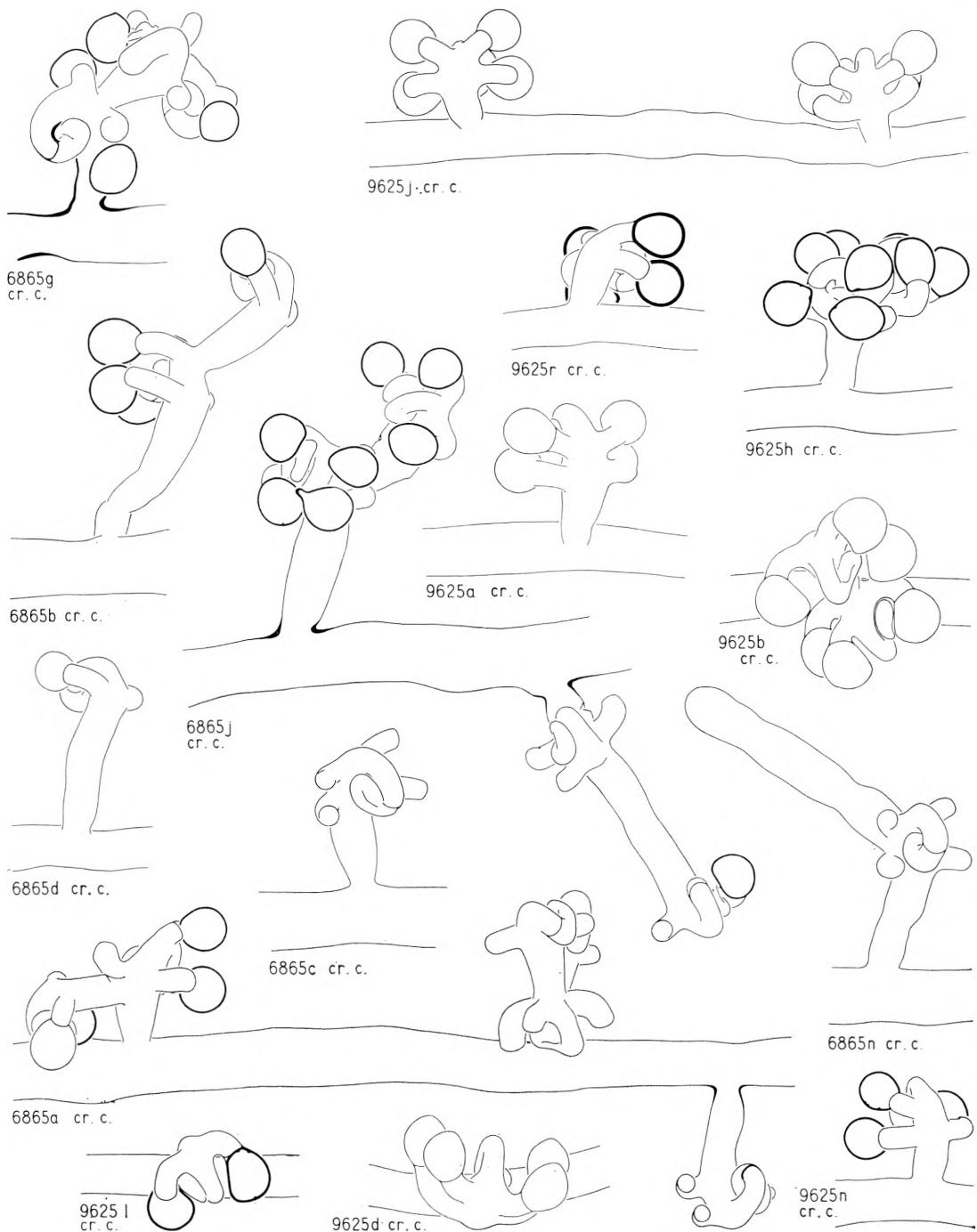
Fig. 10. F; *Vaucheria prona*.  $\times 100$ .

Fig. 11. G; *Vaucheria pseudogeminata*.  $\times 100$ .

branch and pointing upwards. A well developed fruiting branch of H also bears four, but situated one above the other on either side of the branch, and all directed sideways towards the coiled antheridium. It is seen from VAUCHER's illustration of *V. racemosa* that his epithet can cover neither *V. uncinata* nor *V. verticillata* but only H. This agrees with the fact that H but not the two others has been found in VAUCHER's region by the author, and that H is the favourite host of *Proales wernecki*, which was also found by VAUCHER in *V. racemosa*.

VAUCHER says the species is found in nearly all the ditches, especially in the spring. The author has only found it in three places. He may not have hit the best season, but probably the species has also become rarer because the ditches are cleared more thoroughly than in those times. From elsewhere it is the author's impression that *V. racemosa* is favoured by more or less stagnant water over a muddy bottom with decaying leaves. One of the three stations was just that type, a relatively shallow pond at Chambésy with a brook passing through, and surrounded by large trees. Here the plant was found with both aplanosporangia and sexual organs in April 1957, mingled with *V. bursata*, *V. cruciata* and *V. frigida*. On a visit in October 1963 nothing was found of the species. On a last visit in April 1965 the pond was being drained, but a culture strain was secured from a mud sample. Another find was made on mud at a brook fringed with trees at Bois d'Ely. This sample, which was taken in June, contained only a little of *V. racemosa* with old and badly developed fruiting organs, accompanied by the same three species as found in the previous locality. The third station, probably a more accidental one, was a stone basin under the spout of the village well of Ornex. Here the plant was found with aplanosporangia in February, growing in large masses unmixed with other species.

*Proales* galls were found in a crude culture reared from the last sample taken at Chambésy. They are vase-shaped like those studied in the same species by ROTHERT (1896b), and have 3–9 openings, cf. Fig. 13.

Fig. 12. H; *Vaucheria racemosa*, sexual organs.  $\times 100$ .

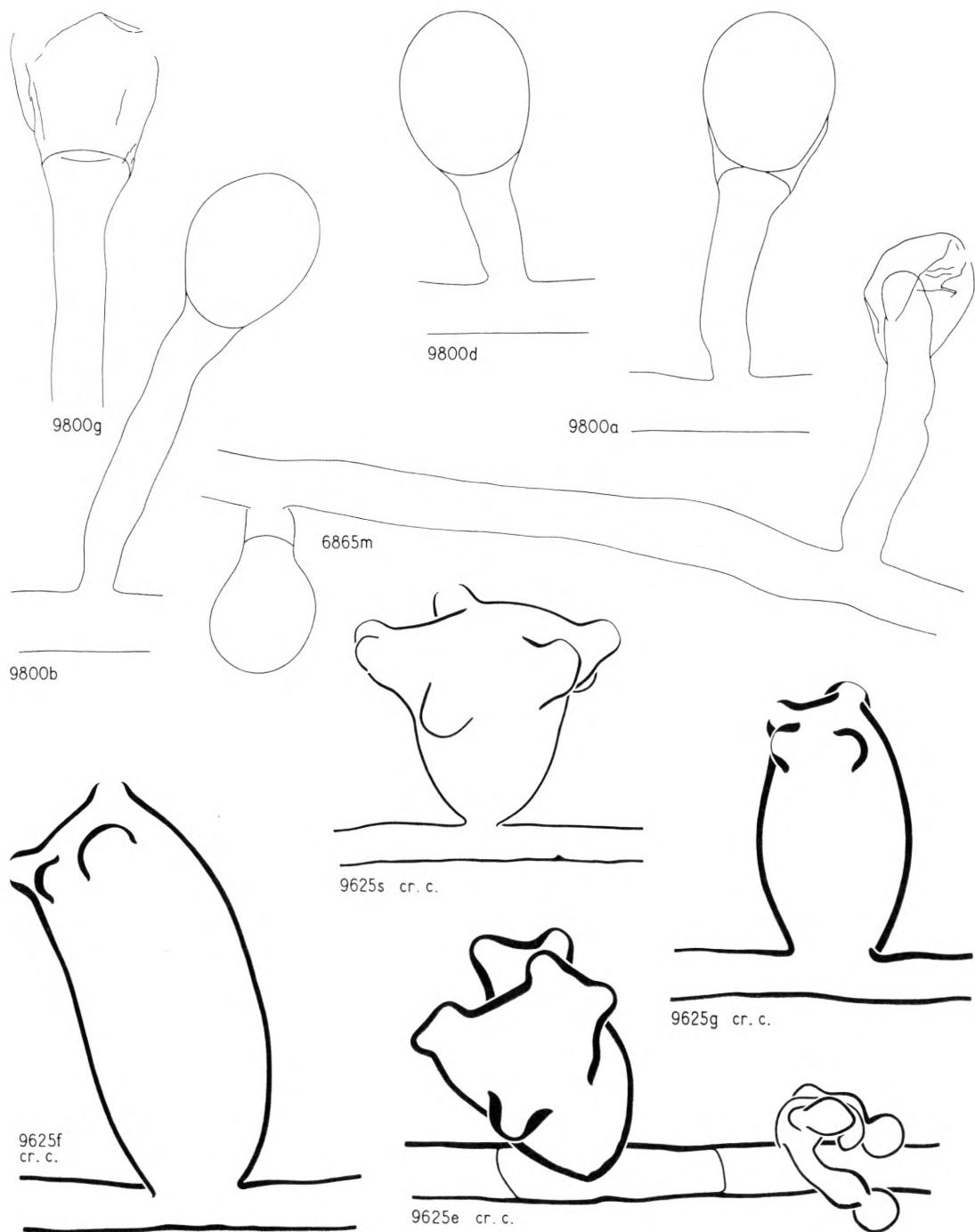


Fig. 13. H; *Vaucheria racemosa*, aplanosporangia and galls.  $\times 100$ .

The plant described by VAUCHER under the name *Ectosperma appendiculata* can hardly be anything but *Vaucheria racemosa* with aplanospores if its appendages are *Proales* galls. If so, this material must either have had unusually small dimensions or must have been rendered at a lower magnification than the rest, contrary to VAUCHER's general statement that all the illustrations were made at the same enlargement. However, *Ectosperma appendiculata* was studied only once, being brought from Lons-le Saunier 70 km away from Geneva. Moreover, the material studied was obviously in a rather bad state. After studying good material of *Proales* galls from the Geneva region as illustrated in the paper finished in April 1800 and printed in 1801, VAUCHER may possibly have assumed that this inferior material was in closer agreement with that first studied than was actually the case. If the appendages shown in the Lons-le Saunier material are not excrescences from the alga, the latter may also be a brackish-water plant, a possibility that was adduced by VAUCHER himself because his find was made at the salt works exploiting the brine source of the town. The particular station does not exist any more, the brine being pumped up from roofed wells and evaporated indoor. A search for topotype specimens in the Geneva, Lyons and Paris herbaria has been fruitless. So the identity of *Ectosperma appendiculata* remains doubtful.

I. (Fig. 14). *Vaucheria dillwynii* (WEB. et MOHR) C. AG. 1812, *Conserva dillwynii* WEB. et MOHR 1803, *Vaucheria pachyderma* WALZ 1866.

This species ranks as number seven out of eleven with regard to frequency in the author's material. So it is rather surprising that VAUCHER does not report it at all. One may assume that he referred all plants with sessile oogonia to his *Ectosperma sessilis*, or that today's landscape has more suitable places for *V. dillwynii* than that known by VAUCHER.

The plant may form rhizoids, rather evenly tapering like those figured from *V. canalicularis* (Fig. 4). Eight of the thirteen samples were taken on the bank of a watercourse, six consisting of creeping filaments like similar growths of *V. frigida*, two more cushion-like, probably started under water. A change with regard to the trees and shrubs now fringing nearly every watercourse of the region may well have increased the possibilities of amphibious growth in such places since the time of VAUCHER, hereby favouring both *V. dillwynii* and *V. frigida*. Two samples were taken under water, both growing on the bottom of ditches with a strong current. Finally, there are three samples from soil not along watercourses. In the latter the species is

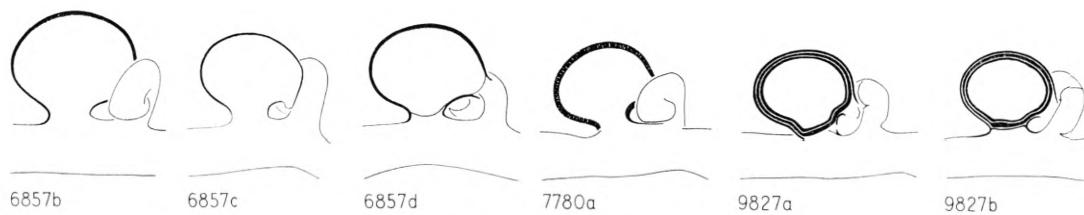


Fig. 14. I; *Vaucheria dillwynii*.  $\times 100$ .

mingled with *V. prona*, in one of them also with amphibious species. All other samples are mixtures with one or more amphibious species, *V. cruciata*, *frigida*, *canalicularis* and *bursata*, cf. Table 1. There are seven April samples, mostly fruiting, five February samples, mostly sterile, and one October sample, which is fruiting.

*J.* (Fig. 15). *Vaucheria bursata* (O. F. MÜLL.) C. AG. 1812, *Conferva bursata* O. F. MÜLL. 1779, *Ectosperma sessilis* VAUCH. 1803, *Vaucheria sessilis* (VAUCH.) DC. in LAM. et DC. 1805, *Vaucheria repens* HASS. 1843, *Vaucheria orthocarpa* REINSCH 1887.

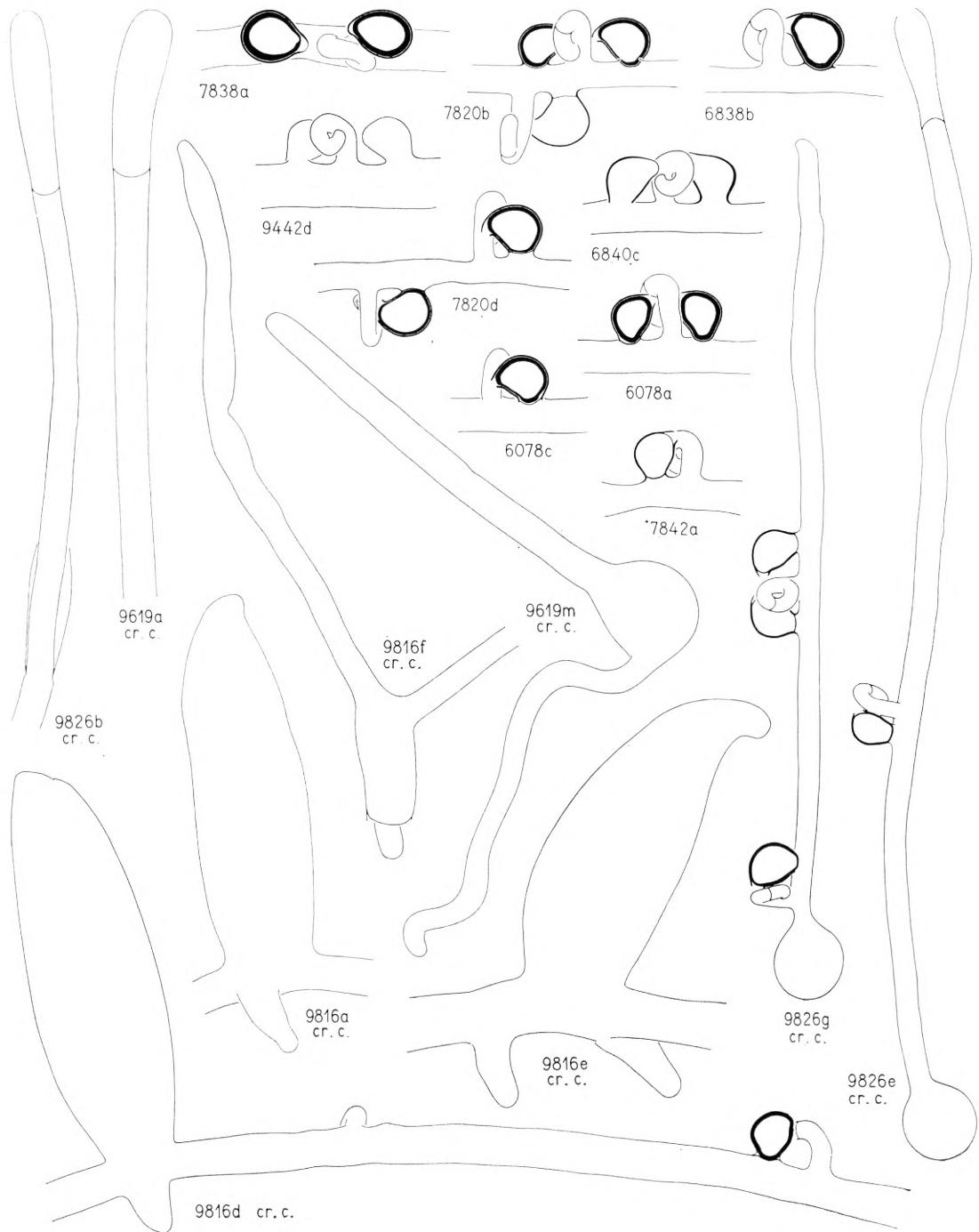
This species varies a good deal with regard to the direction of the oogonium beak, the width of the filaments, and the tendency to form only one oogonium at an antheridium. Like RIETH (1963), the author finds it impossible to subdivide the variation complex on the basis of these characters today. The variation in width exceeds what is found in most species, but the width also varies with culture conditions. Besides, measurements of preserved material have to be used with much caution because very often the filaments are oval in transverse section. Therefore, the author prefers to deal with *V. bursata* as a single entity, at least until proper cultural studies have been carried out.

About half the samples at hand are from swiftly running water, where the species may form large soft cushions constantly submerged or more compact tufts at the water's edge, somewhat similar to those formed by *V. canalicularis* but usually flatter and more even. Slightly fewer samples consist of creeping filaments grown on soil at a watercourse, while only a few come from stagnant water. There are twenty samples taken in middle April, June or October, nineteen of them fruiting, while seventeen samples from February or early April are all sterile. Zoosporangia are formed abundantly when a crude culture is started but have not been observed in nature.

A sample collected in February as dense cushions just under water in the Lion River between Prégnin and Vesignin had *Proales* galls seven days later. The galls are spindle-shaped. Usually they have a single terminal opening, but there may also be two close to one another. In addition, there are mostly one or two short outgrowths from the filament close to the base of the main gall body, pointing in the opposite direction and each forming a single terminal opening (Fig. 15).

*K.* (Fig. 16). *Vaucheria fontinalis* (L.) T. CHRISTENSEN 1968, *Conferva fontinalis* L. 1753, *Ectosperma clavata* VAUCH. 1803 pro parte saltem, *Vaucheria ornithocephala* C. AG. 1817, *Vaucheria polysperma* HASS. 1843.

VAUCHER did not find this species in the fruiting state, but his description of *Ectosperma clavata* covers its appearance when reproducing asexually. As to the zoosporangia there is little difference between *V. bursata* and *V. fontinalis*, and the illustration given by VAUCHER in 1803 may show either. In his first account he pictured three species with club-shaped terminal structures assumed to be antheridia, one of them referred to *Conferva fontinalis* L. (VAUCHER, 1801, p. 354, fig. 13). Later he

Fig. 15. J; *Vaucheria bursata*.  $\times 100$ .

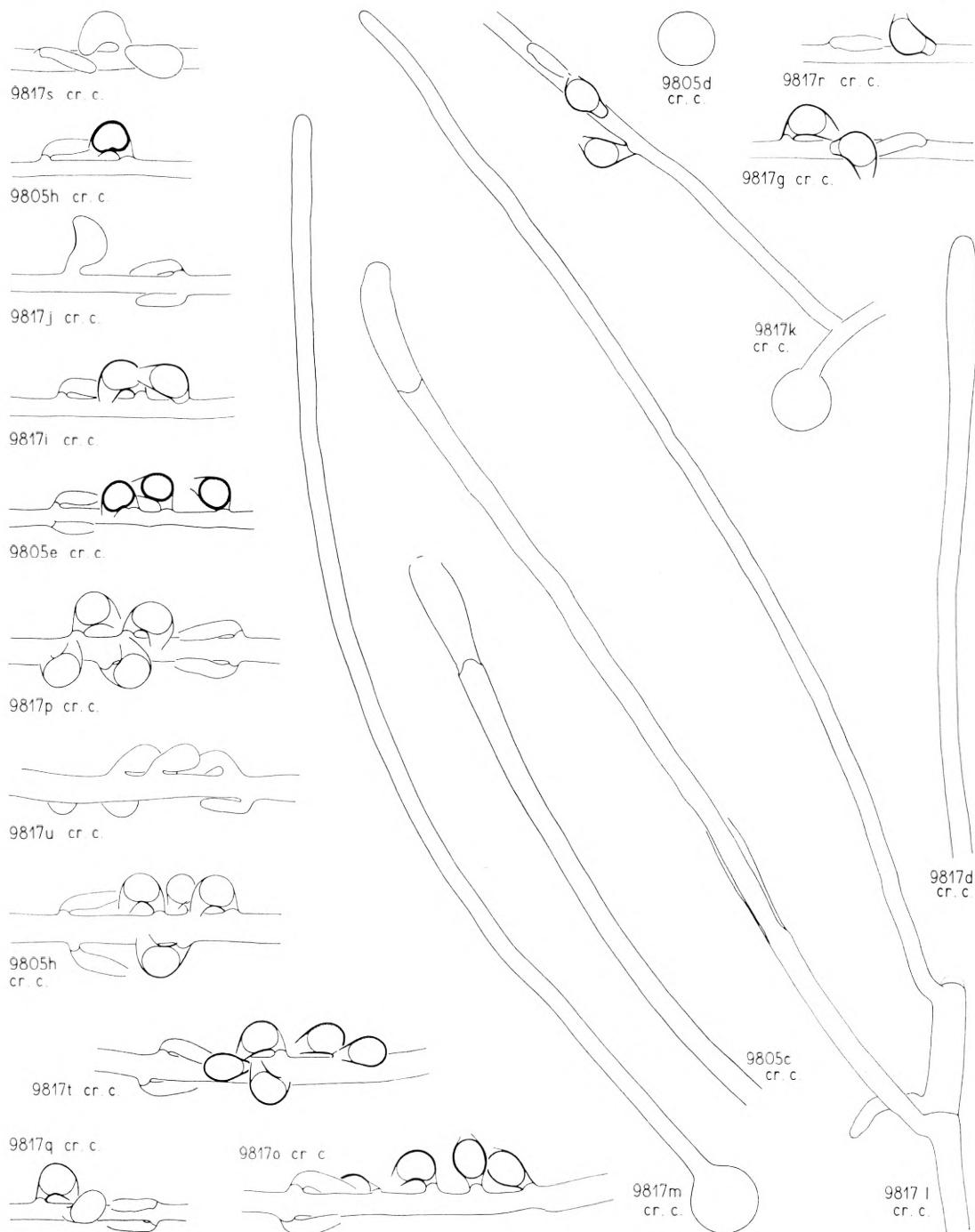
Fig. 16. K; *Vaucheria fontinalis*.  $\times 100$ .

TABLE 1. Frequency of each species in unmixed samples, and mingled with each of the others.

Species	Number of samples in all	Number of samples with no other Vaucheria species	Number of samples containing also										
			V. canalicularis	V. geminata	V. cruciata	V. terrestris	V. frigida	V. prona	V. pseudogeminata	V. racemosa	V. dillwynii	V. bursata	V. fontinalis
V. canalicularis . . . . .	51	13	0	21	0	21	8	3	1	6	15	0	0
V. geminata . . . . .	1	0	0	1	0	1	1	0	0	1	1	0	0
V. cruciata . . . . .	41	1	21	1	0	20	8	3	2	10	20	2	1
V. terrestris . . . . .	14	3	0	0	0	0	11	1	0	0	0	0	0
V. frigida . . . . .	41	7	21	1	20	0	7	1	2	9	17	0	0
V. prona . . . . .	32	8	8	1	8	11	7	3	0	4	3	0	1
V. pseudogeminata . . . . .	5	0	3	0	3	1	1	3	0	0	1	0	0
V. racemosa . . . . .	4	1	1	0	2	0	2	0	0	0	3	0	0
V. dillwynii . . . . .	13	0	6	1	10	0	9	4	0	0	6	0	0
V. bursata . . . . .	37	5	15	1	20	0	17	3	1	3	6	3	0
V. fontinalis . . . . .	3	0	0	0	2	0	0	0	0	0	0	3	0

obviously came to the conclusion that there were only two such species, *Ectosperma ovata* with known spores and a second species in which the spores were still unknown. His written description of this second species, now named *Ectosperma clavata* (1803) must be based on *V. fontinalis*, as the filaments are said to be much thinner than those of other species.

The author has three samples of *V. fontinalis* from the area, all taken in February and all collected in the Lion River, one west of Villard Tacon, one at Vesignin and one 1.5 km further down. The plant grew submerged, forming loose tufts on large stones where there was a swift current and some shade from trees around. In two of the localities large cushions were found mainly consisting of *V. fontinalis*, but in all samples *V. bursata* was also present, and in two of them *V. cruciata* as well. The plant was sterile at the time of collecting.

#### Frequency and Ecological Similarity of the Species

Table 1, in its first column of figures, gives the number of finds of each individual species. These figures, when compared with one another, give an estimate of the relative frequency of the species. From the following columns it can be seen how often any given species has been found unmixed with other species, and how often mingled with each of the others. The figures for common occurrence of two particular species should be compared with the total number of finds for each of them to give an impression of their ecological similarity.

The proportions found are very far from giving precise indications. In the autumn, species that are common on soil can be collected nearly anywhere, and in the spring the same applies to species that are common in ditches. In such cases, therefore, the number of finds is rather an indication of the author's perseverance collecting the same plant under the same conditions over and over again. On the other hand, interesting localities have been looked for more eagerly than average localities and have often been visited more than once, thus giving too large figures for the rarer species. In spite of these deficiencies, however, the figures conclude with tolerable certainty that some of the species are common in the area and that some are mutually rather similar in their ecology. The species that have low figures throughout are likely to be rare or restricted with regard to season or habitat.

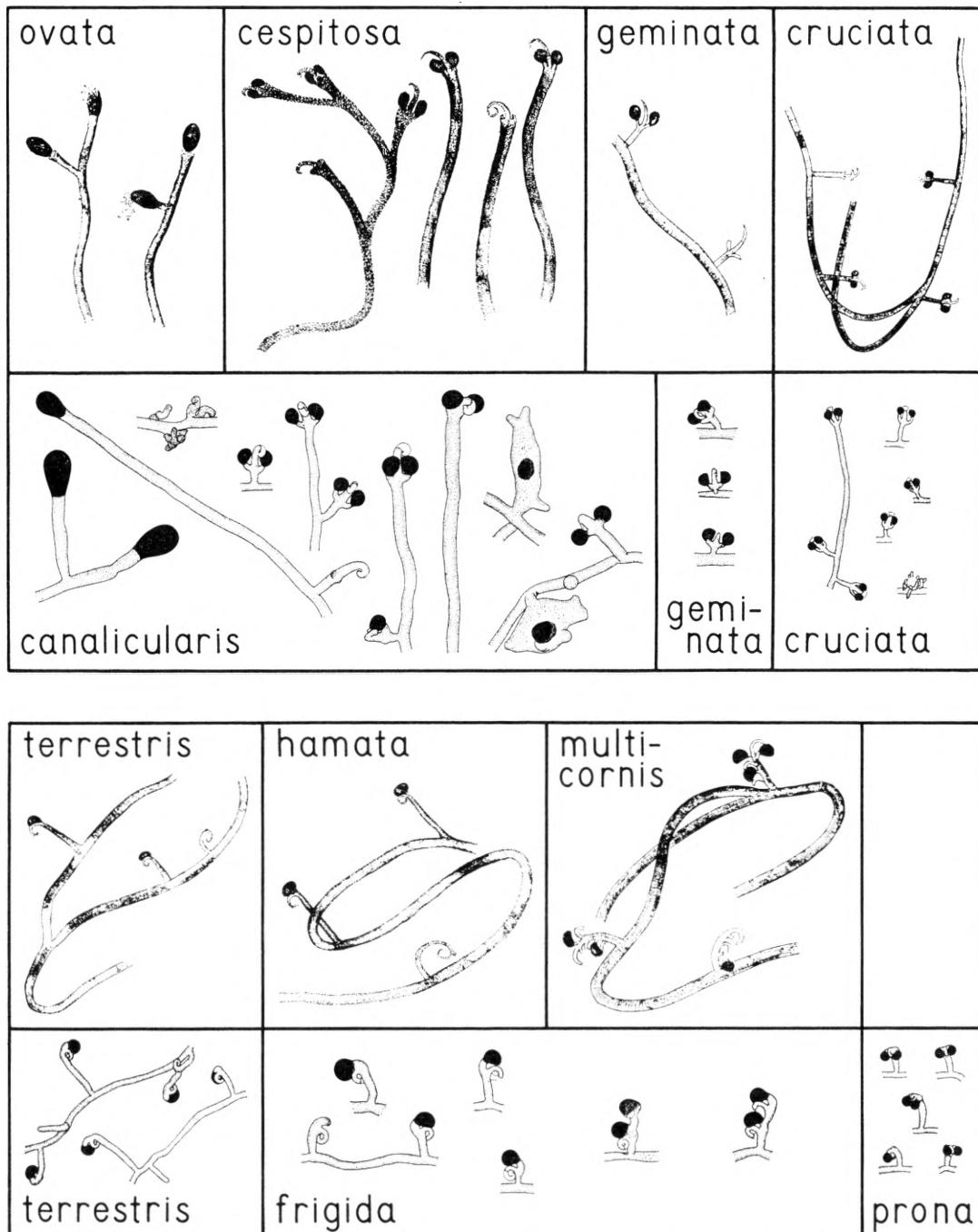
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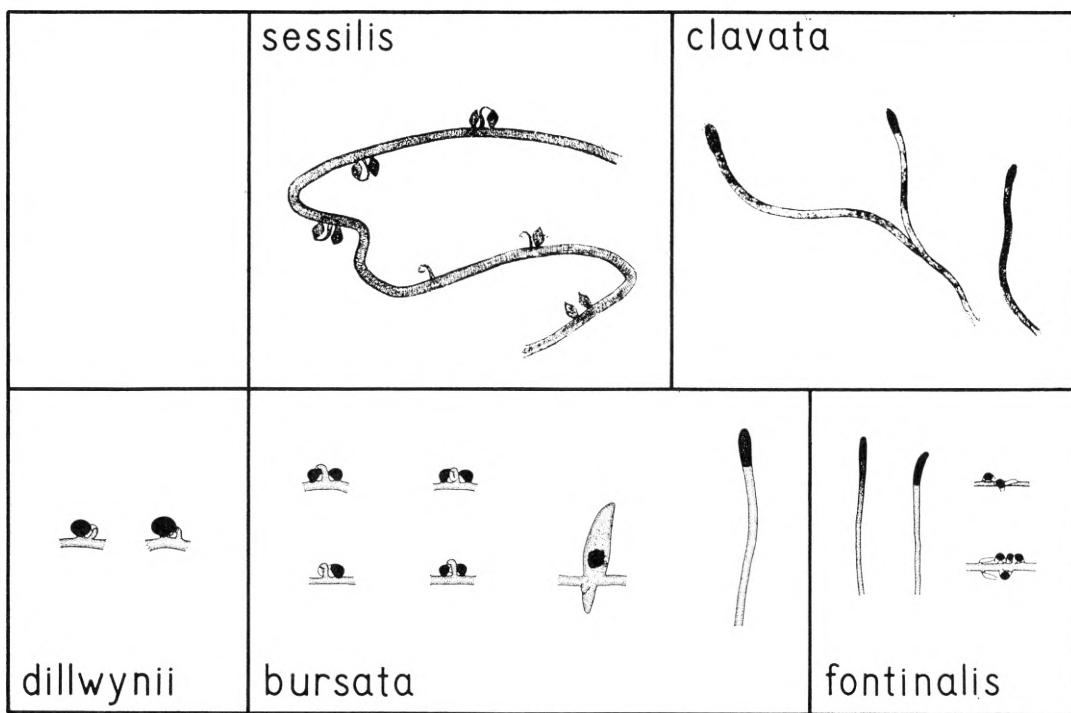
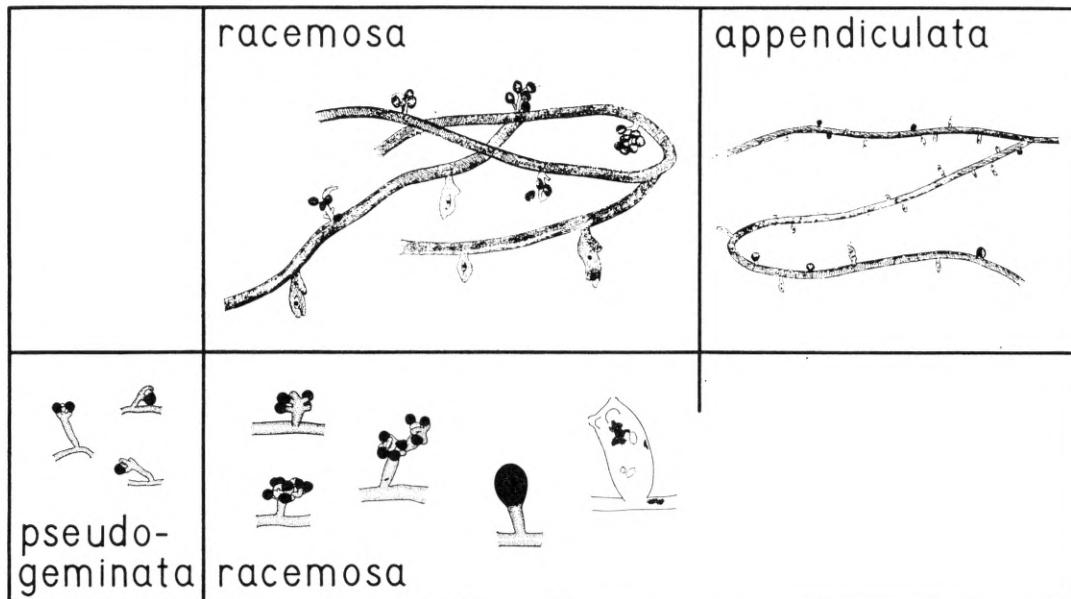
The author's first collections in the Geneva region were undertaken in connexion with a trip paid for by the University of Copenhagen. Large numbers of drawings for comparative purposes were obtained by microprojection, using an arc lamp provided by The Danish State Research Foundation. Professor R. HEIM, Member of the Paris Academy of Sciences, kindly provided a copy of VAUCHER's manuscript from August 1800 kept by the Academy. Dr. C. E. B. BONNER and Dr. R. WEIBEL of the Geneva herbarium, Dr. P. BOURRELLY of the Paris herbarium and Mme A. GILLES of the Lyons herbarium have all been very helpful during visits to their institutions. Mrs. CYNTHIA GYLDENHOLM has carefully checked the English text. The author wishes to express his sincere thanks to all these persons and institutions for their help.

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Fig. 17 pp. 32–33.

Comparative survey of the species taxonomy of VAUCHER and that arrived at by the present author. Names and illustrations in the upper rows are from VAUCHER (1803) except for the first figure of *Ectosperma cespitosa*, which is from VAUCHER (1801). The illustrations in the lower rows are by the author.





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ORGANS OF  
NEOCERATODUS FORSTERI

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### Synopsis

Three males and one female of the Australian lungfish, *Neoceratodus forsteri*, were studied with regard to the urogenital connections and histological structure of the kidney and the testis. Tusch gelatine injections and serial sections of tissue-mat embedded material were applied.

Eleven and thirteen vasa efferentia were present, on one side, in two of the males examined. The vasa efferentia lead from the longitudinal testis duct to the Malpighian corpuscles in the sexual part of the kidney. The structure of the nephrons through which the sperm pass, and that of normal nephrons are identical, except for the dimensions. Peritoneal ducts with open funnels communicate with the neck segments of the nephrons.

The histological structure of the different sections of the nephron was studied and compared with those of the two other genera of lungfishes (see the scheme p. 8).

Finally, a short comparison was made between the male urogenital connections in *Neoceratodus* and that of other genera of lungfishes and primitive *Actinopterygii*.

## Introduction

The first general anatomical description of the testis and kidney of *Neoceratodus forsteri* was given by GÜNTHER in 1871. He found no connections between the testis and the kidney, but described two vasa deferentia running from the testis, attached to the ventral margin of the ureters and terminating at a common opening in the dorsal part of the cloaca.

SEMON (1901) observed that the sperm on its way out passes through some of the Malpighian corpuscles in the kidney.

KERR (1901) investigated the male urogenital organs of *Lepidosiren* and *Protopterus*, and reconstructed the testicular network. At the time he was not able to give a similar description of *Neoceratodus* as he lacked adult material. Later, he was sent several adult males, and BALLANTYNE (1928) made an examination of this material. He found four vasa efferentia on each side, leading from the testis into the kidney tubules or the Malpighian corpuscles near the posterior end of the kidney. He described the testis as composed of a large formative part and a small posterior vesicular section from which the vasa efferentia originated.

As far as we are aware, the urogenital ducts of *Neoceratodus* have not been studied since 1928. As the Institute of Comparative Anatomy in Copenhagen received in 1967 ten adult specimens of this species, it was possible to make a new examination of the urogenital organs with special reference to the testicular network. That this material could be obtained was made possible by a grant from the Carlsberg Foundation.

I want to thank Professor K. G. Wingstrand for all help and assistance.

## Material and Methods

*Neoceratodus f.*: ♂ Tl: 90 cm.

Fixation: Bouin solution, perfused from the dorsal aorta.

Right kidney and testis: 10 and 15  $\mu$  tissuemat sections were stained with PAS-hematoxylin, hematoxylin-eosin or Heidenhains azan.

Left kidney and testis: India ink-gelatine were injected from the longitudinal testis duct through the vasa efferentia to the Malpighian corpuscles in the kidney. Cleared over 96 % and absolute alcohol in benzyl benzoate.

*Neoceratodus II:* ♀ Tl: 95 cm.

Fixation: Bouin solution, perfused from the dorsal aorta.

Left kidney: 10 and 15  $\mu$  tissuemat sections were stained with PAS-hematoxylin, AB, hematoxylin-eosin or PAS-hematoxylin after treatment with diastase.

*Neoceratodus III:* ♂ Tl: 104 cm.

Fixation: Bouin solution perfused from the dorsal aorta.

India ink-gelatine injected through the ureters from the cloaca. The kidneys and testes were cleared over 96 % and absolute alcohol in benzyl benzoate.

*Neoceratodus IV:* ♂ Tl: 78 cm.

Fixation: Glutaraldehyde (2 %) perfused from the dorsal aorta. Small pieces of kidney and testis tissue were post-fixed in OsO<sub>4</sub> and embedded in epon.

Right kidney and testis: Embedded in tissuemat and cut into 10 and 15  $\mu$  sections. A complete series from the anterior to the posterior end of the kidney (12.2 cm) was made. The sections were stained with PAS-hematoxylin or hematoxylin-eosin.

Left testis: The anterior part of the testis was embedded in tissuemat, cut into 10  $\mu$  serial sections and stained with hematoxylin-eosin.

The number of vasa efferentia was counted in *Neoceratodus I* and *IV*. On one side there were in the first case 11 and in the second 13 vasa efferentia. Two perspective graphic reconstructions (LISON, 1936) of nephrons were made, a normal nephron (text-fig. 1) and a nephron in connection with a vas efferens (text-fig. 2).

## Results

The kidney of *Neoceratodus* is a paired organ, situated retroperitoneally in the posterior part of the abdominal cavity. The lengths of the kidneys of the specimens examined were 9–12 cm. The kidney consists of about ten lobes, and is attached ventro-medially to the testis along its anterior half (plate I, fig. 2). In the peritoneal connective tissue, which separates the kidney and the testis, two longitudinally ducts are seen (plate II). The dorsal Müllerian duct extends from the anterior end of the testis to the cloaca. Here the two Müllerian ducts fuse and come to a dead end. The ventrally-situated Wolffian duct, or the ureter, passes from the anterior end of the kidney to the cloaca. The ureters come together immediately in front of the cloaca, and this unpaired duct opens into the dorsal wall of the latter.

The testes are elongated organs of variable shape, about 30–35 cm in length. In the specimens examined they occupy most of the abdominal cavity (plate I, fig. 1). The medial margin is attached to the lung and, at the caudal extremity, to the kidney. The outer surface is covered by the peritoneum. 10  $\mu$  transverse sections from the anterior, the intermediate and the posterior region show no division of the testis into an anterior formative and a posterior vesicular part contrary to BALLANTYNE's thesis. The seminiferous tubules, each with different developmental stages of spermatozoa,

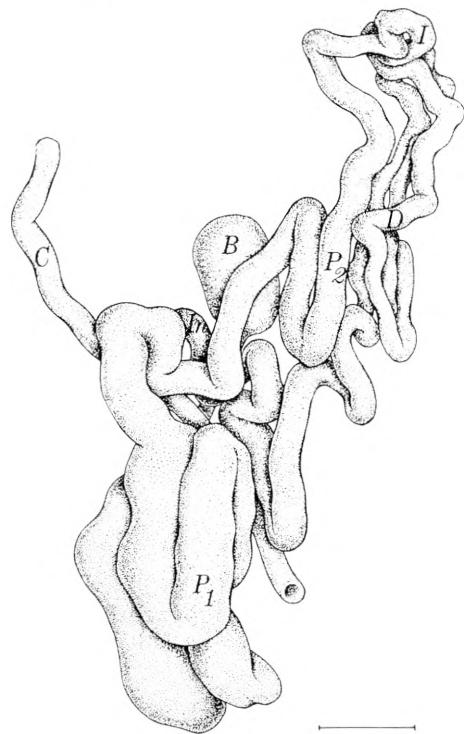


Fig. 1. Perspective graphic reconstruction of a nephron with no connection to a vas efferens. B: Bowman- nian capsule, N: Neck seg- ment, P<sub>1</sub> and P<sub>2</sub>: Proximal segment, I: Inter- mediate segment, D: Distal segment, In: Ini- tial collecting segment, C: Collecting segment.

Scale: 200  $\mu$ .

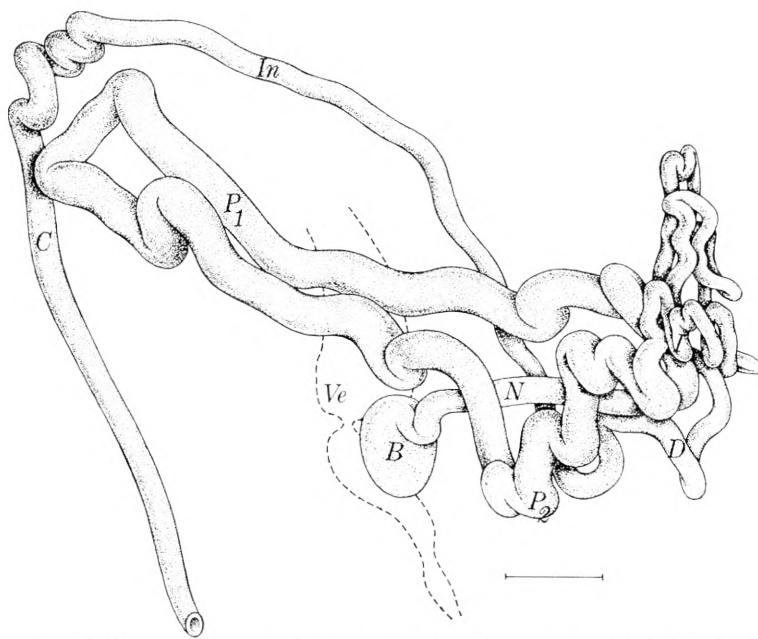


Fig. 2. Perspective graphic reconstruction of a nephron situated in the sexual part of the kidney. Ve: Vas efferens. Other abbreviations, see text-fig. 1. Scale: 400  $\mu$ .

open into a longitudinal marginal testis duct. The posterior part of this duct is connected by the vasa efferentia to some of the Malpighian corpuscles in the kidney. The number and situation of the vasa efferentia were revealed by examination of the serial sections of *Neoceratodus IV* and of the specimen, *Neoceratodus I* (text-fig. 3), in which india ink had been injected. In *Neoceratodus IV* the number was 13, whereas *Neoceratodus I* showed 11 vasa efferentia on one side.

The vasa efferentia start from the longitudinal testis duct with regular intervals (text-fig. 3). The duct continues behind the testis on the ventro-medial edge of the kidney, and is closed at the end. Some of the vasa efferentia start from this renal part of the duct.

The vasa efferentia lead into the part of the kidney lobe situated next to the testis, here called the sexual part (text-fig. 5). In the kidney they ramify and each of them opens into several Malpighian corpuscles (plate III, fig. 1). Widenings of the testis duct also open directly into the Bowmannian capsules (plate III, fig. 2). In the sexual part of the kidney all the scattered nephrons are in connection with vasa ef-

ferentia. The luminary dimensions of these nephrons are about twice the dimensions of a normal nephron (text-figs. 2 and 1).

In the normal part of the kidney lobe, the Malpighian corpuscles are situated on the periphery. The neck segments and first portion of the proximal segments are seen more centrally, and in the centre of the lobe the second part of the proximal segments, the intermediate segments and the distal segments are found. The collecting segments and the peritoneal duets often follow the surface of the lobe (plate II and text-fig. 5). Interrenal tissue is seen in the centre of the kidney in the form of small groups of cells embedded in connective tissue close to the veins (plate VII, fig. 2).

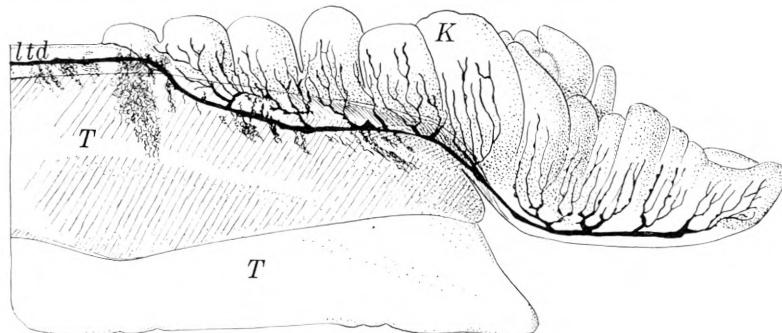


Fig. 3. Lateral view of the left testis (T) and kidney (K). India ink-gelatine 10 % was injected from the testis duct (ltd). Transparency of the tissue was obtained in benzyl benzoate. The drawing shows the 11 vasa efferentia and their ramifications in the kidney lobes. Scale: 0.7 ×.

The peritoneal ducts are seen as systems of narrow ciliated parallel ducts. They open into the peritoneal cavity with ciliated funnels between the testis and the kidney (plate II). They pass across the kidney and communicate with the initial neck segments (text-fig. 5 and plate IV, fig. 2). Different opinions exist about the persistence of the peritoneal funnels in the adult *Neoceratodus*. AYERS (1885) found no peritoneal funnels. SEMON (1901) reported peritoneal funnels from young (up to 17.8 mm) specimens, but not from the adult *Neoceratodus*. BALLANTYNE (1928) described a network of small tubules in the ventral part of the kidney running across from side to side. Some of these tubules open into the nephrons. In the examination of the embryology of the kidney of the dipnoan fishes, KINDAHL (1937) described the development of the peritoneal funnels in *Neoceratodus* up to the 55 mm stage. She had reasons to believe that adult specimens also have persistent funnels.

Histological examinations of the tubule cells in different parts of the nephron show no modifications of the cells of the sperm-transporting nephrons. Only the luminary dimensions vary; the sperm-transporting nephrons are more extended. The diameter of the Bowmannian capsules varies from 200–500  $\mu$  in the normal nephrons and from 400–700  $\mu$  in the sexual nephrons. In both types of nephrons the glomerulus is well-developed. The first segment of the nephron is a long (c. 700  $\mu$ ) ciliated neck segment (plate VI, figs. 2 and 3); then follows a brush-bordered proximal segment

divided into two parts (plate V and plate VI, figs. 2 and 3), a ciliated intermediate segment (plate VI, fig. 1), a distal segment (plate VI, fig. 2), an initial collecting segment (plate VII, fig. 1), and a collecting segment (plate VI, fig. 3), which opens into the Wolffian duct.

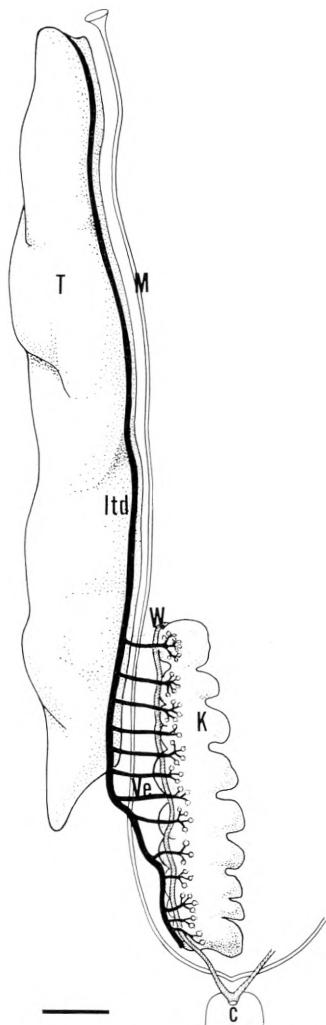


Fig. 4. Diagram showing the urogenital organs of *Neoceratodus* and their connections. T: Testis, K: Kidney, ltd: Longitudinal testis duct, Ve: Vas efferens, W: Wolffian duct, M: Müllerian duct, c: Cloaca. Scale: 2 cm.

The nephron of lungfishes has been described by, among others, CORDIER, 1929 (*Protopterus dolloi*), BARGMANN, 1934 (*Lepidosiren paradoxa*), EDWARDS, 1935 (*Protopterus aethiopicus*), GUYTON, 1935 (*Lepidosiren paradoxa*) and GRAFFLIN, 1937 (*Lepidosiren paradoxa*). Comparisons between *Protopterus*, *Lepidosiren* and *Neoceratodus* are made in the following resumé:

CORDIER (1929) <i>P. dolloi</i>	BARGMANN (1934) <i>L. paradoxa</i>	EDWARDS (1935) <i>P. aethiopicus</i>	GUYTON (1935) <i>L. paradoxa</i>	Present investigation <i>N. forstleri</i>
Malpighian corpuscle 3-4 together diameter: c. 140 $\mu$	Malpighian corpuscle 3-5 together diameter: 100 $\times$ 140 $\mu$	Malpighian corpuscle diameter: c. 153 $\mu$	Malpighian corpuscle 2-12 together 180 $\times$ 200 $\mu$	Malpighian corpuscle 2-15 together diameter: 200-700 $\mu$
Collet cilié	Halsstück ciliated, c. 270 $\mu$ long	Neck segment ciliated, c. 100 $\mu$ long	Neck segment ciliated, c. 300 $\mu$ long	Neck segment ciliated, c. 680 $\mu$ long
Tube contourné brush border, in cytoplasm: hyaline acidophile drops, yellow granules.	Hauptstück brush border, tall cells, nucleus: basal.	Prox. tub. 1 brush border, tall, broad cells, eosinophi. cytoplasm, nucleus: unregular placed.	Prox. tub. 1 brush border, cytoplasm: large granules apically, blue (azan); basally: vacuoles; nucleus: central.	Prox. tub. 1 brush border, tall cells. Granules apically: eosiniphi. PAS-positive, alcianblue-nega- tive, blue in azan. Brown pigment- granules. nucleus: basal.
Segment rectiligne sexuel segment, brush border, vacuolated cytoplasm in males with active testes.	Überleitungs- stück brush border, ciliated cells more frequently in the posterior part.	Prox. tub. 11 brush border, tall cells, cytoplasm: Slightly basophilic.	Prox. tub. 11 3 cell types: Light cells, brush cells and ciliated cells.	Prox. tub. 11 brush border, cubical cells, centrally situated nucleus, brown pigment granules.
Segment grêle cilié ciliated	÷	Intermediate segment uniciliated, cuboidal cells.	Intermediate segment ciliated, low cells.	Intermediate segment low, -cuboidal cells, ciliated.
Segment intermédiaire	Mittelstück cuboidal cells, centrally placed nucleus, striated cytoplasm, secretion on the luminar side of the cell.	Distal segment low, columnar neutrophilic cells.	Distal segment cuboidal cells; nucleus centrally placed, striated cytoplasm, vacuolated cytoplasm.	Distal segment low-cubical cells, vacuolated cytoplasm, centrally placed nucleus, many mitochondria in basal infoldings of the cell membrane.
Segment d'union intracellular canals, vacuolated cytoplasm, many mitochondria.	Querkanal unregular cells be- tween cubical cells, inter or intra- cellular spaces.		Initial collecting segment	Initial coll. segment Vacuolated cyto- plasm, oval nucleus centrally placed. PAS positive secretion on the luminal side of the cell (in the posterior part of the segment).
	Sammelrohr cylindrical cells, unregular cells, to the Wolffian duct.			Collecting segment Cells as in the posterior part of the init. coll. segment. Open into the Wolffian duct.

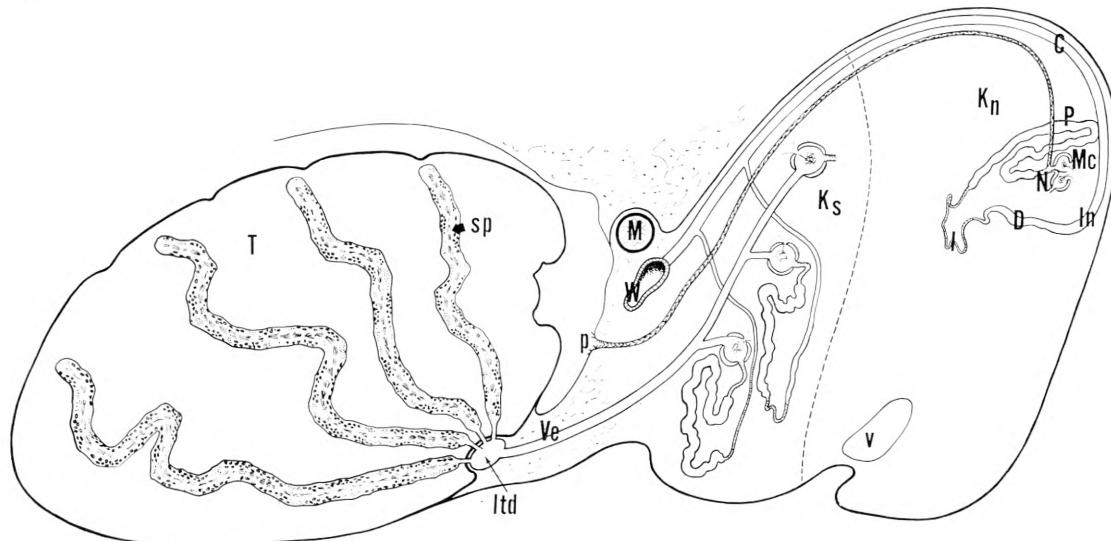


Fig. 5. Diagram showing a transverse section of testis and kidney on one side. The subdivision of the kidney into a normal part ( $K_n$ ) and a sexual part ( $K_s$ ) is shown. In the sexual part three Bowmannian capsules in connection with a vas efferens are seen. In the normal part of the kidney the situation of the different segments of the nephron is shown. Mc: Malpighian corpuscle, N: Neck segment, P: Proximal segment, I: Intermediate segment, D: Distal segment, In: Initial collecting segment, C: Collecting segment, W: Wolffian duct, M: Müllerian duct, p: Peritoneal funnel, v: Vein, Ve: Vas efferens. — In the testis (T) four seminiferous tubules with developmental stages of spermatozoa and their openings into the longitudinal testis duct (ltd) are seen.

The mature spermatozoa (sp) are situated in the lumen of the tubules. Scale: 3 mm.

The results of the investigations of the nephron of *Neoceratodus* are in accordance with the findings of GUYTON and EDWARDS in regard to the division of the nephron into segments. The nephrons of *Lepidosiren*, *Protopterus* and *Neoceratodus* show normal structures of fresh-water fish nephrons. No sexual segment was found in *Neoceratodus* as described by CORDIER in *Protopterus dolloi*.

As to the urogenital connections, the lungfishes are quite different. The two *Neoceratodus* males examined show 11 and 13 vasa efferentia on one side leading from the longitudinal testis duct to the Bowmannian capsules situated in the kidney along its whole length. The testis is not divided into a sperm-producing and a vesicular part.

In *Lepidosiren* the testis ampullae open into a longitudinal duct which continues behind the testis as a simple tube, broken up by trabecules. From this spongy cavity, called the vesicular part of the testis, 5–6 vasa efferentia lead to the normally developed Malpighian corpuscles in the posterior part of the kidney (KERR, 1901).

In *Protopterus* the central testis duct communicates behind the testis with nephrons in the posterior part of the kidney. These nephrons have no excreting function judging from the absence of glomeruli (PARKER, 1892 and KERR, 1901). In principle, *Protopterus* has a single vas efferens which communicates with several kidney tubules.

*Polypterus* was investigated and described by JUNGERSEN (1900). In *Polypterus* the testis duct continues behind the testis and opens into the distal part of the ureter.

In *Lepidosteus* and *Acipenser* the great number of vasa efferentia start from the testis marginal duct along its whole length, and communicate with a longitudinal kidney canal. The kidney in these two genera is a long paired organ extending from the heart region to the cloaca, whereas the testes are short organs situated in the intermediate part of the abdominal cavity. From the longitudinal kidney canal short ducts lead the spermatozoa to the Malpighian corpuscles (SEMON, 1891).

In *Amia* (JUNGERSEN, 1900) the vasa efferentia each opens into a longitudinal kidney canal, and from there the sperm passes directly into the Wolffian duct.

According to the findings reported in this paper it may be concluded that the urogenital connections of *Neoceratodus* show the same primitive evolutionary features as those of *Lepidosteus* and *Acipenser*.

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## PLATES

PLATE I

Fig. 1. *Neoceratodus forsteri* 1 ♂. Ventral view of the testes (T), the abdominal wall is removed. — Scale: 7 cm.  
Fig. 2. *Neoceratodus forsteri* 1 ♂. Lateral view of the kidneys (K) and the posterior part of the testes (T). —  
Scale: 2 cm.

PLATE I

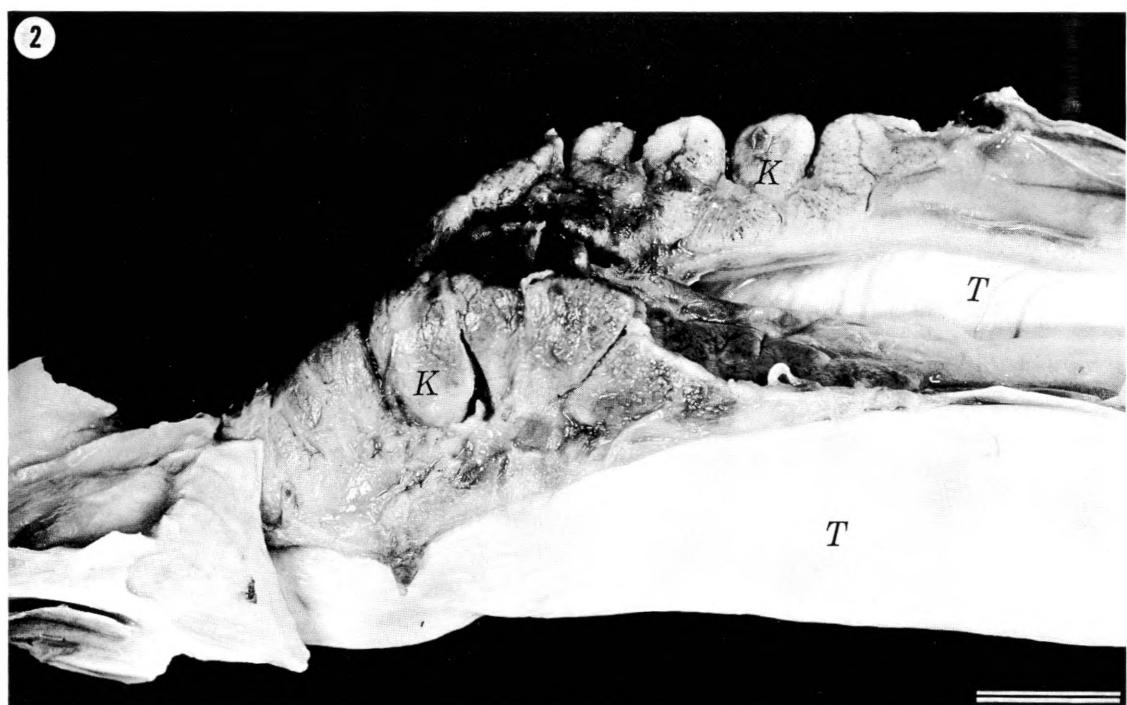


PLATE II

Transverse section of testis (T) and kidney (K). The kidney tissue on the testicular side of the lobe contains scattered nephrons in connection with vasa efferentia. The Müllerian duct (M) and the Wolffian duct (W) are seen. An opening of some peritoneal ducts into the peritoneal cavity is seen (p). —  $15 \mu$  sections. PAS. Scale: 2 mm.

PLATE II



PLATE III

Fig. 1. Three Bowmannian capsules in connection with a vas efferens (Ve). — N: Neck segment. —  $10\ \mu$  section. PAS. NA: 0.20. Scale:  $250\ \mu$ .  
Fig. 2. An opening of the testis canal into a Bowmannian capsule. —  $10\ \mu$  section. PAS. NA: 0.16. Scale:  $250\ \mu$ .

PLATE III

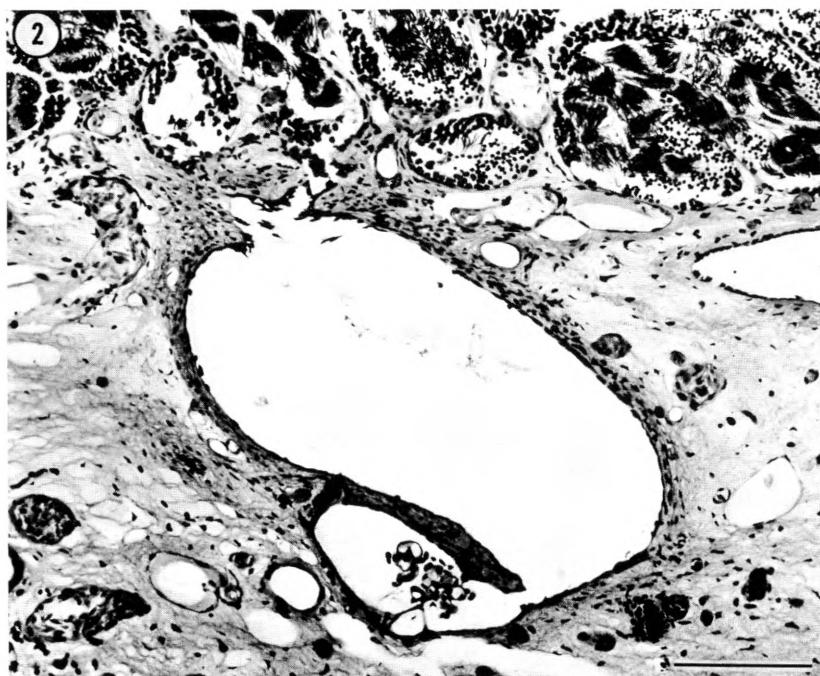
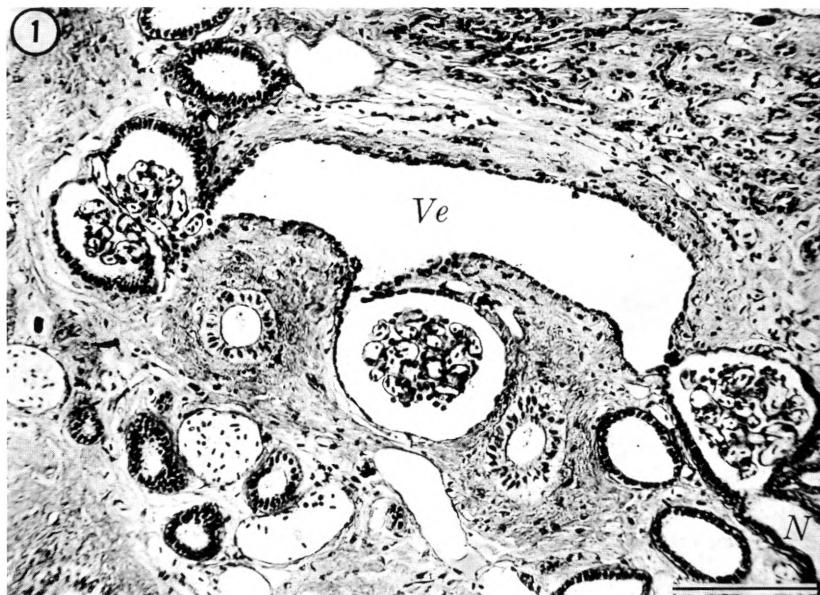


PLATE IV

Fig. 1. Chain of 11 Bowmannian capsules. N: Neck segment. — 10  $\mu$  section. PAS. NA: 0.45. Scale: 200  $\mu$ .  
Fig. 2. Opening of a peritoneal duct (P) into a neck segment (N). — 15  $\mu$  section. HE. NA: 0.45. Scale: 50  $\mu$ .

PLATE IV

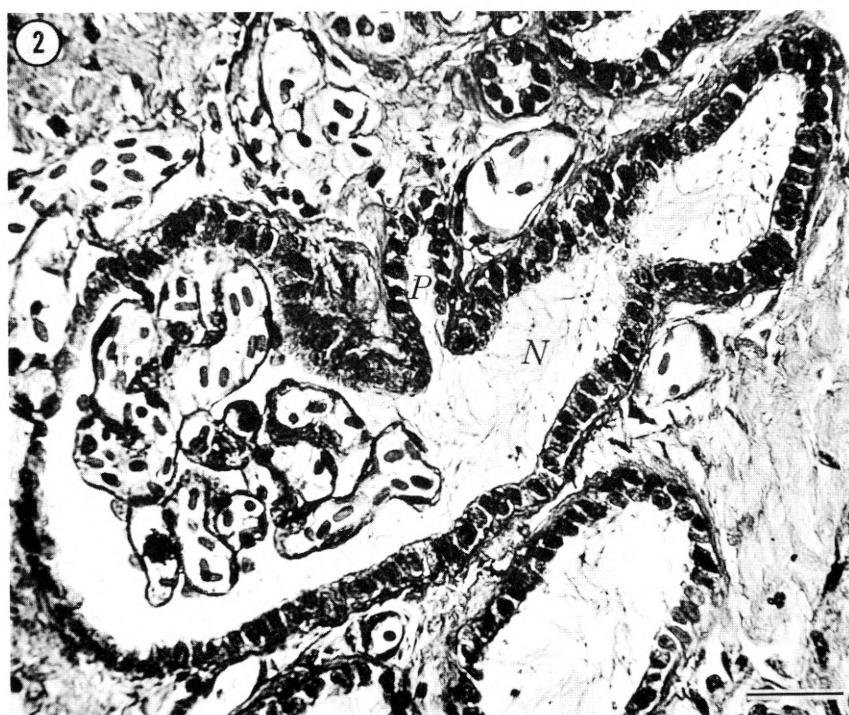
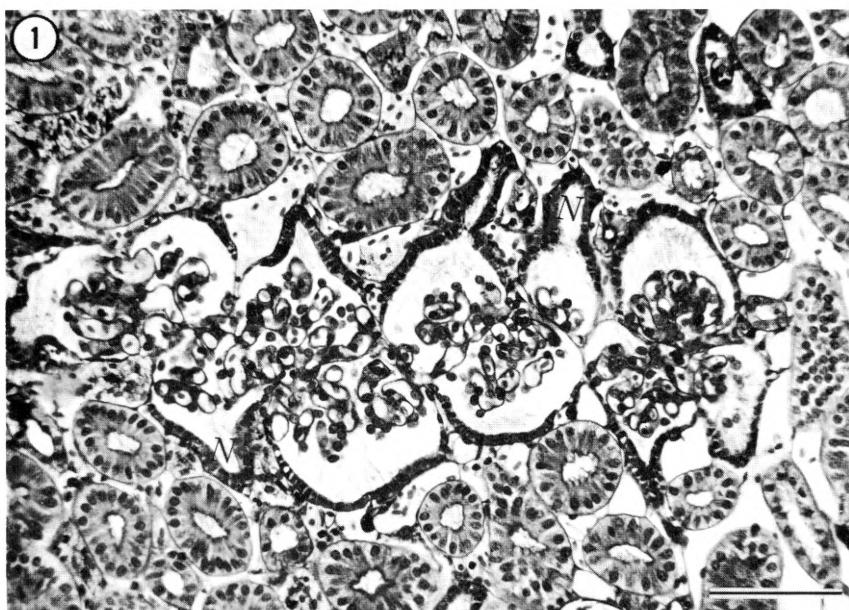


PLATE V

Fig. 1. Proximal segment. Fixation: Glutaraldehyde. — 2  $\mu$  epon section. Toluidin blue. NA: 1.0. Scale 25  $\mu$ .  
Fig. 2. First part of the proximal segment. — 10  $\mu$  section. PAS. NA: 0.65. Scale: 25  $\mu$ .

PLATE V

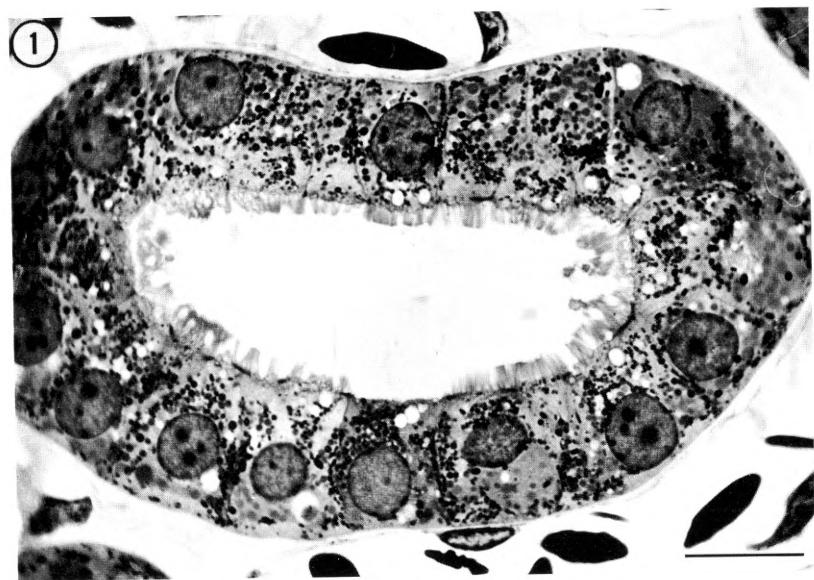


PLATE VI

- Fig. 1. Intermediate segment (I) with cilia. — In: Initial collecting segment. —  $10\ \mu$  section. PAS. NA: 0.45. Scale:  $50\ \mu$ .
- Fig. 2. First and second part of the proximal segment ( $P_1$  and  $P_2$ ) and distal segment (D) with pigment granules. N: Neck segment.  $10\ \mu$  section. PAS. NA: 0.45. Scale:  $50\ \mu$ .
- Fig. 3. Neck segment (N), first part of the proximal segment ( $P_1$ ) and second part ( $P_2$ ). Collecting segment (C). —  $10\ \mu$  section. PAS. NA: 0.45. Scale:  $50\ \mu$ .
- Fig. 4. Bowmanian capsule with spermatozoa. —  $10\ \mu$  section. PAS. NA: 0.45. Scale:  $50\ \mu$ .

PLATE VI

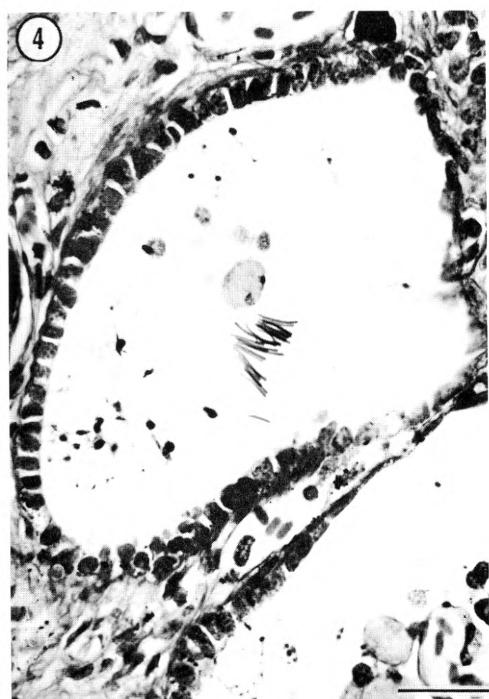
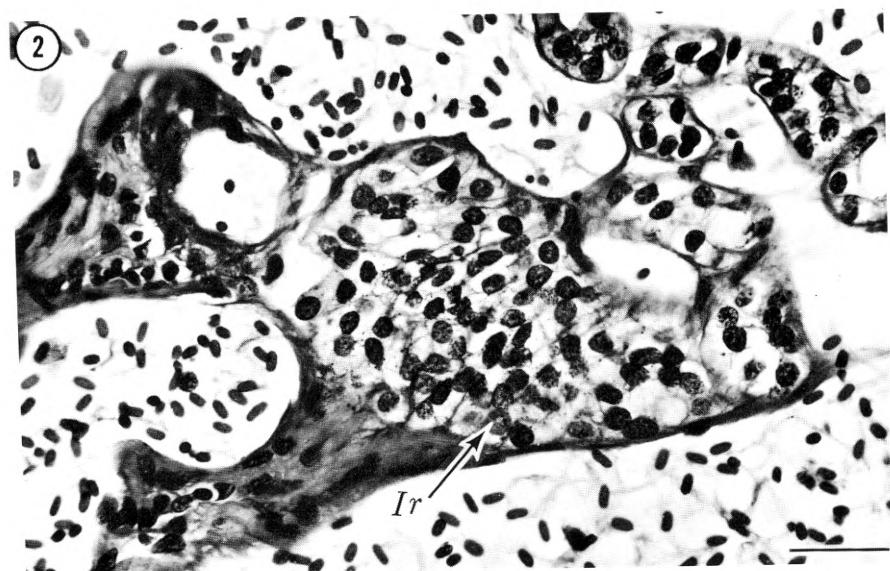
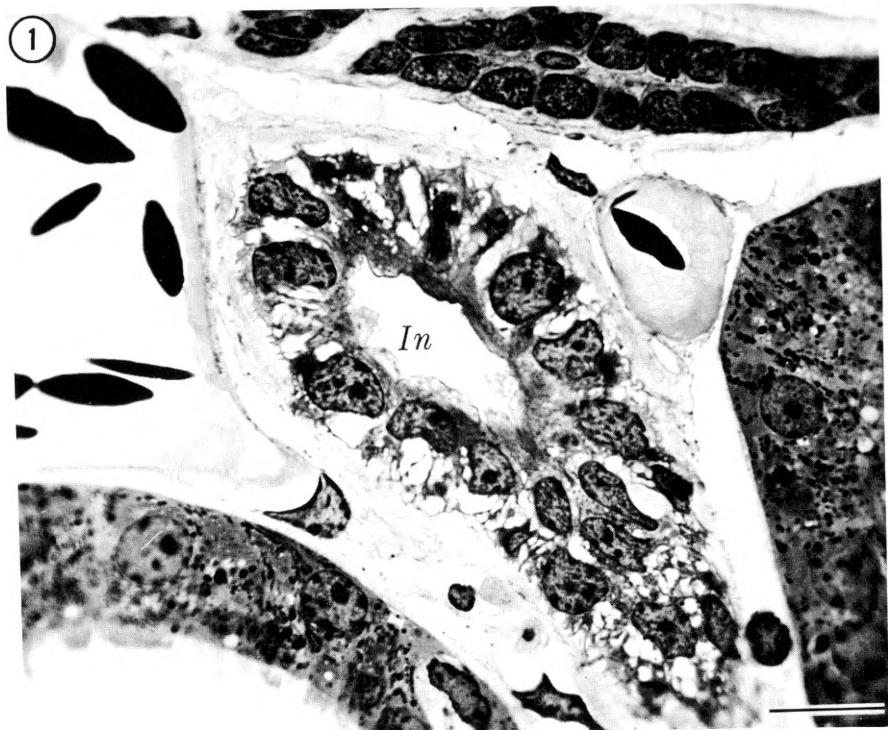


PLATE VII

- Fig. 1. Initial collecting segment (In). Fixation: Glutaraldehyde. — 2  $\mu$  epon section. Toluidinblue. NA: 1.0. Scale: 25  $\mu$ .
- Fig. 2. Interrenal tissue (Ir.). — 10  $\mu$  section. PAS. NA: 0.45. Scale: 50  $\mu$ .





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MARIE HAMMER

ON SOME  
ORIBATIDS FROM VITI LEVU,  
THE FIJI ISLANDS

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### Synopsis

A total of 83 species of oribatids from the Fiji Islands are treated in the present paper. Of these species, 43 are new to science – 8 new genera are established. The 40 previously described species are listed in the table on page 52. Several of these 40 species have a virtually world-wide distribution, while others occur especially in the warmer regions of the southern hemisphere. Besides occurring in the Fiji Islands, a few also occur in West Africa, e.g. *Allonothrus russeolus* and *Oribatella schoutedeni*. This scattered occurrence, which also applies to many of the species listed in the table, may be explained by our still very scanty knowledge of the distribution of the oribatids.

The oribatid fauna of the Fiji Islands are largely a mixture of species from all the areas bordering on the Pacific and from islands in the Pacific. It is surprising that none of the many new genera from New Zealand which are so far endemic to this country, have been found on the Fiji Islands, as New Zealand is the closest greater territory to the Fiji Islands.

## Preface

The material for the present investigation was collected during a week's stay at Viti Levu, the Fiji Islands, in the latter part of October 1962. I collected the material in order later to be able to compare the oribatid faunas of the Fiji Islands and New Zealand and perhaps in this way to obtain a more thorough understanding of conditions of spreading and distribution in this part of the world. Unfortunately time did not permit me to make thorough investigations of the oribatid fauna on the Fiji Islands. Collections were made in two localities at Corolevu on the western part of the south coast and in a rain forest at an altitude of about 400 metres, about 30 miles north of Suva.

For assistance with collecting in the rain forest I should like to offer Mr. P. O'CONNOR, Senior Entomologist at the Dept. of Agriculture, Suva, and his assistant my most cordial thanks.

At Corolevu oribatids were collected partly in a "meadow" at a short distance from the Hotel Corolevu, and partly from withered leaves on a cliff or a bank at the mouth of a river overgrown with mangrove. In the rain forest they were collected from moss and leaves on the forest floor, from moss on living and dead tree trunks, and from moss on stones in a brook. Furthermore, outside the forest from moss on the banks of a man-made canal in a park.

In spite of the very unfavourable and dry conditions near Corolevu, 52 species were found in this locality. On the other hand, the moist biotopes of the rain forest, where there were expectations of rich finds, yielded only 43 species. In all 83 species were collected.

Of these a large number are new species. Others constitute a mixture of species with representatives from nearly all the territories bordering on the Pacific, as will appear from what follows.

I should like to offer my warm thanks to the Carlsberg Foundation for their financial support towards the preparation of the material, and to the Rask-Ørsted Foundation for their financial support towards the translation into English. In addition, I am deeply indebted to the late Mr. N. HAISLUND, M.A., who assisted me with the translation.

*Fredensborg, 6th August 1969.*

MARIE HAMMER

1\*



### List and Descriptions of the Species Found

In this list I have followed the same principles as in Balogh's: A Synopsis of the World Oribatid (Acari) Genera, 1965.

#### Hypochthonoidea BALOGH, 1961

*Eohypochthonius gracilis* (Jacot); fig. 1.

*Hypochthonius gracilis* Jacot, 1936, p. 251, fig. 9.

Length about 0.27 mm. Colour light brown.

The specimen from Viti Levu is a little smaller than indicated by JACOT (0.31 mm. long) and the branches of the pseudostigmatic organs are a little longer. The notogastral hairs do not overlap as illustrated by JACOT.

Suva: One specimen in thin moss on a rotting tree trunk in the rain forest.

*Malacoangelia remigera* Berlese.

— — — , 1913, p. 101, Table VII, fig. 86.

Corolevu: Many specimens in mouldering leaves under trees on a slope above the mangrove.

#### Phthiracaroidea GRANDJEAN, 1954

*Hoplophthiracarus kugohi* Aoki.

— — — , 1959a, p. 17, fig. 12.

Corolevu: One specimen in dead leaves on a slope with trees above the mangrove.

Suva: Two specimens in dead leaves on the forest floor.

*Hoplophorella cucullata* (Ewing).

*Hoploderma cucullata* Ewing, 1909, p. 133, Pl. VI, fig. 35.

Corolevu: One specimen in very thin moss on a root under trees above the mangrove.

*Steganacarus craterifer* n.sp.; fig. 2.

Length of aspis approximately 0.27 mm.

— — notogaster — 0.46 mm.

— — — diagonally 0.42 mm.

— — genital plates 0.11 mm.

— — anal plates 0.10 mm.

Colour brown between the craters, the craters being light brown.

Aspis. The aspis is highly arched with a long and very broad crest, fig. 2a. The latter is bifid. The two parts are rounded distally, where the short spine-shaped rostral hair is situated. Between the two branches of the crest there is a light, round spot. The interlamellar and the lamellar hairs, which are situated in a transverse row between the pseudostigmatic organs, are very short and thick. The pseudostigmatic organ is slightly curved, a little broader distally and unilaterally barbed here, fig. 2b. Large and deep pits cover almost the whole surface of the aspis. Along the posterior border of the latter there are in the middle four longitudinal rows of pits, farther laterally on either side four undulating lines.

Notogaster. Along the anterior border there is a narrow collar, which is not elevated. There are 14 pairs of broad, leaf-shaped hairs with a middle rib. The hairs end distally in a thin tip, fig. 2c,d,e. The sides of the notogaster are covered with large deep pits like craters, which appear light brown surrounded by a darker pigmentation. On the dorsum the pits are smaller and the surroundings are a lighter colour.

Genital-anal region. The genital plates are a little longer than the anal plates, fig. 2f. There are six pairs of genital hairs. In the middle of the anal plates there is a round area, half of it on each plate. Along the medial border of the plate there are four hairs at almost the same mutual distance. Of the two anterior hairs, which issue at the end of a long pore, one is directed posteriorly, the other anteriorly. Both are broad, leaf-shaped. The two posterior hairs are narrower. Near the anterior border of the anal plate there is a fifth hair. The anal plates are densely pitted, the round area faintly pitted. All tarsi are monodactylous.

Suva: One specimen in dead, rather dry leaves on the floor of the rain forest.

#### Perlohmannioidea GRANDJEAN, 1958

*Epilohmannia multiseta* n.sp.; fig. 3.

Length about 0.70 mm. Colour light brown.

Propodosoma. The rostrum is rounded and is a greyish colour. Across the rostrum there is a belt with short, longitudinal stripes. The rostral hairs, which are situated rather close together, almost reach the tip of the rostrum. They are barbed. Between the rostral hairs and the lamellar hairs there is a narrow transverse line, which is broken in the middle. The lamellar hairs are situated halfway between this line and the anterior border of the hysterosoma, far laterally. They are barbed and less than half as long as their mutual distance. They are directed medially. The mutual distance of the interlamellar hairs is longer than that of the lamellar hairs. They are located close to the pseudostigmata. They are erect, longer than the lamellar hairs, and distinctly barbed. The pseudostigma has a very small opening, which is directed outwards. Inside the small cup several small cells can be seen. The pseudostigmatic organ is thread-shaped. Soon after leaving the cup it makes a bend forwards. The distal part is slightly curved and for most of its length set with small bristles, especially

along its anterior border. The pseudostigmatic organs are only a little shorter than their mutual distance. The exopseudostigmatic hair is short.

Hysterosoma. The hysterosoma is egg-shaped with a broad, rounded anterior margin and slightly pointed posteriorly. There are 13 pairs of faintly barbed notogastral hairs, which are almost equally long, c3 being a little shorter, 2f much shorter. The latero-abdominal gland can be seen off e2.

Ventral side. Fig. 3a shows the main features of the ventral side. A longitudinal line separates the epimeres from the two sides. Epimere I is triangular and broad, Epimere II and Epimere III are narrow, and Epimere IV is very large. In all the epimeres very distinct muscle fibres can be seen radiating from the longitudinal middle line towards the acetabula. The genital and the anal fields are separated by a transverse suture. The genital field is a little broader than the anal field. There are eight pairs of genital hairs, viz. five along the medial border and three farther laterally. The number of aggenital hairs is variable. In one specimen there were eight pairs, fig. 3a, in another specimen there were eight on one side, twelve on the other, fig. 3b. There are three pairs of anal hairs and three pairs of adanal hairs, all are moderately long and faintly barbed, when laid bare they overlap.

Legs. Fig. 3c,d, and e show Leg I, Leg II, and Tibia and Tarsus IV, respectively. The hairs are long and barbed. Tarsus IV, which is very long, has a strong ventral spine distally and several very stiff setae. All the tarsi are monodactylous.

The number of solenidia is:

	Leg I	II	III	IV
Tarsus	2	2	0	0
Tibia	1	1	1	1
Genu	1	2	1	1
Femur	0	0	0	0

Fig. 3 f shows the maxilla and the palp. The latter has only two joints but a short transverse line indicates a former separation. Fig. 3 g shows the mandible, which is very strong. Fig. 3 h shows the surroundings of Leg II as seen from inside. The serrate lateral boundary is the outer margin of Epimere II, which is shown also in fig. 3 i, as seen in a ventral view. The lateral border of Epimere I has a strong, transversally striated boundary, the striation being present also farther medially. Epimere II is decorated with a network of long, irregular meshes, being at the same time striated. The serrate outer boundary of Epimere II can be seen only when laid bare.

Suva: Two specimens in a thin layer of moss on a tree.

*Javacarus kühnelti* Balogh; fig. 4.

— — — , 1961 a, p. 31, figs. 39–40.

Length about 0.65 mm. Colour light brown.

The specimen from Corolevu differs a little from BALOGH's species from Java. The pseudostigmatic organs have 10 secondary branches, BALOGH illustrates seven only.

The light spots of the notogaster are perhaps a little bigger and form a pattern, which is slightly different from that of *J. kühnelti*.

Corolevu: One specimen in stiff, green grass in a "meadow" with pasturing cattle near a river.

Nothroidea GRANDJEAN, 1954

*Masthermannia mammillaris* Berlese.

— — — , 1913, p. 100, Table VIII, fig. 92.

Corolevu: One specimen in dry leaves on a slope above the mangrove.

*Cyrthermannia luminosa* n.sp.; fig. 5.

Length about 0.50 mm. Colour dirty brown.

Propodosoma. The rostral hairs are short and thick, probably not bifid. The lamellar and the interlamellar hairs are smooth, bifid with a moderately long anterior part and a very short posterior spur. The distance between the lamellar hairs is much shorter than that between the interlamellar hairs. The pseudostigmatic organs are short, rounded, hairy clubs. On either side of the propodosoma there is a semicircular ridge, which laterally surrounds the pseudostigma, and behind the interlamellar hairs a broad U-shaped ridge on the posterior border of which there are two backwards directed processes like those in *Nanhermannia elegantula* Berl. The sculpture in the anterior part of the propodosoma is irregular with deep, often confluent pits. Posteriorly the pits are smaller and more regular. Between the pits the integument is densely punctate.

Hysterosoma. The hysterosoma is broadest across the middle. Its anterior border is straight. The posterior end is narrow with an incurvation in the middle of the posterior border. The notogastral hairs are bifid and shaped like the lamellar and the interlamellar hairs with a rather long smooth hair and a short posterior spur, fig. 5 a. In the integument there are light irregular spots of different sizes, fig. 5 b. Along the border of the spots there are luminous dots (hence the specific name).

Suva: A great number in thin moss on a tree trunk in the rain forest.

*Malacothrus variosetosus* n.sp., fig. 6.

Length about 0.30 mm. Colour dirty, light brown, the anterior two thirds of the propodosoma is a darker colour than the posterior third.

Propodosoma. The anterior half of the propodosoma is narrow with almost parallel sides. There is a strong projection between Leg I and Leg II. The lamellar ridges, which are broadest in their anterior half, apparently continue to the tip of the rostrum after bending slightly medially. The rostral hairs are thick, short, and barbed. The lamellar hairs, which are situated medially to the lamellar ridges, are thin, smooth, and shorter than their mutual distance. The interlamellar hairs are likewise smooth and no longer than the lamellar hairs. The middle field is densely punctate. Across

its middle two curved punctate lines can be seen and behind them two oblong spots with a coarser punctuation.

Hysterosoma. The hysterosoma has parallel sides, a straight anterior border, and a rounded posterior end. The middle field is bordered by broad, parallel ridges with faint, transverse lines. Also the ridges farther posteriorly are broad and transversally striated. The notogastral hairs are of two kinds, viz. partly short, thick, unilaterally barbed spines, partly much longer, very thin, and smooth hairs. Most of the hairs belong to the first kind. E2, h1, h2, and ps3 belong to the thin, smooth kind.

Ventral side. The epimeric hair formula is: 3-1-3-3, fig. 6a. Most of the hairs are absent. There are six pairs of thin genital hairs, which are situated in the anterior two thirds of the plates. Their length increases towards the posterior pair, which is twice as long as the first. The adanal hairs, which are situated on the posterior half of the plates, are very long and project beyond the posterior border of the hysterosoma. Anal hairs have not been observed. Ps3 is thin and smooth, ps2 thick and barbed.

This species is in many ways similar to *Malacothrus plumosus* Willm. 1931, p. 247, figs. 8–10, from Java, but can be distinguished from the latter by its broader rostrum, its two kinds of notogastral hairs, and the much shorter interlamellar hairs. Suva: Two specimens in thin moss on a tree trunk in the rain forest.

*Malacothrus hexasetosus* n.sp.; fig. 7.

Length about 0.38 mm. Colour yellowish, light brown.

Propodosoma. The anterior part is narrow, not even half as broad as the posterior part. The projection between Leg I and II is rounded. The lamellar ridges are almost equally broad throughout with a rounded tip. In some specimens a narrow translamellar line can be seen between the ridges. The rostral hairs are as long as their mutual distance, thin, and smooth. The lamellar and the interlamellar hairs are like the rostral hairs. A dense punctuation can be seen in the anterior part of the middle field; in the posterior part behind the interlamellar hairs the punctuation is finer and indistinct.

Hysterosoma. The sides are parallel, the anterior border slightly convex, and the shoulder corners rounded. The middle of the posterior end projects as a small rounded tail. The notogastral hairs are erect, thin, and smooth. Most of them are of moderate length but seem short due to their erect position. Six of them, viz. cl, dl, and el are, however, considerably longer, approximately as long as the distance between the hairs dl and el. This can best be seen in a lateral view, fig. 7a. The integument is beautifully pitted with a fine punctuation in between. The pits become smaller towards both ends of the hysterosoma, disappearing finely. There are no longitudinal ridges.

Ventral side. Mentotectum with a “nose-like” projection anteriorly. The epimeric hair formula is: 3-1-3-3. The genital plates have six pairs of genital hairs, which are situated on the anterior two thirds of the plates. The genital hairs are smooth, increasing in length towards the posterior end. The three pairs of adanal hairs are also smooth

and moderately long. Ps2 and ps3 are like the adanal hairs. The very small anal hairs are located at a level a little behind ad3.

Corolevu: 10 specimens in moss and dead leaves on a slope above the mangrove.  
Suva: One individual in moss on a tree trunk in the rain forest.

*Trimalaconothrus crassisetosus* Willm. var. *fijiensis* n.var.; fig. 8.

*Trimalaconothrus crassisetosus* Willm. 1931, p. 252, figs. 17–19.

Length about 0.495 mm. Colour light brown.

The length of the variety is exactly the same as that of the main form from Sumatra. In the size, in the shape of the lamellar ridges, in the long rough setae of the hysterosoma there is a great similarity between the main form and the variety, but they differ in several ways. The variety can be distinguished from the main form by its smooth integument (the main form is foveolate both in the propodosoma and in the hysterosoma), and by the appearance of the lamellar and the interlamellar hairs, which are not so long and not so rough as illustrated by WILLMANN. Furthermore the long notogastral hairs are not thin at their bases. All the notogastral hairs are barbed. In the middle of the hysterosoma there are two longitudinal ridges and farther laterally two more indistinct ridges, all of which are absent in the main form.

The ventral side, which has not been illustrated by WILLMANN, is shown in fig. 8a. The epimeric hair formula is: 3-1-3-3. There are five long and smooth genital hairs, all of which are situated in the anterior two thirds of the plates at almost the same mutual distance. The adanal hairs are much shorter than the genital hairs, thick and barbed. The anal hairs, which can be seen off ad2, are hardly discernible. Ps3 is moderately long and barbed. The tarsi are tridactylous.

However, the variety *fijiensis* may represent an independent species as there are many differences between the main form and the variety.

Suva: Five specimens in wet *Polytrichum* a few cm. above a brook.

*Allonothrus russeolus* Wallwork; fig. 9.

— — — — , 1960a, p. 571, figs. 4–5.

Length about 0.56 mm. Colour brown.

The specimen from the Fiji Islands agrees in most features with *A. russeolus* from Ghana. There are only small differences. The two oblique, dark ridges in the middle of the propodosoma meet as shown by WALLWORK, but a dense, dark punctuation in front of them forms a dark brown point, so that the ridges apparently meet in a pointed tip. The alveoles on the dorsum are separated by thin, light lines on the brown ground, and the alveoles are of different sizes.

Corolevu: One adult and a few nymphs in a moist "meadow" with stiff, green grass and pasturing cattle near a river.

## Hermannelloidea DUBININ, 1954

*Plasmobates hyalinus* n.sp.; fig. 10.

Length about 0.345 mm. Colour light brown.

Propodosoma. The whole surface is completely hidden under a strong layer of secretion. Very characteristic of this species are two hyaline membranes, one on either side of the tip of the rostrum, projecting beyond the latter. On the projecting tip of the membrane the rather thick and curved rostral hair is situated. The dorsal side of the rostrum between the membranes is at a lower level than the roughly sculptured part behind it. The integument on the rostrum is smooth. In the middle of the elevated area in front of the pseudostigmata there are two low keels between which and laterally to which there are longitudinal rows of pits of different sizes. The sculptured middle field is bordered laterally by a smooth ridge, which posteriorly runs laterally to the pseudostigma, then straight backwards to the posterior border of the propodosoma. A more superficial ridge runs in a curve from a short distance in front of the interlamellar hairs laterally to the pseudostigma, and then to the posterior border of the propodosoma, but more medially than the first-mentioned ridge. There is no sculpture on the posterior part of the propodosoma. The interlamellar hairs are absent. The pseudostigmatic organs, which are as long as their mutual distance, are thread-shaped, distally set with minute bristles and ending in a thin tip.

Hysterosoma. The hysterosoma is circular, its middle is elevated. The sculpture consists of pits of different sizes. The pits are not arranged regularly. The space between the pits varies, usually it is big. The lateral tubes are long, narrow, directed forwards. Only five pairs of notogastral hairs, situated on short apophyses, have been observed, viz. one laterally at some distance in front of the lateral tube, three on the posterior border, and one apophysis without a hair laterally to those on the posterior border, removed a little from the border. The three hairs on the posterior border are situated on a curved ridge, which can be seen in a ventral view, fig. 10a. The hairs are very small, shorter than the apophysis.

Ventral side. The genital and the anal fields are approximately equally long, separated by a short distance. There are six pairs of genital hair pores, hairs being absent. Surrounding the outer border of the anal plates there is an irregular semilunar thickening. The short anal hairs are situated close to this thickening. Ad3 is close to the pore for the aggenital hair, preanal. Ad2 is situated off the anterior anal hair. Ad1 is absent. Iad is very long and is located at the latero-anterior corner of the field. Faint pits can be seen on the ventral plate. In front of Leg II there is a big tooth, a smaller one in front of Leg III.

Systematic position. *Plasmobates hyalinus* is related to *P. pagoda* Grdjn. 1929, p. 411, Pl. III, figs. A–F, Pl. IV, figs. A–F, from Martinique. It can be distinguished from the latter by its hyaline rostral processes, and by its very long pseudostigmatic organs. Corolevu: Two adults and a nymph in dead, moist leaves on a slope above the mangrove.

*Hermannella punctulata* var. *columbiana* Berlese.

— — — — — , 1910, p. 224, fig. 59.

Corolevu: One specimen in dry leaves on a slope with trees above the mangrove.

Liodoidea BALOGH, 1961

*Liodes ramosus* n.sp.; fig. 11.

Length about 0.94 mm. Colour reddish-brown.

Propodosoma. The rostrum is semicircular, and very broad. In front of Leg I the propodosoma suddenly widens. At this level a transverse ridge separates the rostrum from the posterior part of the propodosoma. In front of this ridge there is a narrow furrow. The rostral hairs are smooth, curved, and taper towards the tip. The lamellar hairs, which are situated on apophyses, are peachleaf-shaped and approximately as long as their mutual distance. The interlamellar hairs are much shorter, and also foliate. The pseudostigmatic organs are slender clubs set with coarse scales in longitudinal rows. A coarse reticulation covers most of the surface of the propodosoma, but is absent from the space between the furrow and the transverse ridge, and is faintly developed in the middle of the propodosoma. It is absent also in the surroundings of the pseudostigmata.

Hysterosoma. The hysterosoma, which is arched at the middle, is pear-shaped with a broadly rounded anterior end and a pointed posterior end. The latter ends in a short tail with two long apophyses on one of which there is a long hair, the end of which is broken. The hair is missing on the other apophysis. On either side of the tail there are two short apophyses, each with a short foliate hair, set with small scales. The sculpture consists of small dark tubercles between oblique lines, which run from the sides of the hysterosoma towards the middle and then forwards. A few tubercles as seen half in profile are shown in fig. 11 a. They are shown obliquely from the side in fig. 11 b. Each tubercle is surrounded by six luminous dots, which when focused at a lower level can be seen arranged regularly between canals that connect the tubercles (shown schematically in fig. 11 c).

Legs. The legs are very strong with strong apophyses carrying the hairs. Roughly, the latter are foliate, but some are narrow, others broad and some are peculiar by being very broad, hyaline, with a marginal thickening from which irregular branches issue; see fig. 11 d, which shows a hair from the medial side of Femur I. These branched hairs have given this species its name. There are three almost equally strong claws.

The whole mite is covered with a tough layer of secretion, which is especially thick on the legs.

Suva: One specimen in dead leaves on the floor of the rain forest.

*Pedrocortesella sexpilosa* (Ramsay).

— — — — — , Hammer, 1966, p. 48, fig. 60.

Corolevu: A few individuals in thin mosses on a root on a slope above the mangrove.

## Cepheoidea BALOGH, 1961 – Carabodoidea DUBININ, 1954

*Tegeozetes tunicatus* Berlese.

— — — — , 1913, p. 91, Table VI, fig. 62.

Corolevu: One specimen in moist, rotting leaves under trees on a slope above the mangrove.

*Tegeocranellus laevis* (Berlese).*Tegeocranus laevis* Berlese, 1904, p. 237.*Tegeocranellus laevis* Berlese, 1913, p. 93.

Corolevu: One specimen in stiff, green grass in a "meadow" with pasturing cattle near a river.

*Tectocepheus velatus* (Michael).*Tegeocranus velatus*, Michael, 1884, p. 313, plate 21.

Corolevu: One specimen in mouldering leaves under trees on a slope.

Suva: One specimen in dry leaves on the forest floor.

*Gibbicepheus? frondosus* (Aoki); fig. 12.*Diplobodes frondosus* Aoki 1959a, p. 12, fig. 9.

Length about 0.685 mm. Colour dark brown.

The present species, of which only one specimen was found, cannot be identified with certainty as all the hairs of the dorsal side except the rostral hairs, the lamellar hairs, and one pseudostigmatic organ are broken. It agrees, however, so much with *G. frondosus* (Aoki) that if it does not represent this species it must be a variety of it. It differs in its longer rostral hairs, which almost meet in front of the rostrum, in the lack of a transverse ridge behind the interlamellar hairs, which, however, according to AOKI disappears after some time in BERLESE's fluid, and in the shape of the hairs, which apparently have a middle furrow and no middle rib. However, this interpretation may be wrong as details are difficult to see due to a layer of secretion covering the lateral borders of the hairs, fig. 12a. On the posterior part of notogaster there are round alveoles, which are not arranged in regular rows as shown by AOKI. Fig. 12b shows the mite in a lateral view. It appears that there are light, semi-transparent "windows" in the lamellae.

Ventral side. There are four pairs of genital hairs, which are two thirds as long as the plates. The adanal hairs are leaf-shaped, ending in a small tip, fig. 12c. Ad3 is preanal and situated laterally. Ad2 is situated off the middle of the anal field, ad1 off the posterior border of the latter.

Corolevu: One specimen in dead leaves on a slope above the mangrove.

## Eremaeoidea WOLLEY, 1956

*Basilobelba pacifica* n.sp.; fig. 13.

Length about 0.54 mm. Colour light brown to brown.

The present species differs from the two previously described *Basilobelba* species, viz. *B. retiarius* (Warb.) 1912, and *B. africana* Wallw. 1961 in several characteristics as is evident from the following.

**Propodosoma.** The rostral hairs, which are bent medially near the bases, are much thinner than the lamellar hairs. The latter, which are situated on short apophyses, at a much shorter mutual distance than the rostral hairs, are set with short minute barbs, especially on their proximal two thirds. They are almost equally thick throughout, only a little thinner at the tip. The rostrum is separated from the posterior part of the propodosoma by a strong, transverse ridge, on which the lamellar hairs are situated. It is broken in the middle. Laterally it turns sharply backwards, forming two strong, projecting teeth, one on either side of the rostrum. In the posterior part of the propodosoma a transverse bridge connects the pseudostigmata. The middle of it is well developed, then comes a part which is faintly developed; the lateral parts are strong. The rather short interlamellar hairs are located medially to the pseudostigmata. The pseudostigmatic organs are set with short, thick, depressed scales or bristles in their whole length and all the way round. They are almost as long as their mutual distance.

**Hysterosoma.** The anterior margin is straight or slightly concave, the latero-anterior borders are broadly rounded. After removing the tritonymphal scalp, in the posterior end of which there is an oblong opening, 7 pairs of notogastral hairs could be seen only. They are arranged as shown in fig. 13a.

**Ventral side.** The main characters are shown in fig. 13b. The distance between the gnathosoma and the genital field is very short. Apodema I is short and is situated obliquely. The hairs of the ventral plate are arranged asymmetrically. Their position is shown in fig. 13b. I am unable to see the lateral hairs of the epimeric region. The genital field is almost round. There are six pairs of genital hairs. The four anterior ones are situated close together, their pores almost touching. The anal field is oblong and larger than the genital field. The anal hairs are situated in the anterior half of the plates.

The mandibles are short and broad.

**Legs.** The hairs of the legs are narrow, leaf-shaped with a narrow middle rib and on the outer side set with minute bristles, fig. 13c. The claw of Tarsus I is almost straight, those of Tarsi II-IV much more strongly curved and shorter.

**Tritonymph.** The arms of the scalp are broader than in previously described species. The seta c1 has not been observed, nor c2.

In the deutonymph the hairs c1 and c2 are present, fig. 13d. La and lm are represented by their pores only. The protonymph is shown in fig. 13e and the larva in fig. 13f.

The present species can be distinguished by the strong transverse ridge on the rostrum, the transverse bridge between the pseudostigmata, the coarse, densely barbed pseudostigmatic organs, the leaf-shaped hairs of the legs, and the broad arms of the tritonymphal scalp.

**Suva:** Five adults, six nymphs and a larva in a thin layer of moist moss on a tree trunk in the rain forest.

At Corolevu five specimens of *B. pacifica* were found in moss on a tree root. They differ slightly from the specimen from Suva described above by having coarser hairs on the legs, fig. 13g, and by the very broad opening in the tritonymphal scalp, fig. 13h.

*Fosseremus quadripertitus* Grandjean.

— — — — —, 1965, p. 343, figs. 1–8.  
Corolevu: Three specimens in mouldering leaves on a slope with trees, above the mangrove.

*Eremulus curviseta* n.sp.: fig. 14.

Length about 0.32 mm. Colour light brown.

Propodosoma. The rostral and the lamellar hairs are equally long. The interlamellar hairs, which are unusually long, almost reach the lamellar hairs, and are as long as the latter. They are situated immediately behind a narrow transverse ridge, which is located between the longitudinal parts of the lamellar ridges. The distance between the latter is longest in the anterior half of the field. In the posterior part of the field between the lamellar ridges a few transverse rows of pits, each with 5–6, can be seen. There are furthermore a few pits in an oblique row on either side between the pseudostigma and the interlamellar hair and in the posterior part of the propodosoma. The pseudostigmatic organs are serrate flagellants.

Hysterosoma. The hysterosoma is oblong with a straight anterior border. At some distance behind the anterior border there is a broad belt of pits of different sizes, arranged more or less in oblique rows, each with two to three or four pits. The notogastral hairs, which are black, are strong and curved, tapering towards the tip.

Ventral side. In front of the genital field there is a broad, curved belt of deep pits. The aggenital hairs are branched. The medial one is situated closer to the anal field than to the genital field, almost off the anterior border of the anal field. The adanal hairs are ordinary hairs, and stronger and longer than the aggenital hairs. Ad3 and ad2 are situated laterally to the anal field, ad3 at only half the distance of that of ad2 from the anal field. Ad1 is located off the latero-posterior corner of the anal field.

Corolevu: Seven specimens in dead leaves on a slope above the mangrove.

Suva: One specimen in dead leaves in the rain forest.

*Eremulus truncatus* n.sp.; fig. 15.

Length about 0.46 mm. Colour light brown.

Propodosoma. The propodosoma is rather long and narrow as compared with the broad notogaster. The rostral hairs and the lamellar hairs are unusually long and as long as the parallel part of the lamellar ridges. The distance between the latter is approximately the same everywhere. The interlamellar hairs are almost as long as the lamellar hairs. Their tip is very thin. In front of the interlamellar hairs there is an irregularly curved ridge, the middle part of which is indistinct. In *Eremulus* there is

usually a transverse lamellar ridge from the pseudostigma to the longitudinally running part of the lamellar ridge. In this species this ridge is hardly discernible. No pits can be seen between the parallel lamellar ridges except along the medial border. Further laterally there are pits on either side of a curved line, and between the pseudostigmata there are many pits irregularly scattered. The pseudostigmatic organs are thick flagellants set with scattered short spines, which are not arranged in one row only.

*Hysterosoma*. The specific name of this species is due to its truncate shape, the posterior border being almost straight. The hysterosoma is as broad as it is long. Its anterior border is straight, and the anterior part of the hysterosoma is only half as broad as across the middle of the hysterosoma. Behind the anterior margin there is an oblong oval field bordered posteriorly and partly laterally by a belt of two rows of pits. The notogastral hairs, several of which are missing, are stiff, greyish, rather broad, broadest across the middle and pointed at the tip. They are approximately equally long. The second and the third medial pairs are displaced posteriorly, so that the middle of the notogaster is almost bare of hairs, cp. fig. 14.

Corolevu: One female in dry leaves on a slope above the mangrove.

*Sulcoribula* n.gen.

*Sulcoribula* is in many ways similar to *Cultroribula*, having a tripartite rostrum, converging and at the tip fused lamellae with cusps close together; clavate pseudostigmatic organs. Hysterosoma with shoulders. The ventral side differs by having two longitudinal lateral furrows (sulcus) which meet behind the anal field. The anal field is rhombic.

*Sulcoribula laticuspidata* n.sp.; fig. 16.

Length about 0.19 mm. Colour light brown.

Propodosoma. The propodosoma is very broad and rather short as compared with the hysterosoma. The tip of the rostrum is tripartite, the middle part being a short, small tip, which is surrounded by two short, lateral ridges the tip of which is directed forwards and medially. The rostral hairs are situated on the lateral ridges. They are very thin, smooth, and rather long. The lamellae, which are almost equally broad throughout, converge and meet, forming an inverted V-shaped space between them. The cusps, which are as broad as the lamellae, are parallel and so close together that there is hardly any space between them. Their lateral and medial sides are parallel and their anterior border is straight. The lamellar hairs, which are situated in the latero-anterior corner of the cusps, are as long as the distance between their base to the anterior border of the hysterosoma. They are parallel, smooth, very thin at the tip. The interlamellar hairs are like the lamellar hairs. They are situated at a short distance in front of the anterior border of the hysterosoma and close to the lamellae. The pseudostigma is a large cup with the opening directed forwards and outwards. Only a small part of it is hidden below the hysterosoma. The pseudostigmatic organ is club-shaped, the whole organ being a little longer than half of the lamella including the cuspis and as broad as the latter. The club is hairy. A narrow tutorium can be seen on the lateral side of the propodosoma.

Hysterosoma. The hysterosoma is a little longer than broad. The posterior end is rounded. The anterior border is slightly convex with a low incurvation behind the pseudostigma and with a broad, slightly projecting shoulder. There are eight pairs of notogastral hair pores, the hairs being absent. They are situated as shown in fig. 16. Ta is on the shoulder. P1 and p3 have not been observed.

Ventral side, fig. 16a. The ventral side is peculiar, having on either side a light furrow running for almost the whole length of the ventral side, the two furrows joining behind the anal field. Epimeres I are fused and so are Epimeres II. Epimeres III and Epimeres IV are separated by a sternal ridge. The large and broad genital field is surrounded by a chitinized frame. It is separated from the anal field by a distance scarcely half as long as half the width of a genital plate. No hairs have been observed on the ventral side. The genital plate has four pores, viz. one on the anterior border, one immediately behind it, but a little more laterally, and two along the lateral sides on the posterior half of the plate. There may be more hair pores, as it is extremely difficult to see them. The aggenital pore is situated at the latero-posterior corner of the genital field. The anal field, which is longer than the genital field, is rhombic. The anterior anal pore is situated farther from the anterior end than the posterior one is removed from the posterior end. Ad3 is located at a level in front of the anterior anal pore and behind the aggenital pore. Ad2 and ad1 are rather close together near the latero-posterior side of the anal field. Tectop. I is well developed. Tectop. IV is a short broad tooth.

The legs are short. All tarsi monodactylous.

Corolevu: Five specimens in a thin layer of moss on a root on a slope above the mangrove.

#### Oppioidea BALOGH, 1961

##### *Fijirella* n.gen.

Very similar to *Eremella* Berlese, 1913, but with 11 pairs of notogastral hairs. Pseudostigmatic organ clavate, ending in a thin thread. Three pairs of aggenital hairs. Legs short with swollen joints. Monodactylous. Mandibles and palps weakly developed.

##### *Fijirella mollis* n.sp.; fig. 17.

Length about 0.28 mm. Colour light brown.

The hysterosoma is egg-shaped, slightly narrower anteriorly. Its anterior border is almost straight. The middle of the notogaster with a reticulate pattern, the meshes being of very different sizes and shapes. Along the border of the notogaster the pattern is indistinct with small radiating meshes. There are 11 pairs of notogastral hairs, nine of which are marginal, two medial, viz. one immediately behind the anterior border, the other in the middle of the dorsum. These two pairs are short ordinary setae, whereas the marginal setae are like small downy catkins.

Propodosoma. The propodosoma is broadest across the middle, narrow posteriorly. Behind Leg I there is a deep incurvation, mainly formed by a projecting tooth in front

of Leg II. There is a narrow transverse ridge immediately in front of the pseudostigmata and the interlamellar hairs. The latter are short and thick, often covered by secretion. In the middle of the propodosoma there is a reticulate field bordered anteriorly by the narrow translamella, laterally by narrow costulae, which posteriorly merge into one with somewhat broader short curved ridges. The latter do not reach the transverse ridge in front of the pseudostigmata. The rostral and the lamellar hairs are smooth and moderately long. The pseudostigma is a deep cut opening outwards and backwards. The pseudostigmatic organ has a short, slender, clavate head on a long thin stalk. The head ends distally in a thin thread, which is bent dorsally. Ventral side. There is no sternal plate. The sejugal apodemata do not meet in the middle line. Laterally they end in a tooth. Epimeric hair formula: 3-1-3-4. The genital and the anal fields are separated, the marginal zones surrounding them touching. There are five pairs of genital hairs. The long forwardly-directed hairs on fig. 17 a are situated on the anterior border of the frame and represent 4a. There are three pairs of aggenital hairs and three pairs of adanal hairs, all of them of approximately the same length. The anal plates are considerably longer than the genital plates. The two anal hairs are situated far laterally outside a rhombic field covering the medial parts of the plates. The ventral plate is faintly and irregularly reticulate.

Legs. The legs are short and the femora are clavate, the tibiae short and swollen. Fig. 17 b shows Tibia and Tarsus I. As all outlines are covered by secretion, I cannot see every detail with certainty for which reason some of the hairs are drawn with broken lines.

Fig. 17 c shows the infracapitulum and fig. 17 d two sketches of the mandible, which is membranous, very faintly developed and hardly fitted for chewing, ending in a few pointed branches. Fig. 17 e shows a sketch of the palp. BERLESE (1913) did not illustrate nor mention the ventral side of the two *Eremella* species, viz. *E. vestita* and *E. induta*, which he established from Java, while CSISZAR (1962) illustrated only the genital plates with one close-lying aggenital hair of *E. koszabi* from Hungary.

The ventral side of *Eremella induta* has later been illustrated by BALOGH and MAHUNKA (1966), and from this it appears that *Eremella* has only one aggenital hair. *Fijiarella* has three aggenital hairs, and these together with a larger number of notogastral hairs justify the establishment of the new genus.

Corolevu: 16 specimens in moss on a tree trunk and in dead leaves above the mangrove.

*Suctobelba variosetosa* Hammer.

— — — — , 1961, p. 43, fig. 35.

Corolevu: A few specimens in dead leaves on a slope with trees above the mangrove. Suva: One specimen in thick moss on a rotting tree trunk; one in leaves on the forest floor.

*Suctobelba fijiensis* n.sp.; fig. 18.

Length about 0.12 mm. Colour ochreish light brown.

The present species belongs to a group of *Suctobelba* species, which have a short pointed rostrum, the rostral hairs not distinctly composed of a brush-shaped proximal

part and a setaceous distal part, the lamellar knob narrow, pseudostigmatic organs with a smooth club, and the hysterosoma with complicated structures on its anterior border. To this group belong amongst others *S. complexa* Ham. 1958, p. 46, fig. 48, *S. ornatissima* Ham. 1958, p. 47, fig. 49, both from the Andes Mountains, *S. mirabilis* Balogh 1958, p. 16; fig. 20, 1961 b, and *S. hamifera* Balogh 1958, p. 16; fig. 21, 1961 b, the latter two from Angola, Africa. These species have apparently no lateral teeth as usual in *Suctobelba*, and it may be necessary to establish a new genus for these species.

*S. fijiensis* is closely related to *S. mirabilis* Balogh, both having two irregular keels on the dorsum with a light spot between the keels. The space in front of the lamellar knob has a coarse, incomplete reticulation, which is present in most of the species belonging to the above-mentioned group. The lamellar knob, which is broadest posteriorly off the hair pores, is connected with the medial side of the pseudostigma by a lamellar ridge. The interpseudostigmatic ridges have a well developed posterior lobe opposite the anterior end of the dorsal keels. The pseudostigmatic organs are slender, greyish clubs. Lamellar and interlamellar hairs are absent.

Hysterosoma. On the anterior border there are four teeth, viz. two lateral ones and the slightly pointed anterior end of the keels. Between the latter two faint, oblique lines run backwards, medially meeting at some distance in front of the light spot. From the latero-anterior corner of the hysterosoma a transverse ridge runs medially, making a bend below the dorsal keel, then proceeding backwards and disappearing below the keel. There are 10 pairs of rather short notogastral hairs, p1 and p2 being visible in a ventral view only. Ta is situated at some distance laterally to the dorsal keel and in front of the transverse lateral ridge. In *S. mirabilis* Balogh ta is situated on the lateral side of the dorsal keel and the notogastral hairs as well as the dorsal keels are much longer.

Ventral side, fig. 18a. On the fused Epimeres III-IV a thick secretion with folds seems to cover the integument. There are five genital hairs, viz. three near the median border at the anterior end and two in the middle line at the posterior end of the plates. The anal hairs are located in the posterior half of the plates. Ad3 is situated far laterally at a level in front of the aggenital hair, ad2 off the anterior end of the anal field, and ad1 is postanal. The distance ad1-ad1 is as long as the width of the anal field. Iad has not been observed.

Suva: One specimen in thin, moist moss on a tree trunk in the rain forest.

*Suctobelba ponticulus* n.sp.; fig. 19.

Length about 0.195 mm. Colour light brown.

Propodosoma. On the tip of the rostrum there is on either side a long forwardly-directed tip as in *S. falcata* Forssl. Besides this there are two equally long lateral teeth separated by a broad and deep incision, fig. 19a. All of them can be seen in a dorsal view. On the dorsal side of the rostrum there are a few small tubercles. The lamellar knob is rounded and closed, the posterior border being faintly chitinized. In front of the lamellar knob there is a small ridge. The lamellar hairs, which are situated off the middle of the knob, are rather short. The lamellae, which are well developed, reach the

posterior border of the lamellar knob. The interpseudostigmatic ridges are broad with an anterior tip and are broadly rounded posteriorly. They are separated from the pseudostigmata by a good distance. Interlamellar hairs have not been observed, but a pore can be seen near the anterior tip of the interpseudostigmatic ridges. The pseudostigma has a broad lobe on its posterior border opposite the lateral tooth on the anterior border of the hysterosoma. The pseudostigmatic organ has a long, flat, and slender head, which tapers towards the tip and which in its whole length is set with short, black bristles. It is directed outwards and then medially in a broad curve. Hysterosoma. Behind the anterior border there is an H-shaped figure like a bridge (hence its specific name). Its middle is a straight, narrow, transverse ridge on either side of which there is a broad anterior tooth which continues backwards for a short distance as a keel. The lateral tooth opposite the lobe on the pseudostigma is more pointed than the medial tooth. It forms a dorsal keel, too. Behind the H-shaped figure there is a round, light spot. There are 9 pairs of notogastral hairs, the hairs being very different in length as well as in shape. The anterior ones, ta, ti, and te are ordinary smooth, and short setae, whereas ms, r3, r2, and r1 are long and feathered, overlapping. P1 and p2, which can be seen best in a ventral view, are short and smooth. Ventral side. Only five pairs of genital hairs could be seen. Of these the anterior one is very long while the others are short, fig. 19b. Ad3 and ad2 are situated rather far laterally, ad3 on a level in front of the aggenital hair, ad2 off the anterior border of the anal field. Ad1 is located off the posterior half of the side of the field. All the hairs of the ventral side are smooth.

Systematic position. *S. ponticulus* is related to *S. semiplumus* Bal. & Mah. 1967, p. 48, figs. 27–28 from Vietnam, but it can be distinguished from the latter by its long rostral teeth, the presence of lamellar ridges, Tectop. IV without tubercles, the presence of a transverse ridge between the medial notogastral teeth, the much longer feathered notogastral hairs, and the different position of the latter.

Corolevu: Several specimens in dead leaves on a dry slope above the mangrove.

*Suctobelbila dentata* (Hammer).

*Rhyncobella dentata* Hammer, 1961, p. 46, fig. 37.

Corolevu: Three individuals in mouldering leaves under trees on a slope above the mangrove.

*Suctobelbila squamosa* (Hammer).

*Rhyncobella squamosa* Hammer, 1961, p. 47, fig. 38.

Suva: One specimen in moist leaves on the rain forest floor.

*Machuella ventrisetosa* Ham. var. *robusta* n.var., fig. 20.

*Machuella ventrisetosa* Hammer 1961, p. 70, fig. 59.

Length about 0.18 mm. Colour brownish.

The Fiji specimens differ from the main form by their much longer and stronger notogastral hairs, by the larger pseudostigmatic clubs, and by having two longitudinal lines on each side of the dorsum, issuing from the anterior border of the hysterosoma.

The rostral and the lamellar hairs are distinctly barbed. Between the interlamellar hairs there are four light spots.

Fig. 20 a shows the ventral side.

Corolevu: Four specimens in dry moss and bark on a tree trunk overgrown with epiphytes.

*Dampfiella similis* n. sp.; fig. 21.

Length about 0.465 mm. Colour brown.

Propodosoma. The rostrum, which is rounded, has a membranous plate on either side of the tip. The rostral and the lamellar hairs are unilaterally barbed. The interlamellar hairs are situated medially to the pseudostigmata. They are very small. The exopseudostigmatic hair pore can be seen in front of the pseudostigma. The hair is absent. The pseudostigmatic organs are club-shaped and apparently smooth. The light spots between the pseudostigmata are arranged in two longitudinal rows. Further laterally there is a small cluster of spots. "Cuvette dorsale" (GRDJN. 1964) can be seen in front of Acetabulum II.

Hysterosoma. The hysterosoma is twice as long as it is broad. It is very narrow immediately behind the pseudostigmata, whereafter it widens, and then becomes again slightly narrower immediately behind a lateral projection, after which it again becomes broader. The 10 pairs of notogastral hairs are all alike, short and smooth, but stiff. Ta is situated off the small lateral projection, te immediately in front of im. Gl is located close behind im. The distance r3-p3 is shorter than p3-p2 and longer than p2-p1 and p1-p1. The two latter being equally long. Along the lateral border there is a faint line on which ti, ms, and r2 are situated. "Cuvette du notogaster" can be seen behind ta. Ventral side. Apodemata II are fused and form a broad, brown band. The ventral "cuvette" can be seen at the end of the latter, fig. 21 a. Most of the epimeric hairs are absent. Also the genital hairs are absent, and so are the aggenital hairs and ad3 and ad2. Only the pores can be seen. Ad1 and the anal hairs are present. Ad3 is preanal and is situated at a short distance only from the latero-anterior corner of the anal field, ad2 is situated off the middle of the field, and ad1 behind the field at a mutual distance equal to ad1-ad2.

The mandible is rather long and narrow in its anterior half, being much broader behind the seta cha, fig. 21 b. Fig. 21 c shows the infracapitulum. Leg I is shown in fig. 21 d. The claw has a small outer tooth.

Systematic position. The present species is in several characteristics similar to *D. prostrata* Aoki (1965 a), but can be distinguished from the latter by the pseudostigmatic organs, which are rounded, smooth clubs (in *D. prostrata* they are slender and barbed), by the different position of the notogastral hairs, by the appearance of the ventral side, and of the mandibles, which are shorter in *D. prostrata*, and by the shape of the solenidion.

Suva: Three specimens in dead, rather dry leaves on the forest floor.

*Dampfiella dubia* n. sp.; fig. 22.

Length about 0.60 mm. Colour light brown.

This species is very similar to the preceding one and differs only in a few features.

**Propodosoma.** The anterior half of the propodosoma is very narrow. It widens suddenly in front of Leg I. Along the anterior half of this narrow part a more or less membranous plate surrounds the rostrum. The rostral hairs and the lamellar hairs are curved and unilaterally barbed. The interlamellar hairs are short and smooth. The exopseudostigmatic hairs are hardly discernible. The pseudostigmatic organs are clavate, pointed at the tip, and the club is set with minute bristles. The dorsal "cuvette" (cud) is not so deep and distinct as in *D. similis*. Double taenides (GRDJN. 1964, p. 698) can be seen running from the pseudostigma to Acetabulum I.

**Hysterosoma.** This species is like the preceding species, narrow immediately behind the pseudostigmata, and has a slight lateral projection off ta. The notogastral hairs, 10 pairs, are arranged almost like those of *D. similis*, but the hairs are not alike, the marginal ones being stiff and spine-like and considerably longer than the others, which are thin and slightly curved. P1 and p2 are a little longer than p3 and r3. Te is situated immediately in front of im. Along the lateral border there is a faint line, which is almost parallel to the sides of the hysterosoma.

**Ventral side.** It is hardly possible to see any difference between the ventral side of *D. dubia* and that of *D. similis*. There are three pairs of genital hair pores. The setae ad1 are as long and strong as those on the posterior border of the dorsal side of the hysterosoma, fig. 22 a.

Fig. 22 b shows the anterior end of *D. dubia* in profile. The dorsal and the ventral "cuvettes" can be seen behind Tectop. I, and behind the pseudostigma the notogastral "cuvette". Over the dorsal "cuvette" there is an air sac connected with tracheae (broken line). A similar sac is located below the notogastral "cuvette".

The mandible, which is illustrated in fig. 22 c, is rather long and narrow, especially the anterior half in front of the seta cha. The seta chb could not be seen. Fig. 22 d shows the infracapitulum, which differs from that of *D. similis* by having no articulation between the basal and the distal part. This is characteristic of *Beckiella* (GRDJN. 1964). The rutella apparently forms a canal for sucking, which is characteristic of *Beckiella*. Figs. 22 e, f, and g show Leg I, II, and IV, respectively. There may be more hairs than illustrated, which I have missed. The claw of all tarsi has several small teeth on the outer border.

**Discussion.** *D. similis* and *D. dubia* are much alike in almost every respect apart from the infracapitulum, which has an articulation in *D. similis*, but not in *D. dubia*. The mandibles are long and narrow in both, but in neither of them do the mandibles belong to the peloptoid type as in *Beckiella*. The hair chb, which is absent in *Dampfiella*, and present in *Beckiella*, has not been observed in either of the two species. I do not think that the difference in the building of the infracapitulum is sufficient to place these two species within different genera. *D. similis* and *D. dubia* are probably transitions between

*D. procera* Selln. (1931) with the short, strong mandible, infracapitulum with an articulation, and three pairs of genital hairs, and *Beckiella cejensis* (Beck) (1962 b) with elongated, peloptoid mandible, infracapitulum without articulation and four pairs of genital hairs. If additional transitional forms are found, it may be doubtful whether the genus *Beckiella* can be maintained.

Corolevu: Five specimens in dead, dry leaves on a slope above the mangrove.

*Dolicheremaeus fijiensis* n. sp.; fig. 23.

Length about 0.395 mm. Colour light brown.

According to AOKI's key for the identification of the species belonging to the genus *Dolicheremaeus* (1967), the present species is closest related to *D. papuensis* Aoki, but differs by having smooth genital plates (in *D. papuensis* they are striated), and to *D. elongatus* Aoki, which has smooth genital plates. It can be distinguished from the latter by its broad hysterosoma, its much smaller size (*D. elongatus* 0.505–0.620 mm. long) and by iad, which is situated obliquely to the anal field (in *D. elongatus* iad is parallel to the anal field).

Propodosoma. The rostral and the lamellar hairs are unilaterally barbed, the lamellar hairs are the stronger. They are situated close to the lateral side of the lamellae. The anterior part of the lamellae in front of the lamellar hair diverges distally. The lamellae are parallel for most of their length, diverging posteriorly. The posterior part has a sharp dorsal keel, the anterior part behind the lamellar hairs is transversally wrinkled and is a little irregular in shape. The interlamellar hairs are shorter than the lamellar hairs. They are more or less erect. Between the interlamellar hairs there is a dense punctuation in oblique streaks. The dorsal pseudostigmatic plates cover the whole pseudostigma. The latter opens latero-anteriorly. The pseudostigmatic organ is spindle-shaped, smooth. On one specimen the head of the pseudostigmatic organ is a little swollen and the tip appears slightly bifid (left side in fig. 23). The expseudostigmatic hair, which can be seen in a lateral view only, is minute, fig. 23 a. The four prodorsal condyles are of nearly equal size. They are all rounded and equally spaced from one another, as regards the tip. The two middle ones are, however, so broad that they almost touch at their bases.

Hysterosoma. The hysterosoma is oval apart from the anterior straight border. The integument has a fine and dense punctuation. The four condyles on the anterior margin are subequally spaced from one another, the distance between the middle ones being shorter than that between the middle one and the lateral one. The median condyles are as long as they are broad, the tip being square and irregular. The lateral condyles are broadly triangular. There are 10 pairs of notogastral hairs, which are rather long, stiff, blunt at the tip, and smooth. P1, p2, p3, and r2 are a little longer than the others. Im and g1 are located laterally to ti.

Ventral side, fig. 23b. Apodemata II meet in the middle line. Epimeres II are fused. The sternal plate is developed only between the fused Epimeres III–IV. Epimeric

hair formula: 3-1-3-3. 1a, 2a, 3a, 4a, and 4c are shorter than the remainder. The genital field is broadest anteriorly. It is smooth.

The anal field has parallel sides. The anal hairs are as long as the width of the anal plates. The distance ad3-ad3 is only a little longer than ad2-ad2. The anal hairs are smooth. Iad is situated obliquely to the anal field, its anterior end almost touching the side of the field.

Legs. Type of ultimate hairs: L-L-L-L. Solenidium  $\omega_1$  on Tarsus I slightly curved, blunt at the tip,  $\omega_2$  a little thinner, tapering into a thin, hook-shaped tip. The famulus is almost half as long as  $\omega_1$ , swollen distally, fig. 23c.

Corolevu: Four specimens in dead leaves on a slope above the mangrove.

*Oppiella nova* (Oudms.) (= *neerlandica* auct.).

*Oppia neerlandica* (Oudms.), WILLMANN, 1931, p. 128, fig. 132.

Corolevu: A few specimens in dead leaves on a slope above the mangrove.

Suva: A few specimens in thin moist mosses on a rotting tree trunk and in dead leaves on the forest floor.

*Oppia arcualis* (Berlese).

*Damoeosoma arcuale* Berlese, 1913, Redia IX, p. 89, Tb. VII, fig. 69.

The specimens from the Fiji Islands agree better with the specimen illustrated by BALOGH & MAHUNKA from Vietnam, 1967, p. 45, Plate III, figs. 17–18, than with BERLESE's figure, as the pseudostigmatic organ has three very long, distal hairs, as found also in the specimens from Vietnam, whereas BERLESE illustrates only two. According to BALOGH & MAHUNKA, variations in the number and length of apical hairs of the pseudostigmatic organ lie within the specific limits, an opinion which I share with them. In the specimens found in New Zealand there are only two apical hairs on the pseudostigmatic organ.

Corolevu: Found frequently among dead, dry leaves on a slope above the mangrove.

*Oppia exiguum* n. sp.; fig. 24.

Length about 0.21 mm. Colour ochreish light brown.

Propodosoma. The anterior half of the propodosoma is narrow, conical. The rostrum is rounded. The rostral hairs, which are situated on the dorsal surface, are smooth and about twice as long as their mutual distance. The lamellae are broken and only their anterior ends are distinct. A translamella connects the lamellae. There are no cusps. The lamellar hairs are thin, smooth, shorter than their mutual distance, and apparently shorter than the rostral hairs. They are situated on the rounded corner where the lamella and the translamella meet. The interlamellar hairs are minute. Between the latter there are four light spots, and in front of the interlamellar hair a more laterally located spot. The pseudostigmatic organs have a round, dark, dish-shaped head on the end of a comparatively long stalk. On the posterior border of the pseudostigma a small knob can be seen. Along the posterior border of the propodoso-

ma, parallel to the anterior border of the hysterosoma, there is a narrow ridge, the middle of which disappears between the light spots.

Hysterosoma. The hysterosoma is narrow, being one and a half times longer than it is broad. Its anterior end projects slightly. On either side of the anterior border there is a small tooth, which corresponds to the knob on the pseudostigma. The notogastral hairs, 10 pairs, are short and thin.

Ventral side. Apodemata II are separated by a broad plate, fig. 24a. The sejugal apodemata form a broad transverse belt, on the posterior border of which there is on either side a lobe on which the hair 3a is situated. The fused Epimeres III-IV from the two sides are separated by a broad sternal plate. The genital plates have four pairs of hairs, only. Ad3 is preanal and is situated far laterally and rather far anteriorly, too. Ad2 is located off the sides of the anal field and ad1 is postanal. Iad is very long and is situated obliquely to the anal fields off the latero-posterior corner of the latter, which is an unusual position so far posteriorly. The projection between Leg III and Leg IV is short.

Legs. Tibia I has a short anterior process, on which the long solenidion is situated.  
Corolevu: Two specimens in dead leaves on a slope above the mangrove.

*Oppia lanceosetoides* n. sp.; fig. 25.

Length about 0.295 mm. Colour light brown.

Propodosoma. The most characteristic feature of this species is two slightly curved longitudinal lines, one on either side of the light spots between the interlamellar hairs. The rostral hairs, which are situated rather far posteriorly, are smooth and about as long as their mutual distance. Lamellae absent. The lamellar hairs are a little shorter than their mutual distance. A faint line runs backwards from the base of the lamellar hair and at some distance in front of the latter there is a faint transverse line. The interlamellar hairs are minute. On the posterior border of the pseudostigma there is a small lobe. The pseudostigmatic organs, which are almost equally thick throughout, are slightly curved and the end unilaterally set with minute bristles, fig. 25a.

Hysterosoma. The hysterosoma is only a little longer than broad. Below the anterior border there is in the middle a small projecting tip. The notogastral hairs, 10 pairs, which are equally thick throughout, except at the base which is slightly dilated, fig. 25c, are slightly curved. On their distal half they are unilaterally barbed. They have the same appearance as the pseudostigmatic organs, but are shorter. Ta is absent, but its pore can be seen behind the pseudostigma. Ventral side. The ventral side is shown in fig. 25b. Ad3 is situated rather far anteriorly and laterally, ad2 off the anterior half of the anal field, and ad1 is postanal. Iad is small and parallel to the side of the anal field. This species is closely related to *Oppia lanceoseta* Balogh, 1959a, p. 96, fig. 9. The latter can be distinguished by its very long notogastral hairs, which also are dilated at the base.

Corolevu: One specimen in dead dry leaves on a slope above the mangrove.

Suva: Seven specimens in wet *Polytrichum* on a rock in a brook just above water level.

*Ramusella chulumaniensis* (Ham.) var. *curtipilus* n. var.; fig. 26.

*Oppia chulumanensis* Hammer 1958, p. 57, fig. 66.

Length about 0.245 mm. Colour yellowish.

The specimens from the Fiji Islands are very similar to the main form from Bolivia, but can be distinguished from the latter by their much shorter notogastral hairs and by the position of these. In the main form the distances ti-ti, ms-ms, r2-r2, and r1-r1 are equally long, in the variety the distance r2-r2 is longer, and r1-r1 is shorter than in the main form. The number of branches of the pseudostigmatic organ is nine in the variety (fig. 26a), in the main form it varies from 7 to 10, the number of branches never being constant in this kind of pseudostigmatic organs. The disk of the pseudostigmatic organ is broader in the variety, longer and narrower in the main form. Fig. 26b shows the ventral side.

Apodemata II are narrow and separated by a broad sternal plate. In front of the sejugal apodemata there are two rounded lobes. The fused Epimeres III-IV are bordered by a darker brim. Apodemata III are very short and narrow. Behind them a light spot or opening can be seen.

Since these differences are only slight and I cannot evaluate their significance, I prefer to establish a new variety rather than a new species.

Suva: Three specimens in thin, moist moss on a tree trunk in the rain forest.

*Amerioppia Woolleyi* Ham., fig. 27.

*Amerioppia Woolleyi* Ham. 1968, p. 31, fig. 34.

In the specimens from the Fiji Islands the setae r1 are somewhat shorter than the corresponding ones in the specimens from New Zealand.

Corolevu: Several specimens in moss and dead leaves on a slope above the mangrove.

Suva: A single specimen in thin moss on a tree trunk in the rain forest.

*Amerioppia vicina* n. sp.; fig. 28.

Length about 0.245 mm. Colour light brown.

*A. vicinia* can be distinguished from the so far described *Amerioppia* species by the position of the setae r2, which are situated rather close together (*vicinus*).

Propodosoma. The pseudostigmatic organs are long, thin clubs, which are broadest near the tip. They are set with minute bristles.

Hysterosoma. The hair ta has not been observed. Ti, te, ms, r3, r2, and r1 are approximately equally long, r1 perhaps a little shorter. P1 is almost twice as long as p2, and p2 is longer than p3. The distance r2-r2 is not much longer than r1-r1.

Ventral side. On the anterior border of the sejugal apodemata immediately behind the hair 2a there is a brown rounded lobe, fig. 28a.

Corolevu: One specimen in thin moss on a tree root above the mangrove.

Suva: A great number in dead leaves on the floor of the rain forest.

*Globoppia (Aeroppia) pauciseta* n. sp.; fig. 29.

Length about 0.44 mm. Colour light brown.

Propodosoma. The rostral, the lamellar, and the interlamellar hairs are strong, barbed, and moderately long. The rostral hairs are inserted laterally as in *Globoppia* and not on the dorsal surface of the rostrum as usual in *Aeroppia*. The lamellar hairs are situated on the end of reduced costulae and at rather a large mutual distance. In *Aeroppia* the lamellar hairs are situated close together. Between the interlamellar hairs six light spots can be seen and above them there are two dark lines. The pseudostigmatic organ is large, dark, and pear-shaped. It is broadest distally. Its margin is clear, the inner area being black.

Hysterosoma. The hysterosoma is only a little longer than broad. Its anterior margin is very broad. Ta is absent. There are eight long and barbed notogastral hairs, which probably represent ti, te, ms, and r2. Of these te is almost twice as long as the others. The distances ms-ms and r2-r2 are equally long and almost twice as long as ti-ti. The hairs p1 are parallel, air-filled, narrow spindle-shaped, and as long as their mutual distance. P2 and p3 are hardly discernible.

Ventral side. The epimeres are all bordered medially by a broad margin. The margin of Epimeres II touch, whereas there is a furrow between Epimeres I and between the fused Epimeres III-IV. Between Apodemata II there is a broad plate. The genital plates have in their anterior border two semicircular indentations. Of the five genital hairs three are situated on the anterior half of the plate along the medial border, two posteriorly along the lateral border. The latter are twice as long as the former. The two anal hairs are situated far laterally. The aggenital hair and the three adanal hairs are situated in a broad curve laterally to and in front of the anal field.

There can hardly be any doubt that the species described belongs to *Globoppia*. The lateral position of the rostral hair, the rather long distance between the lamellar hairs situated on reduced costulae, and the reduced number of notogastral hairs together with the different length of the latter are characteristic of *Globoppia*. The air-filled setae p1, due to which the genus *Aeroppia* was created, is not apparently a generic character, but so far it is still too early to decide whether *Aeroppia* must be abolished. Corolevu: One specimen in thin moss on a tree root above the mangrove.

*Cheloppia* n. gen.

The name *Cheloppia* indicates that this genus has enormously long chelicera or mandibulae. Posteriorly they reach as far as the anterior border of the pseudostigmata. The chewing part is very short.

Propodosoma and hysterosoma separated. Lamellae, lamellar hairs, and interlamellar hairs present. Pseudostigmata with a posterior lobe. Pseudostigmatic organ branched. Anterior border of hysterosoma with a small lateral tooth. 9 pairs of notogastral hairs. Five pairs of genital hairs. One pair of aggenital hairs, two pairs of anal hairs, and three pairs of adanal hairs. Iad parallel to the side of the anal field. Legs as in *Oppia*. Tibia I with a distal process. Monodactylous.

*Cheloppia hyalina* n. sp.; fig. 30.

Length about 0.175 mm. Colour whitish.

Propodosoma. The propodosoma is as long as the hysterosoma, fig. 30 a. Its sides are parallel. The rostrum is apparently broad and rounded, but as it is hyaline I am unable to see its anterior border with certainty. The same is the case with the rostral hairs; they can be seen in profile, fig. 30 a. The lamellae are narrow, slightly undulating, about equally broad throughout. The lamellae are connected by a narrow translamella. There are no cusps. The lamellar hairs are thin and short. On either side of a cradle-like structure the interlamellar hairs can be seen. The cradle-like figure surrounds six light spots. The pseudostigma is a deep, open bowl, which opens outwards. On its lateral border there is a ridge, on the posterior end of which there is a lobe corresponding to a small lateral tooth on the anterior border of the hysterosoma. The pseudostigmatic organ has an oblong, flat head on the outer border of which six branches radiate, fig. 30 a.

Hysterosoma. The hysterosoma has almost parallel sides, the posterior end is broadly rounded, and the latero-anterior borders are rounded, too. Opposite the lobe on the pseudostigma there is a small lateral tooth. There are 9 pairs of notogastral hairs, ta being missing. The hairs are equally thick throughout apart from the tip, which is slightly thickened and bent. The hairs are arranged more or less in transverse rows. Ventral side. Apodemata II are narrow ridges, which reach the broad, but faintly chitinized sternal plate, fig. 30 b. The sejugal apodemata, which form a broad, transverse belt, have on their anterior border a broad, but faintly chitinized lobe. The posterior part of the sternal plate between the fused Epimeres III-IV is more strongly chitinized than the anterior part and bordered by faint ridges. Some of the epimeric hairs have probably not been seen because of their minute size. The genital field is slightly pointed anteriorly. There are five pairs of small and thin genital hairs. The anal field is considerably larger than the genital field. There are two pairs of short and thin anal hairs, which are situated in the middle of the plates. Ad3 is preanal, situated laterally to and a little posteriorly to the aggenital hair. Ad2 is located off the middle of the side of the anal field, and ad1 is postanal. Iad is long and parallel to the side of the anal field, off ad2.

Legs. The legs are like those of *Oppia* with clavate femora. Tibia I with a narrow, distal process with the solenidion, fig. 30 a. All the tarsi are monodactylous. As I am unable to dissect the only specimen found without spoiling it, it is impossible to describe the legs further. The mandibles are extremely long and narrow with short cheliceres. The palp is proportionately very big. The infracapitulum is hyaline and details cannot be discerned.

Suva: One specimen in thin moss on a tree trunk in the rain forest.

## Hydrozetoidea BALOGH, 1961

*Hydrozetes lemnae* (Coggi).

— — — — , Grandjean 1948, p. 328, figs. 2–3.

Suva: Several individuals in wet mosses along the bank of a canal in a park.

## Ameronothroidea BALOGH, 1961

*Licneremaeus polygonalis* n. sp.; fig. 31.

Length about 0.175 mm. Colour light dirty brown.

The latero-anterior borders of the notogaster meet at an almost straight angle immediately behind the transverse ridge, which connects the S-shaped lateral ridges of the propodosoma. The light spots of the notogaster are arranged as shown in fig. 31. Several of the spots are angular and closely fitted together like polygons (hence the specific name). Along the border of the notogaster the spots are round or oblong. By this polygonal shape of the spots this species can be distinguished from the four previously described species (*L. licnophora* Mich. 1882, *L. discoidalis* Willm. 1930, *L. exornatus* Grdh. 1931, and *L. prodigiosus* Schuster 1958).

On the posterior part of the notogaster there is a curved line along which the posterior spots are situated. This line is present, too, in *L. prodigiosus* Schuster. There are 12 pairs of hairs, 4 median and 8 lateral pairs. The two anterior median pairs are directed backwards, the third pair medially and the fourth outwards.

Propodosoma: Besides the above-mentioned transverse ridge connecting the S-shaped lateral ridges, there are two more transverse ridges, viz. one in front of the lamellar hairs and an incomplete one halfway between the other two. Both the rostral and the lamellar hairs are well developed and are approximately as long as the notogastral hairs. The interlamellar hairs are much shorter. The pseudostigmatic organ is a round disk surrounded by a brim of secretion. There is apparently an indentation distally, fig. 31a. In fig. 31 the pseudostigmatic organ is probably drawn directly from above. Ventral side, fig. 31b: The ventral plate is reticulate, the pattern, however, being absent on a broad margin round the genital and the anal plates. There are five pairs of genital hairs, viz. three on the anterior border and two on the posterior part. There are two pairs of anal hairs and two pairs of adanal hairs (only the pores can be seen). In front of the genital field there is a semicircular chitinous ring which opens posteriorly. In *L. prodigiosus* there is in this place two short backwards directed processes, one on either end of a curved ridge. All tarsi have three claws the middle of which is the stronger.

Of the five *Licneremaeus* species so far known, *L. polygonalis* seems to be closest related to *L. prodigiosus*, the two species having the following characteristics in common: an anteriorly pointed notogaster, a posterior curved ridge on the notogaster and a semicircular ring in front of the genital field.

Corolevu: Four specimens in moss and dead leaves on a slope above the mangrove.

*Scapheremaeus bicornutus* n. sp.; fig. 32.

Length about 0.315 mm. Colour dirty, light brown.

Propodosoma. Two elevated, broad ridges with a deep furrow between them represent the lamellar ridges. Their anterior third projects like long horns or apophyses, on the end of which the short lamellar hair is situated. The apophyses are connected by a narrow ridge or translamella on which they are situated. Farther anteriorly another transverse ridge can be seen running across the whole width of the rostrum. The rostral hairs are thin and smooth. Between the pseudostigmata there is an irregular dark ridge with spurs towards the anterior border of the hysterosoma and with irregular dark spots in front of it. The space lateral to the lamellae and the dorsal surface of the rostrum is faintly reticulate. The pseudostigmatic organ has a pear-shaped, black head, which is directed forwards. Tectopodium II is rounded, not angular as in most *Scapheremaeus* species.

Hysterosoma. The shoulder edge projects a little and forms a small tip. The outer margin of the hysterosoma is smooth. A light furrow forms the border between the middle field and the marginal field. The middle field is surrounded by a dark ridge, which is set with dark tongues on its outer border. The surface of the middle field has deep round alveoles, usually arranged in clusters, each with a number from four to six-eight alveoles, the clusters being separated by dark pigmented secretion grains. The pale area on the anterior part of the marginal field is posteriorly halfway surrounded by a dark ridge. The marginal field has irregular, radiating dark lines, which at the outer border end in brown tongues. There are 14 notogastral hairs. In the marginal field there is one on either side of the shoulder projection, and one a little farther posteriorly. The latter is a lighter colour. A fourth hair is situated on the outer border of the middle field in the posterior fourth of the latter. On the posterior border of the hysterosoma there are six hairs. The hairs, which are situated on apophyses, have a dark ball-shaped head, which is shorter than the apophysis.

Ventral side. The distance between the genital and the anal field is as long as the width of the genital plate. The aggenital hair is located off the latero-posterior corner of the genital field, i.e. far anteriorly and close to the latter. There are six pairs of genital hairs and two pairs of anal hairs. Iad is situated off the anterior third of the anal field. Ad1 are postanal and situated rather close together, ad2 at the latero-posterior corner of the plates and ad3 at a level a short distance behind iad, but a little farther laterally. The distance ad1-ad2 is approximately the same as ad2-ad3. Legs. Tarsi II-IV dorsally with a long erect hair ending in a short spatular head. Tibia I with a thick, dark club-shaped hair situated on its dorsal surface behind the distal process. The tarsi are all tridactylous, the lateral claws being extremely thin. Suva: Four specimens on *Hibiscus* sp., found at the quarantine station Washington, D.C. No. 63-25628.

*Scapheremaeus arcuatus* n. sp.; fig. 33.

Length about 0.40 mm. Colour light brown to brown.

**Propodosoma.** The rostral hairs are very short and thin. In the middle of the propodosoma there is a middle field on the anterior border of which two low apophyses for the lamellar hairs can be seen. The lamellar hairs, however, are absent. The anterior part of the middle field in front of a narrow transverse line is reticulate; behind this line there is an irregular, faint pattern. Between the pseudostigmata two thin lines, almost parallel to the anterior border of the hysterosoma, run medially, meeting a curved transverse ridge. Lamellar ridges are scarcely developed. They are represented by two undulating lines, which anteriorly end in the two lamellar apophyses. Farther laterally there is a sharp edge or ridge on the lateral side of which the integument is set with small round knobs. The pseudostigmatic organs are slender, black clubs, which are directed backwards. Tectopodium II is narrow, angular distally.

**Hysterosoma.** The anterior border is rounded. Shoulder corners are very small. The outer border is smooth and the posterior end is broadly rounded. The middle field is apparently highly arched, the middle being at a higher level than the lateral parts. There is rather a broad and deep furrow between the middle field and the marginal field. This furrow is irregular with clusters of alveoles cutting into it from both sides. In the middle field there are three irregular longitudinal furrows; in the two lateral furrows two pairs of hair pores can be seen, viz. one a little in front of the middle of the hysterosoma, the second in the posterior fourth. The hairs are absent. The sculpture consists of oblong alveoles most of which are arranged so that their medial border is at a higher level than their lateral border, which apparently means that the surface slopes towards the sides. Some are at a deeper level. In the marginal field there are also alveoles, but they are fainter, more indistinct, with chitinous wrinkles interfering. On the posterior border there are four hardly discernible hairs.

**Ventral side.** An irregular reticulation covers the whole ventral surface. The distance between the genital and the anal field is as long as the width of a genital plate. The aggenital hair is located at the latero-posterior corner of the genital field. Ad3 is near the latero-anterior corner of the anal field, ad1 and ad2 are postanal and situated rather close together.

**Legs.** There are no dark spatular or club-shaped hairs on the tibiae or tarsi as in the preceding species. All tarsi are monodactylous.

**Suva:** One specimen in wet *Polytrichum* on a rock, about 1–2 cm. above the water level in a brook in the rain forest.

*Seteremaeus* n. gen.

*Seteremaeus* is very similar to *Scapheremaeus*. Hysterosoma with a middle field and a marginal field. Pseudostigma a very small cup, not much broader than the thick seta-shaped pseudostigmatic organ. Interlamellar hairs present. Tectop. II rounded, continuing backwards. Coxa III with three thick, soft setae. Ventral side with a large projection between Legs III and IV.

*Seteremaeus spinosus* n. sp.; fig. 34.

Length about 0.40 mm. Colour dirty brown.

Propodosoma. The propodosoma is as broad as the hysterosoma. The rostrum is broad, triangular. The rostral hairs are short and thick. In the middle of the propodosoma there is a middle field bordered laterally by two longitudinal lamellar ridges, the lateral edge of which is distinct, the medial border indistinct. The lamellar hairs, which are short, spine-shaped, are situated between the anterior end of these ridges. Farther laterally there is on either side another ridge. A broad, dark, curved ridge, which is parallel to the anterior border of the hysterosoma, connects the pseudostigmata and forms the posterior border of the middle field. Behind the pseudostigmata it continues backwards, disappearing below the lateral sides of the hysterosoma. A short ridge situated in front of the pseudostigma continues for a short distance laterally, and then disappears. The interlamellar hairs, which are short spines, are located between the pseudostigma and the lamellar ridge. The pseudostigma is a very small cup, its opening not much bigger than the base of the pseudostigmatic organ. The latter is a thick, blackish bristle (seta). This tapers evenly towards the tip, which is blunt. The pseudostigmatic organs are approximately half as long as their mutual distance. In the area behind the broad, curved ridge there are two faint lines running from the pseudostigma to the middle of the anterior border of the hysterosoma. Behind these lines there are two short spines! (?). Tectop. II is rounded distally. It is almost membranous with a strong, dark border.

Hysterosoma. The hysterosoma is oval. There is a middle field and a marginal field, the latter being slightly narrower at the posterior end. Behind the anterior border there is a light spot. The middle field, which is separated from the marginal field by a light narrow furrow, has a depression in its anterior border into which the light spot fits. The sculpture consists of small pits arranged regularly in rows in several directions. They appear brownish on the lighter surface. In the marginal field irregular, dark wrinkles radiate, and anteriorly furthermore some pits. There are 13 pairs of short spines, viz. five pairs in the middle field, six in the marginal field, and two on the posterior border, located ventrally. In the posterior part of the middle field there are two shallow depressions, one on either side of an elevated area.

Ventral side. Apodemata II are well developed. Between them there is a greyish, transverse plate, fig. 34a. The sejugal apodemata is a little shorter than Apodemata II, and Apodemata III is still shorter. The genital and the anal fields are separated by a distance as long as the genital plates. The anal field is almost twice as large as the genital field. There are six pairs of genital hairs, of which the anterior pair is very long, the others thin and short. They are situated along the medial margin. There are two pairs of anal hairs and three pairs of adanal hairs. Ad1 and ad2 are postanal, ad3 is situated behind iad, which is parallel to the lateral margin of the anal field. Between Leg III and Leg IV there is a broad Tectopodium IV.

Fig. 34b and c show Leg I and Tibia and Tarsus II, respectively. Both sketches are made of the legs in situ. The hairs of femur I are short thick spines. Genu I has

an outer long, thick, and soft hair. The tibiae are short. The hairs are partly short spines, partly long and soft setae. The tarsi with soft, broad hairs pointed at the tip. One strong claw. Coxa III has three long, soft and thick hairs of the same kind as that illustrated on Genu I. In figs. 34b and 34c not all the hairs could be seen, i.e., only one solenidion on Tarsus I, but as the only specimen found does not belong to me I was unable to dissect it to see more details.

Suva: One specimen collected on *Hibiscus* sp., found at the quarantine station Washington, D.C., No. 63-25628, together with *Scapheremaeus bicornutus* n. sp.

#### Microzetoidea BALOGH, 1961

*Microzetes auxiliaris* Grdjn. var. *pachyseta* n. var.; fig. 35.

Length about 0.175 mm. Colour light brown.

*Microzetes auxiliaris* Grandjean, 1936, p. 138, figs. 1-4.

The specimen from the Fiji Islands differs from the type by having longer and considerably thicker interlamellar hairs. The latter meet in front of the rostrum in a big curve. The spine-shaped lamellar hair is much thinner than shown by GRANDJEAN and the secondary bristles are better developed and reach for most of their length beyond the tip of the rostrum. The space between the lamellae is broader. Due to dirt, I could not show the harpoon-like structure between the lamellae.

Corolevu: One specimen in dead leaves on a slope above the mangrove.

#### Pelopoidea BALOGH, 1963

*Pelops monodactylus* Hammer.

— — — — , 1966, p. 97, fig. 128.

Suva: Three specimens in dead leaves on the floor of the rain forest.

#### Oribatelloidea WOOLLEY, 1956

*Lamellobates palustris* Hammer.

— — — — , 1958, p. 100, fig. 124.

Corolevu: A few specimens in stiff, green grass in a "meadow" with pasturing cattle near a river.

*Oribatella schoutedeni* Balogh; fig. 36.

*Oribatella schoutedeni* Balogh 1959a, p. 106, figs. 50-51, West Africa.

Length about 0.28 mm. Colour light brown.

The specimens from the Fiji Islands agree extremely well with BALOGH's description, except that p3 has not been observed in the specimens from the Fiji Islands.

As stated by BALOGH there is only one adanal hair, viz. ad1, and one anal hair, an1, fig. 36a. Genus I and Femur II with a strong tooth ventrally, fig. 36b, c. Genu II has a long stiff spine. Tarsi monodactylous.

Corolevu: Two specimens in rotting leaves.

## Ceratozetoidea BALOGH, 1961

*Punctizetes* n. gen.

As the name indicates, the whole surface of this mite, both the dorsal and the ventral side, is set with small luminous dots. Lamellae present. Translamella indicated. Rostral and lamellar hairs long, interlamellar hairs short and brush-shaped. Pseudostigmatic organs clavate. Areae porosae hardly discernible. 10 pairs of notogastral hairs. Four pairs of genital hairs, one pair of aggenital, two pairs of anal, and three pairs of adanal hairs. Monodactylous.

*Punctizetes penicillifer* n. sp.; fig. 37.

Length about 0.28 mm. Colour light brown.

**Propodosoma.** The propodosoma is narrow and short as compared with the hysterosoma. The rostrum is triangular and pointed. The rostral hairs, which are situated laterally, are thin and barbed, and reach for half their length beyond the tip of the rostrum. The lamellae, which in a dorsal view cover the sides of the propodosoma, taper only slightly towards their tip. Their medial borders, which are parallel, have a strong thickening, which anteriorly ends in a kind of a cuspis, which, however, does not reach beyond the outer border of the lamellae. From the base of this "cuspis" a hardly discernible translamellar line runs medially. The lamellar hairs are considerably longer than their mutual distance, rather thin, and barbed. The interlamellar hairs are short and thick brushes (hence the specific name). The pseudostigmata are almost hidden below the anterior border of the hysterosoma. They open forwards and outwards, and they have a rounded lobe on their posterior border. The pseudostigmatic organs are thick, coarse clubs, which are set with spiny bristles, longest at the tip of the head.

**Hysterosoma.** The anterior border is arched and reaches halfway between the interlamellar hairs and the anterior border of the pseudostigmata. The anterior border of the pteromorphae is strongly withdrawing, the whole anterior border forming one long and low arch. The distal margin of the pteromorphae are bent centrally. The areae porosae are barely discernible, and only Aa and A3 could be seen. There are probably 10 pairs of notogastral hairs, although nine pairs only could be seen, p3 being absent or impossible for me to see. They are arranged a little irregularly and they are extremely difficult to see. The whole surface is decorated with irregularly scattered, small bright dots.

**Ventral side, fig. 37 a.** The sternal plate is narrow anteriorly widening into a triangular plate in front of the genital field. Apodemata II are well developed and the sejugal apodemata are a little longer than the former. Apodemata III do not quite reach the triangular sternal plate. There are four pairs of fine genital hairs, which are situated in a longitudinal row in the middle of the plates. One pair of aggenital hairs, two pairs of anal hairs, and three pairs of adanal hairs, all are short and thin. Ad3 is preanal, ad2 is situated off the latero-posterior corner and ad1 is postanal, but located almost behind the lateral sides of the anal field. The ventral side, apart from the triangular sternal

plate, is covered with bright dots, which are bigger than those of the dorsal side, and which on the ventral plate are arranged more or less in undulating, longitudinal rows. Legs. The legs are short. All the femora are decorated with dots.

Femur II has a broad ventral keel. All the tarsi are monodactylous.

Suva: One specimen in a thin layer of mosses on a tree.

*Galumnoidea* BALOGH, 1961

*Galumna flabellifera* Hammer.

— — — — , 1958, p. 93, fig. 116.

Corolevu: A few specimens in dead leaves under trees on a slope down to the mangrove.

*Galumna fordii* (Jacot).

*Zetes fordii* Jacot, 1934, p. 73, Pl. 11, figs. 118–120.

Corolevu: One specimen in a “meadow” with stiff, green grass and pasturing cattle near a river.

*Galumna Samoënsis* Jacot; fig. 38.

— — — — , 1927, p. 85, figs. 1–12.

Suva: One specimen in thick moss on a mouldering tree trunk in the rain forest.

*Pergalumna corolevuensis* n. sp.; fig. 39.

Length about 0.73 mm. Colour reddish brown.

The propodosoma and the hysterosoma are not separated by a dorso-sejugal line, only by a difference in the colour, the propodosoma being light brown, the hysterosoma reddish brown. The propodosoma is slightly pointed. The rostral hairs, which are inserted ventrally, are moderately long and barbed. The lamellar hairs, which are situated on a small edge at some distance in front of the lamellar tip, are longer than the rostral hairs, and distally barbed. Interlamellar hairs are absent. The pseudostigmatic organs are very thin, rather long, feathered hairs. The area porosa dorso-sejugalis is oval with a narrow spur to the pseudostigma. There is no sculpture of any kind on the propodosoma. The pteromorphae have a brown pattern with finger-like spots radiating from the medial border towards the distal border, at the same time dissolving into a dense pattern of less dark patches. The pattern is darkest in the posterior half of the pteromorphae. The area porosa Aa is removed from the pteromorpha by a distance similar to its own length. It is oval, perhaps a little broader medially. A1 is almost round, a little more than half as big as Aa, A2 is about half as big as A1, and A3 is elongate. Notogastral hairs are absent. Their pores are located as shown in fig. 39.

The ventral side is shown in fig. 39a. The genital and the anal fields are separated by a distance as long as the length of the anal field. There are six pairs of genital hairs. Iad is short and is located between ad3 and the side of the anal field. Ad1 and

ad2 are postanal. The hairs of the ventral side are moderately long and smooth. All the tarsi have three claws, the middle of which is twice as thick as the lateral ones.  
Corolevu: Three specimens in dry leaves on a slope overgrown with mangrove.

*Trichogalumna duoporosa* n. sp.; fig. 40.

Length about 0.57 mm. Colour light brown.

The dorso-sejugal line is absent. The propodosoma is triangular with a slightly pointed rostrum. The rostral hairs, which are inserted ventrally, reach the tip of the rostrum. The lamellar hairs are situated medially to the line L at a good distance in front of the lamellar tip. The rostral and the lamellar hairs are approximately equally long. The rostrum is at a lower level than the area in which the lamellar hairs are situated. The interlamellar hairs, which are erect, are shorter than the lamellar hairs. At their base there is a pore besides the hair pore. The pseudostigmatic organs are flabelliform, the head pointing distally. It is set with short, dark scales, fig. 40 a.

The pteromorphae are a yellowish colour and are decorated with slightly darker, finger-like spots, radiating towards the distal border. Along the anterior margin of the pteromorphae there is a yellowish-greyish border, which is separated from the posteriorly situated part of the pteromorpha by a light line (shown by a broken line). All the notogastral hairs are present, but extremely small. Their pore is double. There are two areae porosae adalares (hence the specific name). The anterior one is situated near the medial border of the pteromorpha, the other, which is a little bigger and a little irregular in shape, at a right angle to the medial margin of the pteromorpha. A1 is irregular, too, with a crack at its medial side. A2 is almost as big as A1, and A3 is twice to three times as long. Fig. 40 b shows the main features of the ventral side. There are six pairs of genital hairs. All the hairs of the ventral side are very small. All the claws are tridactylous, the middlemost being more than twice as thick as the lateral ones.

Suva: One specimen in dry leaves on the forest floor.

*Trichogalumna taeniata* n. sp.; fig. 41.

Length about 0.295 mm. Colour yellowish to light brown.

There is no dorso-sejugal line, and there is not even any difference in the colour of the propodosoma and that of the hysterosoma. The rostrum is broadly rounded. The rostral hairs are absent. The lamellar hairs are very thin and moderately long, the interlamellar hairs are barely discernible. Behind the narrow area porosa dorso-sejugalis there is a greyish band (taenia), which continues backwards along the median border of the pteromorpha (hence the specific name).

The pseudostigmatic organ consists of a flat, greyish disk, which is broadest distally, and a long thin stalk.

The pteromorphae are yellowish and the pattern inconspicuous. The fissure is broad, and the hair ta is barely discernible. The area porosa adalaris, Aa is broadly oval and is situated close to the pteromorpha, in a longitudinal direction. A1 is round,

A2 smaller than A1, and A3 as big as A1. The notogastral hair pores are not double as in the preceding species, and the hairs are so minute that I cannot see all of them with certainty. Between the hairs ms two pores behind each other can be seen, the posterior one being the most distinct.

Fig. 41a shows the main features of the ventral side, which is a light colour. There are six pairs of genital hair pores. No hairs can be seen on the ventral side. Iad is located close to the side of the anal field. Behind the anal field there is an oblong area porosa postanalis. All the legs are tridactylous, the lateral claws being very thin. Suva: Four specimens in moist moss and dead leaves in the rain forest.

#### Oribatuloidea WOOLLEY, 1956

?*Xylobates monodactylus* (Haller); fig. 42.

Length about 0.43 mm. Colour light brown.

As I am not completely sure that the present species represents *Xylobates monodactylus* (Haller) I have illustrated it. It corresponds fairly well to a drawing which I have made of *Protoribates monodactylus* Haller from BERLESE's collection (slide number 74/16), from Columbia, North America. The latter, however, is in a very bad condition, and details could not be studied. Fig. 42a shows the ventral side.

Suva: One specimen in dead leaves on the forest floor of the rain forest.

*Xylobates triangularis* n. sp.; fig. 43.

Length about 0.53 mm. Colour curryish-yellow to light brown. The lamellae light brown.

Propodosoma. The rostrum is truncate, but its middle is prolonged as a short rounded snout on either side of which the short and thin rostral hairs are situated. They just reach beyond the tip of the snout. The lamellar hairs, which are situated at some distance medially to the end of the lamellae, are not much longer than the rostral hairs and reach the base of the latter. Behind their base there is a small dark spot. The lamellae are broad proximally, tapering towards the tip. In their whole length they cover the sides of the propodosoma. Their medial border apparently is at a lower level than the lateral border. The interlamellar hairs are distinctly barbed. They are situated close to the medial border of the lamellae. They are erect and thicker and longer than the lamellar hairs. The pseudostigmatic organs have a thin stalk, which widens into a flat head. The stalk is set with short bristles for most of its length on its anterior border, the bristles becoming stronger distally towards the head, on the outer border of which the distance between the bristles is equal to their length, fig. 43a. The pseudostigmatic organs reach by half their length beyond the latero-anterior corner of the pteromorphae.

Hysterosoma. The anterior border of the hysterosoma is slightly arched. The anterior borders of the pteromorphae have a deep incision laterally to the pseudostigma. The pteromorphae are triangular (hence the specific name), being short with a good part

bent ventrally. There are 10 pairs of very small notogastral hairs. Ms is situated closely behind A1, r<sub>2</sub> is located between A2 and r<sub>1</sub>, which is different from its position in *X. monodactylus*, where r<sub>2</sub> is situated immediately behind A2. The distance r<sub>1</sub>-r<sub>1</sub> is a little shorter than p<sub>1</sub>-p<sub>1</sub>. The hair pores are bright with a greyish spot round their bases. The adanal hairs are so short, that they cannot be seen in a dorsal view, as for instance in the preceding species.

Ventral side. The ventral side does not differ much from that of *X. monodactylus*. All the hairs are very short. Ad<sub>2</sub> is located a little more laterally than in *X. monodactylus*.

Legs. Tibia I with a short distal process. Tarsus I with a long, thin solenidion and a short thick one. Famulus hooked. Femur II has a broad ventral keel. There are no spine-shaped hairs on the legs. Monodactylous.

Corolevu: Two individuals in thin moss on a tree root, on a slope above the mangrove.

*Xylobates capucinus* (Berlese).

*Protoribates capucinus* Berlese, 1908, p. 2.

— — — — , Hammer 1961, p. 108, fig. 103.

Corolevu: A few individuals in dead leaves on a slope above the mangrove.

*Xylobates seminudus* n. sp.; fig. 44.

Length about 0.57 mm. Colour light brown.

Propodosoma. The tip of the rostrum is rounded. The rostral hairs, which are situated on the dorsal surface, but far laterally, are distinctly unilaterally barbed, and they are as long as their mutual distance. The lamellae are broad and located laterally. There is a line, not a real translamella, between the tips of the lamellae. The lamellar hairs are barbed and as long as their mutual distance. The same is the case with the interlamellar hairs. On the outer border of the pseudostigma there is a big, rounded lobe. The pseudostigmatic organ has a long, thin stalk and a lanceolate head, both of which are set with long bristles on their outer or anterior border. The stalk is bare in its proximal half.

Hysterosoma. The anterior border is straight, and the anterior border of the pteromorphae is straight, too, forming a right angle to the almost parallel sides of the pteromorphae. The posterior end is broad and rounded. The pteromorphae are narrow and reach posteriorly as far as im. Their distal margin is bent ventrally. They are mobile. There are 10 pairs of bright notogastral hair pores, the hairs being absent from the dorsum, but present on the ventral side (hence the name). The pores are situated as shown in fig. 44. The distance r<sub>1</sub>-r<sub>1</sub> is considerably shorter than p<sub>1</sub>-p<sub>1</sub>. P<sub>3</sub>-p<sub>2</sub> is very long.

Ventral side. Epimeres I and II from the two sides are separated by an undulating sternal line, fig. 44 a. Apodemata II are short, the seugal apodemata and Apodemata III long. The two latter meet at the anterior border of the genital field as in *Scheloribates*. The hairs of the ventral side are well developed. There are five pairs of genital

hairs, one pair of aggenital hairs, three pairs of adanal hairs, and two pairs of anal hairs. Ad3 is located a little in front of the latero-anterior corner of the anal field, ad2 off the latero-posterior corner, and ad1 is postanal. The two latter are very thin, longer than ad3, and they reach beyond the posterior border of the hysterosoma. The distance ad1-ad2 is shorter than the hairs in question. All the femora are broad and have a ventral keel. Tibia IV with a dorsal, distal tip. Many of the hairs of the legs are spine-shaped. All the tarsi have three claws, the middle one being much stronger than the lateral ones.

Corolevu: Two specimens in dead dry leaves on a slope above the mangrove.

?*Xylobates sinlimes* n. sp.: fig. 45.

Length about 0.34 mm. Colour yellowish to light brown.

Propodosoma. The propodosoma and the hysterosoma are not separated (sin limes) and it should probably be established as a new genus although its similarity to *Xylobates* is very great. The rostrum is rounded, the rostral hairs shorter than their mutual distance. The lamellae are broad, their tips rounded at the outer corners. The lamellar hairs absent or very short, their pores are distinct. The interlamellar hairs are erect and for that reason they appear short. The pseudostigmatic organ has a long stalk, which is equally thick throughout. On its outer or anterior border it is set with about 18–20 rather long, flexible, and smooth branches.

Hysterosoma. There is no anterior border on the hysterosoma. The anterior border of the pteromorpha is arched, its distal tip long and triangular. It is bent ventrally. The pteromorphae are short and reach posteriorly only as far as the hair te. They are mobile. There are 10 pairs of notogastral hairs, which are of moderate length and arranged as shown in fig. 45. The distances ti-ti, ms-ms, and r2-r2 are approximately equally long, r1-r1 and p1-p1 a little shorter. They are situated a little asymmetrically. Ti, ms, r2, r1, and p1 are situated in an almost longitudinal line. In *X. capucinus* r2 is outside this line (cp. HAMMER, 1961, fig. 103). Aa is round and much bigger than the others, which are equally big. Im is located rather medially and much farther anteriorly than is usually the case.

Ventral side. The sternal plate is broad and faintly chitinized, fig. 45a. The apodemata II are short. The sejugal apodemata and Apodemata III are long and meet in front of the genital field. The epimeric hairs 1a, 1b, 2a, and 3a are short, thick, and bushy. The remaining hairs are ordinary and thin. There are five pairs of genital hairs, the anterior one of which is longer than the others. One pair of barely discernible aggenital hairs. Two pairs of anal hairs and three pairs of adanal hairs. Ad3 is situated at some distance in front of the anal field (the two hairs at a different distance), their mutual distance is equal to the width of the field. Ad2 is located off the middle of the side of the anal field, and ad1 is postanal. The distance ad1-ad1 is almost the same as ad1-ad2. Iad is long and parallel to the side of the field, off ad2. The hairs of the ventral plate are ordinary thin setae.

Legs. Femur II has a broad ventral keel, which in a dorsal view appears as a big

projecting tooth. Femur III has a narrower keel. All the tarsi are monodactylous. Suva: One specimen in thin moist moss on a mouldering tree trunk in the rain forest.

*Haplozetes quadripilus* (Berl.); fig. 46.

*Protoribates* (*Protoribates*) *quadripilus* Berlese, Redia XII, 1916, p. 316.

Length about 0.65 mm. Colour light brown or rather orange-yellow with chestnut brown lamellae and border of the hysterosoma.

BERLESE's species from Java is 0.50–0.55 mm. long. The species from the Fiji Islands is thus somewhat bigger. As BERLESE's description is very short and as he has not illustrated his species, it is of course impossible to decide whether the species from the Fiji Islands represents *Protoribates quadripilus*, or is an independent species. The four long hairs, which can be seen on the posterior border, make me believe that they have given the species its name.

Propodosoma. On the tip of the rostrum there is a short, small, rounded snout, fig. 46a. The rostral hairs, which reach by half their length beyond the tip of the rostrum, are barbed and rather thin. The lamellae are brown, broad and strong, inclining and tapering towards the tip. The lamellar hairs are erect, barbed, and longer than their mutual distance. Round their base there is a brown spot. The interlamellar hairs, which are as long as their mutual distance, barbed, and rather thin, are situated close to the lamellae. The pseudostigma has no posterior lobe. The pseudostigmatic organ has a long, thin stalk, which for most of its length is set with tiny bristles on its anterior border. The head has a rounded anterior border, a more or less straight posterior border and it ends in a thin tip, fig. 46b. It is set with coarse bristles in 2–3 longitudinal rows.

Hysterosoma. The anterior border is almost straight. Behind the pseudostigma on the anterior border of the pteromorpha there is a rounded lobe, which is separated from the latero-anterior border by a deep incision. The hysterosoma is broadest across im, and narrowest behind the anterior border. The pteromorphae are mobile. Their lateral border is bent ventrally. There are 10 pairs of short, thin, equally long notogastral hairs. The hairs are situated at the end of a long pore, fig. 46c. There are four pairs of sacculi. Faint pits can be seen along the sides of the hysterosoma. Behind the posterior border four long hairs project. They represent ad1 and ad2.

Ventral side. The sternal plate is faintly chitinized, fig. 46d. Apodemata II and III are very short. The seugal apodemata are long and reach the anterior border of the genital field. The epimeric hairs are moderately long and smooth. 3a are situated close to the anterior margin of the genital field. There are five pairs of genital hairs, two pairs of anal hairs, which are directed posteriorly and then forwards. They are as long as the width of an anal plate. Ad3 is preanal and is located at a short distance in front of the latero-anterior corner of the anal field. Ad2 is situated off the latero-posterior corner and ad1 is postanal. Ad1 is longer than ad2, and the latter is longer than ad3. They are all very thin and a little uneven. Iad is parallel to the latero-anterior border and very close to the latter. Faint pits can be seen on the lateral parts

of the ventral plate, also on the anal plates. Between the pits there is a dense punctuation. Legs. Femur II has a ventral keel with a long feathered hair. All the tarsi are tridactylous, the lateral claws being much thinner than the middle one.

There is some difference between the two specimens found. In the specimen not described the lamellar hairs are situated at a short distance medially to the tip of the lamellae. Besides, the interlamellar hairs are removed a little from the border of the lamellae. On the ventral keel of Femur II there are three long, feathered hairs, on Femur I two similar hairs.

Corolevu: Two specimens in dead leaves on a slope above the mangrove.

*Maculobates ventroacutus* n. sp.; fig. 47.

Length about 0.28 mm. Colour light brown.

Propodosoma. The rostrum is pointed and the long barbed rostral hairs reach by only half their length beyond the tip of the rostrum. The lamellar hairs reach beyond the tip of the rostral hairs. They are situated immediately behind the tip of the lamella. Fig. 47 a shows that the lamella is faintly bent at about one third from its tip. The interlamellar hairs are shorter than the rostral and the lamellar hairs, and barbed. This species can easily be distinguished by its pseudostigmatic organ with the long stalk, which is not hidden below the anterior border of the hysterosoma. The head has parallel sides and is truncate at the tip.

Hysterosoma. The hysterosoma is very broad in its anterior half. The middle of the anterior border is arched, the latero-anterior borders are slightly withdrawn. The distal margin of the pteromorphae are bent ventrally. The hairs are arranged as shown in fig. 47. The distance r1-r1 is shorter than p1-p1.

Ventral side, fig. 47 b. In front of the genital field there is a curved chitinized band, which ends anteriorly in a long pointed tip at the base of which the hairs 2a and 3a are situated close together. The tip lies within the faintly chitinized and much broader sternal plate. This pointed tip on the ventral side has given this species its name, *ventroacutus*. There is nothing characteristic in the position or in the number of the hairs of the ventral plate. The base of Leg III has a peculiar structure round its base. It looks like a collar issuing from the posterior border of Tectop. II, but I cannot interpret it. The tarsi are monodactylous.

Corolevu: A few specimens in dead leaves on a slope above the mangrove.

Suva: Two individuals in moist moss and dead leaves on the forest floor.

?*Maculobates dubius* n. sp.; fig. 48.

Length about 0.23 mm. Colour light brown.

Propodosoma. The rostrum is slightly pointed. Both the rostral hairs and the lamellar hairs are very long and barbed. The interlamellar hairs, which are erect, appear much shorter than they are, fig. 48 a. The lamella is much complicated with an outer, strongly chitinized border (or an accessory ridge?), which runs to the lamellar hair, and a more faintly chitinized medial and broader part, in the border of which the

interlamellar hair is displaced. The medial part has a more strongly chitinized lateral border that probably represents the real lamella, which is attached to the pseudostigma. This species differs from *Maculobates* in the lack of a line from the pseudostigma to the interlamellar hair, forming the latero-anterior borderline of the hysterosoma. A prolamella and an interlamellar ridge are present. The pseudostigmatic organs have round disk-shaped, rather big clubs on a proportionately long stalk. The pseudostigma is only half hidden below the anterior border of the hysterosoma. Hysterosoma. A very slight difference in the colour of the integument only indicates the anterior border of the hysterosoma. The latter is not characteristic in any way. The 10 pairs of notogastral hairs are short and thin. The distance r<sub>1</sub>-r<sub>1</sub> is equal to p<sub>1</sub>-p<sub>1</sub>. Across the pteromorphae there is a curved light line, but the pteromorphae do not seem to be hinged.

Ventral side, fig. 48b. The sternal plate is broad between Apodemata II and between the sejugal apodemata with a deep incursion off Epimeres II. The hairs 2a are situated almost halfway between Apodemata II and the sejugal apodemata, 3a immediately in front of the genital plates, both pairs within a slightly darker chitinous area. There are three pairs of genital hairs. The aggenital hairs, adanal hairs, and anal hairs as in *Maculobates*. On the ventral plate on either side of the anal field there are two indistinct light furrows.

Femur II has a ventral keel. All tarsi are monodactylous.

Suva: One specimen in moist moss and dead leaves in the rain forest.

*Incabates medius* n. sp.; fig. 49.

Length about 0.305 mm. Colour greyish light brown.

*Incabates medius* is not so broad as *I. nudus* Ham., 1961, p. 108, fig. 104 (0.36 mm. long), but it is broader than *I. angustus* Ham., 1966, p. 43, fig. 57 (0.35 mm. long), and it is smaller than both of them. It is approximately twice as long as broad across im. *I. angustus* is almost two and a quarter times as long as broad across im. It seems to be more like *I. angustus* with its convex anterior border of the hysterosoma than like *I. nudus*, which has an almost straight anterior border. Its latero-anterior border of the hysterosoma is straight, in *I. angustus* it is withdrawn. The pteromorphae are narrow and their distal border is not bent ventrally as in *I. angustus*. Across the pteromorphae there is a bright, curved line. P<sub>3</sub> and r<sub>3</sub> are situated on a transverse line, in *I. angustus* p<sub>3</sub> is located much farther anteriorly. As mentioned above, the three species are very similar and they differ only in a few characteristics. The ventral side is shown in fig. 49a. It is like the ventral side of *I. angustus* (fig. 57a).

Corolevu: Only two specimens were found in dead leaves above the mangrove.

?*Scheloribates praeincisus* (Berl.) var. *interruptus* Berl.; fig. 50.

*Protoribates* (*Scheloribates*) *praeincisus* var. *interruptus* Berl. 1916, p. 315. Redia XII. *Scheloribates praeincisus* var. *interruptus*, Willm. 1931, p. 273, fig. 45.

Length about 0.53 mm. Colour clear brown.

The specimens from the Fiji Islands agree with the description by WILLMANN, apart from their slightly smaller size (WILLMANN 0.57 mm.), and the appearance of the outer border of the pseudostigma, which has a strong tooth (according to WILLMANN: a strong, rounded border). Neither BERLESE nor WILLMANN mentions the notogastral hairs, which are fairly well developed. The pseudostigmatic organs are clavate, rounded distally and set with minute scales in several longitudinal rows. Fig. 50a shows the anterior part of *Sch. praeincisus* var. *interruptus* half in profile, and fig. 50 b gives the main features of the ventral side. The tarsi are tridactylous.

Corolevu: Five specimens in a "meadow" with stiff grass and pasturing cattle close to the river.

Suva: A great number in dry leaves in the rain forest.

*Scheloribates praeincisus* (Berlese); fig. 51.

*Protoribates (Protoribates) praeincisus* Berl. Redia VI, p. 384, 1910.

*Protoribates (Scheloribates) praeincisus* Berlese, Sellnick 1925, p. 82, figs. 4-5.

This species seems to vary very much both in size, number of claws, and in several other features, as will appear from the following. According to BERLESE the species is 0.50 mm. long; SELLNICK writes that it varies from 0.319 mm. to 0.462 mm. in length. BERLESE does not mention the number of claws; SELLNICK writes that the tarsi have two claws (one specimen was tridactylous), the stronger being the outer claw on Tarsi I-II, on Tarsi III-IV the stronger is the inner claw. All the specimens from the Fiji Islands are tridactylous. The specimens from the Fiji Islands vary in the length of the body, in the length of the interlamellar hairs, the shape of the pseudostigma, the size of the pseudostigmatic organ, and in a few other characteristics. Figs. 51, 51a and b show three different forms, a being the commonest (0.42 mm. long). Between the tips of the lamellae there is a faint transverse ridge, which is broken in the middle. This ridge can be more or less distinct, in a few cases only so distinct as shown in fig. 51. The pseudostigma has a broad lateral tooth. The head of the pseudostigmatic organ is small. Form b, fig. 51a, is smaller (0.37 mm. long) and there is no ridge between the tip of the lamellae. Otherwise it has the same appearance as form a apart from minor differences, i.e. the shorter distance p1-p1. Form c, fig. 51b, which is 0.525 mm. long, differs from a and b by its very long and extremely thin lamellar and interlamellar hairs. The posterior border of the pseudostigma is rounded and the head of the pseudostigmatic organ is considerably larger, the stalk shorter. Medially to r3 there is a round light spot. No notogastral hairs could be seen (in a and b a few hairs on the posterior border can be seen). The variations from the commonest form are so pronounced, that they justify the establishment of a new variety, *Sch. praeincisus* var. *tenuiseta*.

As the V-shaped line between the tips of the lamellae is found in other *Scheloribates* species different from the species so far considered to be BERLESE's *Sch. praeincisus*, it is in reality impossible from the literature to find out what *Sch.*

*praeincisus* looks like. It is apparently a very old species, which in the Pacific area has developed different varieties and (or) forms through millions of years.

Corolevu: All the different forms were found in dead leaves on a slope above the mangrove.

*Scheloribates praeincisus* (Berl.) var. *fijiensis* n. var.; fig. 52.

Length about 0.37 mm. Colour light brown.

This variety has the V-shaped lines between the tips of the lamellae in common with *Sch. praeincisus* and its different forms, which were mentioned above. Its general habitus is so different from *Sch. praeincisus*, that perhaps it would be more correct to establish a new species. However, as it has the *praeincisus* line and we in fact do not know which species the name *praeincisus* covers, it must keep the name *praeincisus* at present.

The hysterosoma is narrow as compared with that of *Sch. praeincisus*, and the latero-anterior border of the hysterosoma is withdrawn. The propodosoma does not differ much from that of *Sch. praeincisus* apart from the pseudostigmatic organs, which are distinctly hairy. Their ventral side is straight, the dorsal side convex and set with short bristles, which can be seen in several longitudinal rows on the surface of the head. The latter ends distally in a tip, fig. 52 a. The outer border of the pseudostigma is rounded, without a tooth. The anterior border of the hysterosoma is convex, the latero-anterior borders slightly withdrawn. There are 10 pairs of short and thin notogastral hairs, which are situated as shown in fig. 52. By the presence of notogastral hairs it definitely differs from the forms of *Sch. praeincisus* described above. Fig. 52 b shows the main features of the ventral side, which is very similar to the ventral side of *Sch. praeincisus* var. *interruptus*, fig. 50 b. All the tarsi are tridactylous.

Corolevu: A few specimens in dead leaves on a slope above the mangrove.

*Scheloribates thermophilus* Ham. var. *corolevuensis*, n. var.; fig. 53.

*Scheloribates thermophilus* Ham., 1961, p. 95, fig. 85.

Length about 0.33 mm. Colour ochreish light brown.

Propodosoma. The rostrum is long and pointed. Both the rostral and the lamellar hairs are long and barbed, the lamellar hairs being the longer. The interlamellar hairs, which are erect and barbed like the former, are, when seen in profile, as long as the lamellar hairs. The head of the pseudostigmatic organ is almost equally broad throughout, slender, and slightly pointed at the tip. The stalk is no longer than the head.

Hysterosoma. The anterior border is arched and reaches beyond the anterior border of the pseudostigmata. The latero-anterior border of the pteromorphae almost forms a right angle. Only a very small part of the distal margin of the pteromorphae is bent ventrally. Across the pteromorphae there is a curved line outside which the pteromorphae are a dirty yellowish-grey colour. The notogastral hairs are very small and they are situated as shown in fig. 53.

Ventral side. Fig. 53 a shows the main features of the ventral side. The variety differs from the main form by its smaller size (the main form from Peru is 0.42 mm. long),

by the appearance of the tip of the rostrum, which is not hyaline, and by its much longer lamellar hairs.

Corolevu: One specimen in dry mosses and bark on a tree overgrown with epiphytes.

*Scheloribates fimbriatus* Thor; fig. 54.

— — — Sig Thor, 1930, p. 196, figs. 13–14.

Length about 0.655 mm. Colour brown.

The only specimen found agrees well with THOR's description apart from its considerably larger size. SIG THOR's species measures about 0.48 mm. in length. THOR's species was found in a mountain brook about 100 km. south of Tashkent in Turkestan. WILLMANN found *Scheloribates fimbriatus* in Java, but his species differs a little from that of SIG THOR, having a translamellar line as found in *Scheloribates praeincisus* var. *interruptus* Berl., for which reason he established the variety *javensis* (0.51–0.56 mm. long). WILLMANN found it in coconut shells full of water.

The pseudostigmatic organs of this species are so characteristic, fig. 54a, that there is hardly any doubt that the specimens from the Fiji Islands belong to *Scheloribates fimbriatus* Thor. Neither THOR nor WILLMANN mentions the number of claws. The specimens from Viti Levu are tridactylous. Fig. 54b shows the ventral side. The ventral plate is clear brown.

Corolevu: Three specimens in a kind of "meadow" with stiff, green grass near a river.

*Trischeloribates* m. gen.

Propodosoma and hysterosoma separated dorsally. Pteromorphae long with distal border bent ventrally. Rostral hairs on ridges separated from the rostrum by a deep incision, rostrum thus being tripartite. Lamellae twisted. 10 pairs of notogastral hairs. Varying number of sacci. Three pairs of genital hairs, no aggenital hairs. Three pairs of adanal hairs. Monodactylous.

*Trischeloribates acutus* n. sp.; fig. 55.

Length about 0.235 mm. Colour yellowish to light brown.

Propodosoma. The tip of the rostrum is very pointed (acus). The rostral hairs are situated just behind the end of a lateral ridge, which almost reaches the tip of the rostrum, but is separated from the latter by a deep incision. The rostral hairs, which are barbed, reach for most of their length beyond the tip of the rostrum. The lamellae, which are almost parallel and situated near the lateral border of the propodosoma, are twisted, the proximal part apparently with an erect keel, the distal part turned laterally. They have a small tip beyond the lamellar hair. The lamellar hairs are barbed and as long as their mutual distance. They reach beyond the tip of the rostrum. The interlamellar hairs, which are shorter than the lamellar hairs, are also barbed. The pseudostigmata are half hidden below the hysterosoma. There is a lobe on their posterior border. The pseudostigmatic organs are clavate, the clubs, when laid bare, being long and narrow with parallel sides, slightly pointed at the tip.

Hysterosoma. The anterior border is convex in the middle, its latero-anterior borders slightly withdrawn. The posterior end is rounded. The hysterosoma is broadest across te. The distal margin of the pteromorphae is bent ventrally. The notogastral hairs, 10 pairs, are very small. R3 and ms are situated on a transverse row. The distance r1-r1 is approximately the same as p1-p1. There are four pairs of small sacculi. The posterior end of the hysterosoma is in one specimen covered by a layer of secretion, as indicated in fig. 55 by a line.

Ventral side, fig. 55a. In front of the genital field there is a shield-shaped sternal plate. Apodemata II are very short, the seugal apodemata reach the sternal plate. There are only three pairs of genital hairs, viz. one near the anterior border and two in the posterior half. Aggenital hairs are absent. The anal field is very broad. This species apparently has only one pair of anal hairs, the posterior one being missing. Ad3 is preanal, near the anterior border of the field; ad2 is located off the latero-posterior corner, and ad1 is postanal. The distance ad1-ad2 is about half as long as ad1-ad1. Iad is parallel to the sides of the anal field.

Legs. Tibia I with a distal process. Femur II with a short ventral keel. All legs with one claw only.

Suva: Several specimens in dead leaves on the forest floor.

*Trischeloribates rotundus* n. sp.; fig. 56.

Length about 0.23 mm. Colour light brown, darkest at the posterior end of the hysterosoma.

Propodosoma. The rostrum is in this species shaped like a protruding, rounded snout, on either side of which the lateral ridges with the rostral hairs can be seen. The rostral hairs are shorter than in the preceding species and barbed, and the lamellar hairs are shorter, too. The lamellae are like those of the preceding species, except that there is no tip beyond the lamellar hair. The pseudostigmatic organs are clavate, the club being shorter than that of *T. acutus*.

Hysterosoma. The anterior border is not so arched in the middle as in *T. acutus*, and the latero-anterior borders are more straight. The hysterosoma is narrower than that of *T. acutus*, with almost parallel sides. The pteromorphae are smaller, their distal margin is bent slightly ventrally. The 10 pairs of notogastral hairs are situated as in the preceding species. Of the sacculi only Sa and S3 are present. Im is very long, and is situated in front of r3. There are very small and faint pits in the integument; they can be seen best on the lateral parts of the hysterosoma.

Ventral side, fig. 56a. The ventral side differs from that of *T. acutus* by the shape of the sternal plate in front of the genital field. In this species it is a broad plate, which continues as a narrow plate forwards between Epimeres II, becoming only a line between Epimeres I. There are three pairs of genital hairs, no aggenital hairs, two pairs of anal hairs, and three pairs of adanal hairs. They are situated as in the preceding species. Faint pits can be seen also on the ventral plate.

Legs as in the preceding species.

Suva: One specimen together with the preceding species in dead leaves on the forest floor.

*Trischeloribates latus* n. sp.; fig. 57.

Length about 0.285 mm. Colour light brown.

Propodosoma. The propodosoma is in a dorsal view very short and it is a little broader than long. The sides are almost parallel. The rostrum is broadly rounded and prolonged as a snout, which is bent slightly ventral. The rostral hairs, which are situated on short free tips as in the preceding species, are smooth, thin, and approximately as long as their mutual distance. The lamellae, which are about two thirds as long as the propodosoma, are situated along the sides of the propodosoma. They are almost parallel and almost equally broad throughout. Their anterior end has a rounded outer edge. The lamellar hairs are situated on the tip of the lamellae, near the medial side. They are almost as long as the lamellae, smooth, and they reach in a broad curve beyond the tip of the rostrum. Behind the tip of the lamellae a faint transverse line can be seen. The interlamellar hairs, also smooth, are erect and probably as long as the lamellar hairs. Most of the pseudostigmata are hidden under the anterior border of the hysterosoma. On their posterior border there is a rounded lobe. The pseudostigmatic organs are clavate, the head approximately as long as the stalk. The club is set with short, coarse bristles in transverse rows.

Hysterosoma. The anterior border forms a long, low arch, which projects beyond the anterior border of the pseudostigmata. The latero-anterior borders are slightly withdrawn. The sides of the hysterosoma are almost parallel, i.e. the transverse line across r3-r3 is almost equal to a line across te-te. The posterior end is rounded. The pteromorphae are long and reach posteriorly as far as to r3. Their distal border is bent ventrally, at the same time forming a slight incurvation laterally. The 10 pairs of notogastral hairs are thin and moderately long. They are situated as shown in fig. 57. Ti, ms, r2, and r1 are directed medially, the remainder outwards. R3 and ms from the two sides are situated on a transverse line. The distance r1-r1 is equal to p1-p1. The sacci are indistinct, only Sa and S3 are present. The integument has no sculpture. Ventral side. The ventral side is very similar to that of *T. rotundus*, fig. 57a. There are small differences in the shape of the sternal plate and the length of the hairs. The sculpture consists of very low, light, oblong, and faint pits of different sizes. They are arranged in irregular rows. The pits are present also on the anal plates.

Legs. Femur II with a very broad keel, Femur I with a smaller keel. Fig. 57b and c show Leg I and Leg IV, respectively. They have been drawn in situ and for that reason all the hairs probably are not illustrated. Tibia I has a short distal process. Tarsus I is short and broad. Coxa IV and Femur IV apparently are convex proximally, but I may have interpreted their shape incorrectly. They are very broad as compared with the narrow genus.

Suva: Three specimens in dead leaves and mosses on the forest floor.

*Fijibates* n. gen.

*Fijibates* is in several characteristics similar to *Scheloribates*, but can be distinguished from the latter by the rostral hairs, which are situated rather close together on the dorsal surface of the rostrum. No ridge between the tip of the lamella and the rostral hair. No distinct separation between the propodosoma and the hysterosoma. Apodema III does not reach the frame of the genital field. The posterior genital hairs are situated along the sides of the plates. One claw.

*Fijibates rostratus* n. sp.; fig. 58.

Length about 0.30 mm. long. Colour light brown.

Propodosoma. The rostrum is pointed like a snout on the dorsal side of which the rostral hairs are situated. The rostral hairs are densely barbed and several times longer than their mutual distance. They project for most of their length beyond the tip of the rostrum. The lamellae are like those in *Scheloribates*. The lamellar hairs, which are barbed, reach in a dorsal view as far beyond the tip of the rostrum as the rostral hairs do. The interlamellar hairs, in front of which a short faint line can be seen, are also barbed and they are as long as the lamellar hairs. The pseudostigma has a narrow opening and a rounded posterior border. The pseudostigmatic organ is clavate. The head, which is as long as the stalk, is set with minute bristles. It is pointed distally. When laid bare it is very slender, fig. 58a.

Hysterosoma. The anterior border of the hysterosoma is faintly developed. The middle is convex, the latero-anterior borders straight or slightly withdrawn. The pteromorphae have a faint incurvation of their distal margin, which is clear and transparent. The posterior end of the hysterosoma is rounded. The notogastral hairs, 10 pairs, are short and thin. R1 and r2 from the two sides are situated on a transverse row, r1 farther anteriorly than in *Scheloribates*. Also S3 is removed a good distance from the posterior border, and ip is situated unusually far laterally, immediately behind r2.

Ventral side. Fig. 58b shows the main features of the ventral side, which is similar to that of *Scheloribates*, apart from Apodema III, which is short and does not meet the sejugal apodema in front of the genital field as in *Scheloribates*. There are four pairs of genital hairs, two of which near the anterior margin, two in the posterior half, near the lateral margin. The anal field is much larger than the genital field. There are two anal hairs and three adanal hairs. Ad3 is preanal and is situated immediately in front of the field, ad2 and ad1 are postanal, the distance ad1-ad1 being a little longer than ad1-ad2. Iad is parallel to the lateral side of the anal field, situated at a short distance behind ad3. The solenidia of Tibiae I and II and of Genus I-II are very long and thin. All the tarsi are monodactylous.

Suva: Three specimens in a thin layer of moss on a tree trunk in the rain forest.

*Nesozetes* n. gen.

This genus is characterized by broad, hyaline membranes, which cover the lateral sides of the propodosoma, apparently attached for their whole length to the propodo-

soma. Costulae present. Rostral, lamellar, and interlamellar hairs ordinary. Pseudostigmatic organ spindle-shaped. Propodosoma and hysterosoma separated dorsally. Areae porosae present. 10 pairs of notogastral hairs. Ventral side with a broad sternal plate. All apodemata well developed, except Apodemata IV, and narrow. Four pairs of genital hairs. Aggenital hairs absent. Anal field very large. Two pairs of anal hairs. Only two pairs of adanal hairs. Legs ordinary, with one claw.

*Nesozetes rostropterus* n. sp.; fig. 59.

Length about 0.27 mm. Colour light brown.

Propodosoma. The posterior part is as broad as the anterior border of the hysterosoma and has straight sides. Its anterior half is triangular. The tip of the rostrum is narrow and rounded. The rostral hairs, which are approximately twice as long as their mutual distances, are very thin and smooth. They are situated at the end of a faint ridge. The costulae are broad in the proximal part, tapering towards the end, which is very narrow, forming a small plate, on which the lamellar hair is situated. The latter are long and smooth, and in a dorsal view reach beyond the tips of the rostral hairs. The interlamellar hairs, which are considerably longer than the lamellar hairs, are seen in fig. 59a. They are very thin and situated at a short distance in front of the projecting middle part of the anterior border of the hysterosoma. On either side of the propodosoma a hyaline membrane can be seen. The membranes are apparently attached to the ventral side of the propodosoma for their whole length from the rostral hair to the pseudostigma. As they are hyaline I cannot see where they are attached nor really find out whether they represent real membranes. In fig. 59a they can be seen in profile. They are concave medially, broadest anteriorly, becoming narrow towards the pseudostigma. The latter is half hidden below the anterior border of the hysterosoma. It opens laterally. The pseudostigmatic organ has a small spindle-shaped head on a proportionately long and very thin stalk. Laterally to the costula there is an area porosa.

Hysterosoma. Its anterior border projects almost as far as the base of the interlamellar hairs. The pteromorpha or shoulder is rounded, withdrawn, and has a small edge off ta. The sides of the hysterosoma are parallel, the posterior end slightly pointed. The 10 pairs of notogastral hairs are thin and short with the exception of the setae p1, which are situated rather close together, and which are twice as long as the others. The hairs are arranged very irregularly and not all the 20 hairs could be seen. Two pairs of areae porosae could be seen only, viz. the areae porosae adulares, Aa and the areae posteriores A2, both small and inconspicuous. Im and ip are distinct.

Ventral side. Fig. 59b shows the main features. The sternal plate is developed in its whole length. In front of the genital field it widens into an irregular plate. Apodemata II, the sejugal apodemata, and Apodemata III are narrow and straight, meeting the sternal plate. Apodemata IV are not developed. There are no hairs on the ventral side and the hair pores are very inconspicuous, for which reason probably not all pores have been illustrated. The genital field is oval. There are four pairs of pores, all

situated in a longitudinal row in the middle of the plates. Aggenital hairs are absent. The anal field is very large with parallel sides. There are two pairs of anal pores, which like the genital pores are located in the middle of the plates. Ad1 is postanal, ad2 approximately off the middle of the side of the field, and ad3 is absent. Iad is parallel to the side of the field, close to the latero-anterior border. On either side of the ventral plate there is a faint line, which runs from Acetabulum IV almost to the posterior end of the anal field.

Legs. All the femora are rather slender. Femora I-II with a strong stiff, erect dorsal seta, fig. 59a, c. Fig. 59c shows a sketch of Leg I drawn in situ and therefore probably not showing all the hairs. All the tarsi are monodactylous. The claw is long and slender. Mouthparts have not been studied.

Suva: Two specimens in flat, wet moss on the bank of a canal in a park.

*Rostrozetes foveolatus* Sellnick; fig. 60.

— — — , 1925, p. 84, figs. 6–7.  
— — — , Beck 1965, p. 43, fig. 136.

In the material from the Fiji Islands there are two different forms of this species, partly the typical form, described by SELLNICK from Sumatra, which was found at Corolevu, partly a more or less reticulate form, found at Suva, fig. 60. According to BECK both belong to *R. foveolatus* although they differ much in the pattern of the dorsum. In the latter the alveoles are connected by lines as bright as the alveoles. This form recalls one mentioned by BECK 1965, p. 43, fig. 136, from Madagascar, the reticulate form being present also in the rain forest of Peru.

Corolevu: Two specimens in a “meadow” with stiff, green grass and pasturing cattle, near a river.

Suva: A few specimens in thick moss on a mouldering tree trunk in the rain forest.

*Tuberemaeus bellissimus* n. sp.; fig. 61.

Length about 0.345 mm. Colour clear light brown.

Propodosoma. The rostrum is rounded. The rostral hairs, which are situated laterally, are rather thin and unilaterally feathered. The costulae, which are equally broad throughout, have a faint bending almost in their middle. The lamellar hairs, which are about half as long as the costulae, are barbed. The interlamellar hairs, which are erect, appear short, but they are longer than the lamellar hairs, which can be seen in a lateral view, fig. 61a, and they are not so densely barbed as the lamellar hairs. The pseudostigma is almost hidden below the anterior border of the hysterosoma. The pseudostigmatic organ is a short club, pointed at the tip and set with short spine-like bristles. Exopseudostigmatic hair absent. Between the costulae small, light dots can be seen.

Hysterosoma. The hysterosoma is oval, though slightly narrower anteriorly. On the shoulder there is a small edge. There are 10 pairs of thin, short notogastral hairs. Ta is situated behind the shoulder edge. The distance ti-ti is longer than ms-ms; the

latter is twice as long as r1-r1. The dorsum is beautifully decorated with shining yellow pits and splits, the latter in oblique longitudinal rows, slightly radiating towards the lateral and the posterior borders. The anterior part of the hysterosoma has transverse rows of large pits. Fig. 61a shows *T. bellissimus* in profile.

Ventral side, fig. 61b. The epimeres from the two sides are separated by a narrow sternal plate. Apodemata II are narrow and separated by a small plate. In front of the genital field the sternal plate widens into another plate, where the sejugal apodema<sup>4</sup> and Apodema III meet. The genital field has four pairs of small hairs. There is one pair of aggenital hairs. The anal field is much larger than the genital field and has two pairs of small hairs. Ad1 is postanal, ad2 is located at the latero-posterior corner of the anal field, and ad3 is preanal. The ventral side is decorated with splits like the dorsal side, the splits running in different directions.

Legs. All the femora are furnished with pits or splits; there are a few pits also on Tibia IV. The remaining joints are smooth. Tarsi I-II are short, see fig. 61c, which shows Leg I. All the tarsi are monodactylous, the claw being very strong.

Suva: A great number in thick moss on a mouldering tree trunk in the rain forest.

### General Remarks on the Oribatid Fauna on Viti Levu, the Fiji Islands

A total of 83 species was found in this fairly accidental and very spontaneous collection of oribatids, of which 43 are new to science. 8 new genera have been set up. The other 40 species, which have previously been described, have been listed in the table, where the localities of the finding-places of the species have been indicated above. Australia is not included in the table as it is still almost unknown as regards oribatids. Nor have the various varieties with which a number of species are represented merely locally been considered, apart from *Scheloribates praeincisus* var. *interruptus*, which seems generally distributed over large parts of the Pacific area.

The large number of gaps in the table is presumably in many cases due to our ignorance of the distribution of the oribatids rather than to the absence of the species in the places in question. Some of the 40 species are widely distributed nearly all over the whole earth. This applies to *Hermaniella punctulata*, *Tectocepheus velatus*, *Fosseremus quadripertitus*, *Oppiella nova*, *Hydrozetes lemiae*, *Xylobates monodactylus*, and *Xylobates capucinus*. Most species are mainly distributed in the warmer regions of the southern hemisphere. It is peculiar to find *Allonothrus russeolus* and *Oribatella schoutedeni* in the Fiji Islands as their distribution so far is in West Africa. The fact that again and again we find *Scheloribates praeincisus* in Pacific areas, where it occurs in different varieties, must suggest, as mentioned under that species, that it was able to spread at a very early time, perhaps with flotsam. It is a surprising fact that the Fiji Islands have no more than 12 species in common with New Zealand, which is the largest area of land nearest to the Fiji Islands. It is especially surprising that none

	Localities										
	New Zealand	Indonesia	Thailand Vietnam } Asia		Japan	Hawaii	Pacific area	North America	South America	East Africa	West Africa
Known species found in the Fiji Islands											
<i>Eohypochthonius gracilis</i> . . . . .								x	x		
<i>Malacoangelia remigera</i> . . . . .		x						x	x	x	x
<i>Hoplophthiracarus kugohi</i> . . . . .			x								
<i>Hoplophorella cucullata</i> . . . . .				x				x	x		
<i>Javacarus kühnelti</i> . . . . .					x						
<i>Masthermannia mamillaris</i> . . . . .	x										x
<i>Trimalaconothrus crassisetosus</i> . . . . .		x									
<i>Allonothrus russeolus</i> . . . . .										x	
<i>Hermannella punctulata</i> . . . . .					x						x
<i>Pedrocortesella sexpilosus</i> . . . . .	x										
<i>Tegeozetes tunicatus</i> . . . . .		x						x		x	x
<i>Tegeocranellus laevis</i> . . . . .			x					x			x
<i>Tectocepheus velatus</i> . . . . .	x		x		x			x	x		
<i>Gibbiccephus? frondosus</i> . . . . .	x		x		x						
<i>Cultroribula lata</i> . . . . .	x		x		x						
<i>Fosseremus quadripertitus</i> . . . . .	x		x		x			x	x		
<i>Suctobelba variosetosus</i> . . . . .	x							x	x		
<i>Suctobelbila dentata</i> . . . . .	x							x	x		
— <i>squamosa</i> . . . . .								x	x		
<i>Machuella ventrisetosa</i> . . . . .	x							x	x		
<i>Oppiella nova</i> . . . . .	x	x	x		x		x	x	x		
<i>Oppia arcuatis</i> . . . . .	x		x	x	x					x	
<i>Ramusella chulumaniensis</i> . . . . .	x		x	x	x			x	x		
<i>Amerioppia Woolleyi</i> . . . . .	x										
<i>Hydrozetes lemnae</i> . . . . .	x							x	x		
<i>Microzetes auxiliaris</i> . . . . .	x							x	x		
<i>Pelops monodactylus</i> . . . . .	x		x				x				
<i>Lamellobates palustris</i> . . . . .								x	x		
<i>Oribatella schoutedeni</i> . . . . .										x	
<i>Galumna flabellifera</i> . . . . .			x		x			x	x		
— <i>fordi</i> . . . . .			x		x						
— <i>Samoänsis</i> . . . . .											
<i>Xylobates monodactylus</i> . . . . .	x			x			x	x	x		
— <i>capucinus</i> . . . . .				x			x	x	x		
<i>Haplozetes quadripilus</i> . . . . .	x										
<i>Scheloribates praeincisus</i> v. <i>interruptus</i> . . . . .	x	x	x		x	x	x		x		
— — . . . . .											
— <i>thermophilus</i> . . . . .											
— <i>fimbriatus</i> . . . . .									x	x	
<i>Rostrozetes foveolatus</i> . . . . .	x	x						x	x	x	

of the many new genera from New Zealand, which are so far endemic to this country, have been found on the Fiji Islands. It would seem as if it has been easier for species from other areas of the Pacific to gain a footing in the Fiji Islands rather than for species from New Zealand.

All in all the oribatid fauna of the Fiji Islands consists of a mixture of species from all areas bordering on the Pacific and from the islands in the Pacific.

It is still too early to suggest how the Fiji Islands have been populated with oribatids, but there is a fair number of species which the Islands have in common with Indonesia, and which perhaps can be explained by a previous connexion by land by way of a large number of islands stretching from towards New Guinea to Indonesia.

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## Explanation of the Figures of Plates I-XXXV

Fig. 1. *Eohypochthonius gracilis* (Jacot).

- 2. *Steganacarus craterifer* n. sp.
- 2 a. — — aspis.
- 2 b. — — pseudostigmatic organ.
- 2 c. — — notogastral hair in dorsal view.
- 2 d. — — — in profile.
- 2 e. — — — with hair pore.
- 2 f. — — ano-genital region.
- 3. *Epilohmannia multiseta* n. sp.
- 3 a. — — ventral side.
- 3 b. — — genital field with surroundings.
- 3 c. — — Leg I.
- 3 d. — — Leg II.
- 3 e. — — Tibia and Tarsus IV.
- 3 f. — — maxilla and palp.
- 3 g. — — mandible.
- 3 h. — — surroundings of Leg II.
- 3 i. — — Epimeres I and II.
- 4. *Javacarus kühnelti* Balogh.
- 4 a. — — ventral side.
- 5. *Cyrtthermannia luminosa* n. sp.
- 5 a. — — notogastral hair.
- 5 b. — — sculpture of hysterosoma.
- 6. *Malaconothrus variosetosus* n. sp.
- 6 a. — — ventral side.
- 7. *hexasetosus* n. sp.
- 7 a. — — in profile.
- 7 b. — — ventral side.
- 8. *Trimalaconothrus crassisetosus* Willm. var. *fijiensis* n. var.
- 8 a. — — — — — ventral side
- 9. *Allonothrus russeolus* Wallw.
- 10. *Plasmobates hyalinus* n. sp.
- 10 a. — — ventral side.
- 11. *Liodes ramosus* n. sp.
- 11 a. — — tubercles of hysterosoma, half in profile.
- 11 b. — — — — — from the side.
- 11 c. — — sculpture of the hysterosoma, schematically.
- 11 d. — — hair from medial side of Femur I.

Fig. 12. *Gibbicepheus? frondosus* (Aoki).

- 12a. — — rostral hair.
- 12b. — — in profile.
- 12c. — — adanal hair.
- 13. *Basilobelba pacifica* n. sp.
- 13a. — hysterosoma without tritonymphal scalp.
- 13b. — ventral side.
- 13c. — hair from Tibia IV (narrow) and from Genu IV (broad).
- 13d. — deutonymph.
- 13e. — protonymph.
- 13f. — larva.
- 13g. — hair from Tibia IV (narrow) and from Genu IV (broad), specimen from Corolevu.
- 13h. — tritonymphal scalp, specimen from Corolevu.
- 14. *Eremulus curviseta* n. sp.
- 15. — *truncatus* n. sp.
- 16. *Sulecoribula laticuspidata* n. gen. n. sp.
- 16a. — ventral side.
- 17. *Fijirella mollis* n. gen. n. sp.
- 17a. — ventral side.
- 17b. — Tibia and Tarsus I.
- 17c. — infracapitulum.
- 17d. — mandible in different views.
- 17e. — sketch of palp.
- 18. *Suctobelba fijiensis* n. sp.
- 18a. — ventral side.
- 19. — *ponticulus* n. sp.
- 19a. — rostral teeth.
- 19b. — ventral side.
- 20. *Machuella ventrisetosa* Ham. var. *robusta* n. var.
- 20a. — — — — — ventral side.
- 21. *Dampfiella similis* n. sp.
- 21a. — ventral side.
- 21b. — mandible.
- 21c. — infracapitulum.
- 21d. — Leg I.
- 22. — *dubia* n. sp.
- 22a. — ventral side.
- 22b. — anterior end in profile showing "cuvette dorsale" (cud), "cuvette ventrale" (cuv), and "cuvette notogaster" (cun).
- 22c. — mandible.
- 22d. — infracapitulum.
- 22e. — Leg I.
- 22f. — Leg II.
- 22g. — Leg IV.
- 23. *Dolicheremaeus fijiensis* n. sp.
- 23a. — left pseudostigma and surroundings.
- 23b. — ventral side.
- 23c. — solenidia and famulus, Tarsus I.
- 24. *Oppia exiguum* n. sp.
- 24a. — ventral side.

Fig. 25. *Oppia lanceosetoides* n. sp.

- 25a. — — in profile.
- 25b. — — ventral side.
- 25c. — — notogastral hair.
- 26. *Ramusella chulumaniensis* (Ham.) var. *curtipilus* n. var.
- 26a. — — — — pseudostigmatic organ.
- 26b. — — — — ventral side.
- 27. *Amerioppia Woolleyi* Ham.
- 27a. — — ventral side.
- 28. — — *vicina* n. sp.
- 28a. — — ventral side.
- 29. *Globoppia (Aeroppia) pauciseta* n. sp.
- 29a. — — — — ventral side.
- 30. *Cheloppia hyalina* n. gen. n. sp.
- 30a. — — in profile.
- 30b. — — ventral side.
- 31. *Licneremaeus polygonalis* n. sp.
- 31a. — — pseudostigmatic organ.
- 31b. — — ventral side.
- 32. *Scapheremaeus bicornutus* n. sp.
- 33. — — *arcualatus* n. sp.
- 34. *Seteremaeus spinosus* n. gen. n. sp.
- 34a. — — ventral side.
- 34b. — — Leg I (drawn in situ).
- 34c. — — Tibia and Tarsus II (drawn in situ).
- 35. *Microzetes auxiliaris* Berl. var. *pachyseta* n. var.
- 36. *Oribatella schoutedeni* Balogh.
- 36a. — — ventral side.
- 36b. — — Leg I.
- 36c. — — Femur and Genu II.
- 37. *Punctizetes penicillifer* n. gen. n. sp.
- 37a. — — ventral side.
- 38. *Galumna Samoënsis* Jacot.
- 39. *Pergalumna corolevuensis* n. sp.
- 39a. — — ventral side.
- 40. *Trichogalumna duoporosa* n. sp.
- 40a. — — ventral side.
- 41. — — *taeniata* n. sp.
- 41a. — — ventral side.
- 42. *Xylobates monodactylus* (Haller).
- 42a. — — ventral side.
- 43. — — *triangularis* n. sp.
- 44. — — *seminudus* n. sp.
- 44a. — — ventral side.
- 45.? — — *sinlimes* n. sp.
- 45a.? — — ventral side.
- 46. *Haplozetes ?quadripilus* (Berl.).
- 46a. — — tip of rostrum.
- 46b. — — pseudostigmatic organ.
- 46c. — — hair tip with pore.
- 46d. — — ventral side.

Fig. 47. *Maculobates ventroacutus* n. sp.

- 47a. — — left lamella with surroundings.
- 47b. — — ventral side.
- 48.? — *dubius* n. sp.
- 48a. — — left lamella with surroundings.
- 48b. — — ventral side.
- 49. *Incabates mediuss* n. sp.
- 49a. — — ventral side.
- 50. *Scheloribates? praeincisus* Berl. var. *interruptus* Berl.
- 50a. — — — — — propodosoma half in profile.
- 50b. — — — — — ventral side.
- 51. — — form a.
- 51a. — — form b.
- 51b. — — form c. (var. *tenuiseta* n. var.).
- 52. — — var. *fijiensis* n. var.
- 52a. — — — — pseudostigmatic organ.
- 52b. — — — — ventral side.
- 53. — — *thermophilus* Ham. var. *corolevuensis* n. var.
- 53a. — — — — — ventral side.
- 54. — — *fimbriatus* Thor
- 54a. — — pseudostigmatic organ.
- 54b. — — ventral side.
- 55. *Trischeloribates acutus* n. gen. n. sp.
- 55a. — — ventral side.
- 56. — — *rotundus* n. sp.
- 56a. — — ventral side.
- 57. — — *latus* n. sp.
- 57a. — — ventral side.
- 57b. — — Leg I (drawn in situ).
- 57c. — — Leg IV (drawn in situ).
- 58. *Fijibates rostratus* n. gen. n. sp.
- 58a. — — pseudostigmatic organ.
- 58b. — — ventral side.
- 59. *Nesozetes rostropterus* n. gen. n. sp.
- 59a. — — in profile.
- 59b. — — ventral side.
- 59c. — — Leg I (drawn in situ).
- 60. *Rostrozetes foveolatus* Selln.
- 61. *Tuberemaeus bellissimus* n. sp.
- 61a. — — in profile.
- 61b. — — ventral side.
- 61c. — — Leg I.

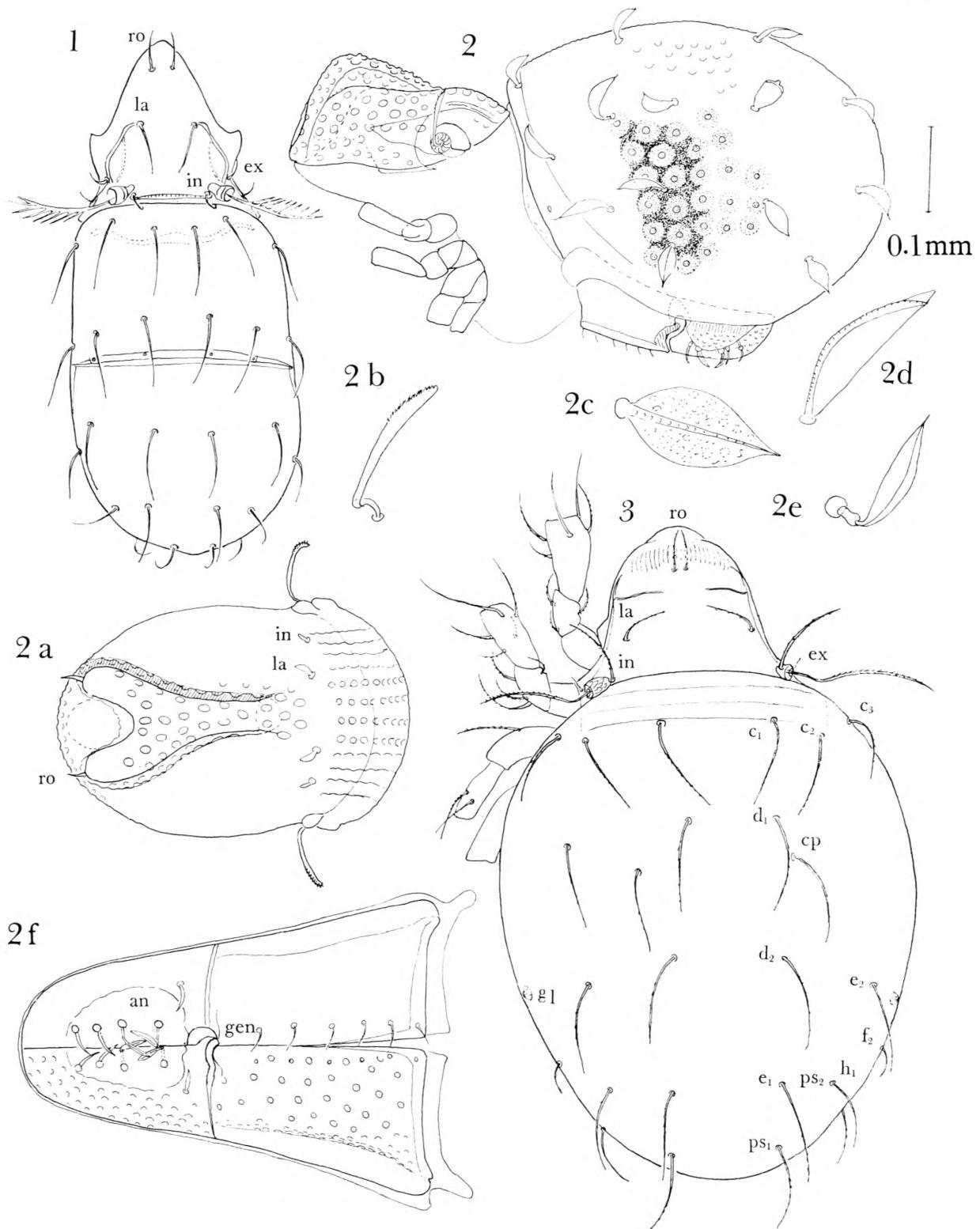
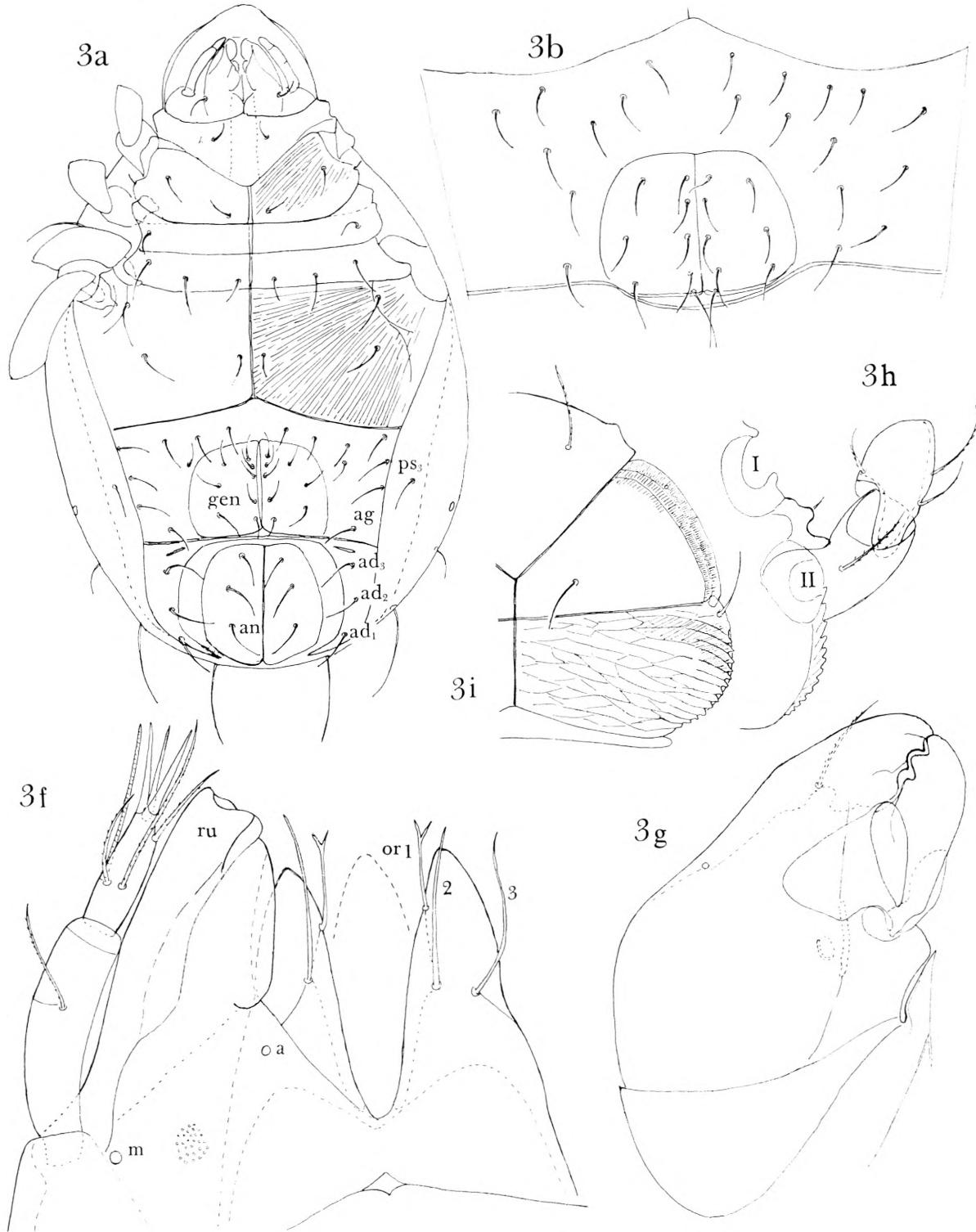


PLATE II



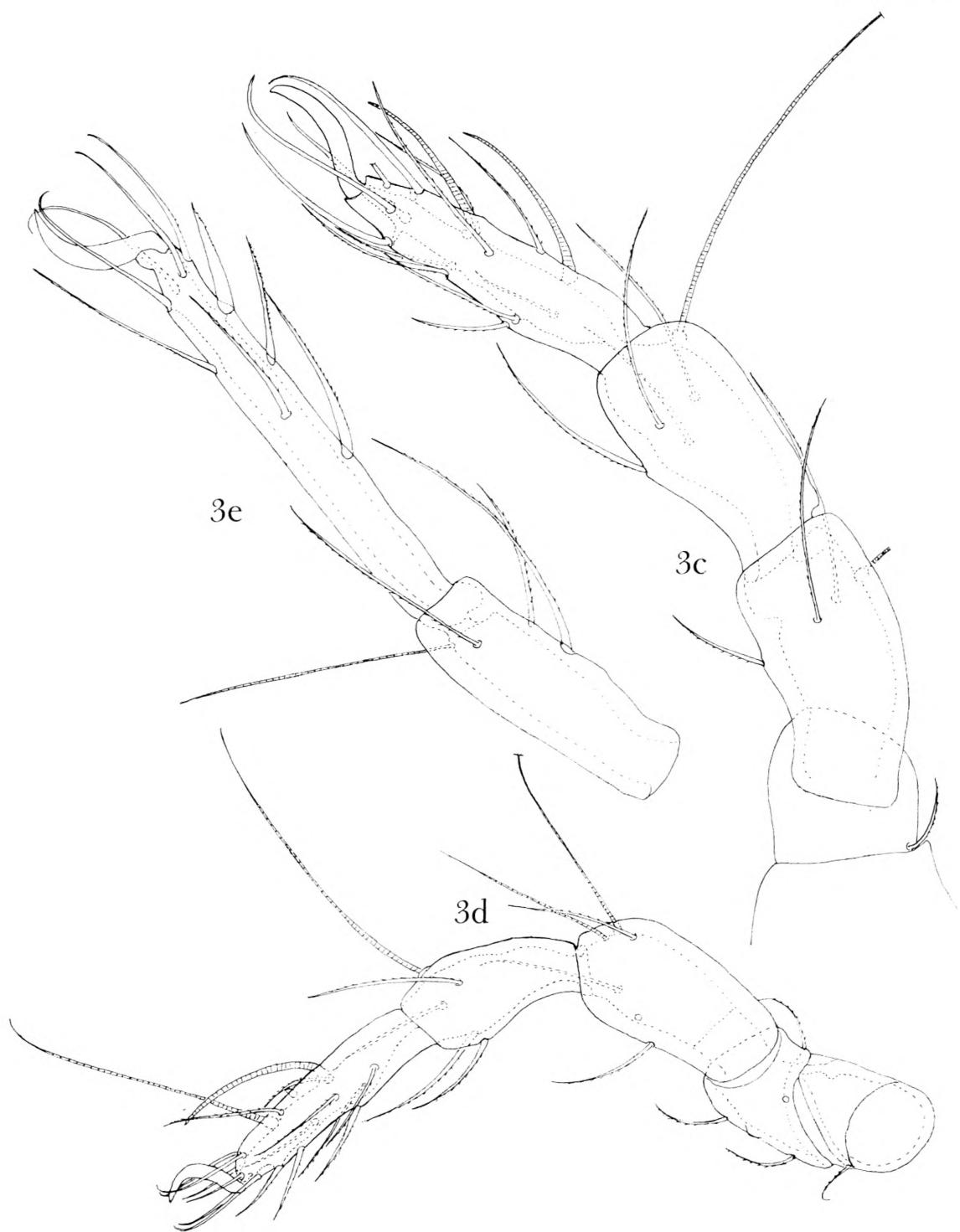
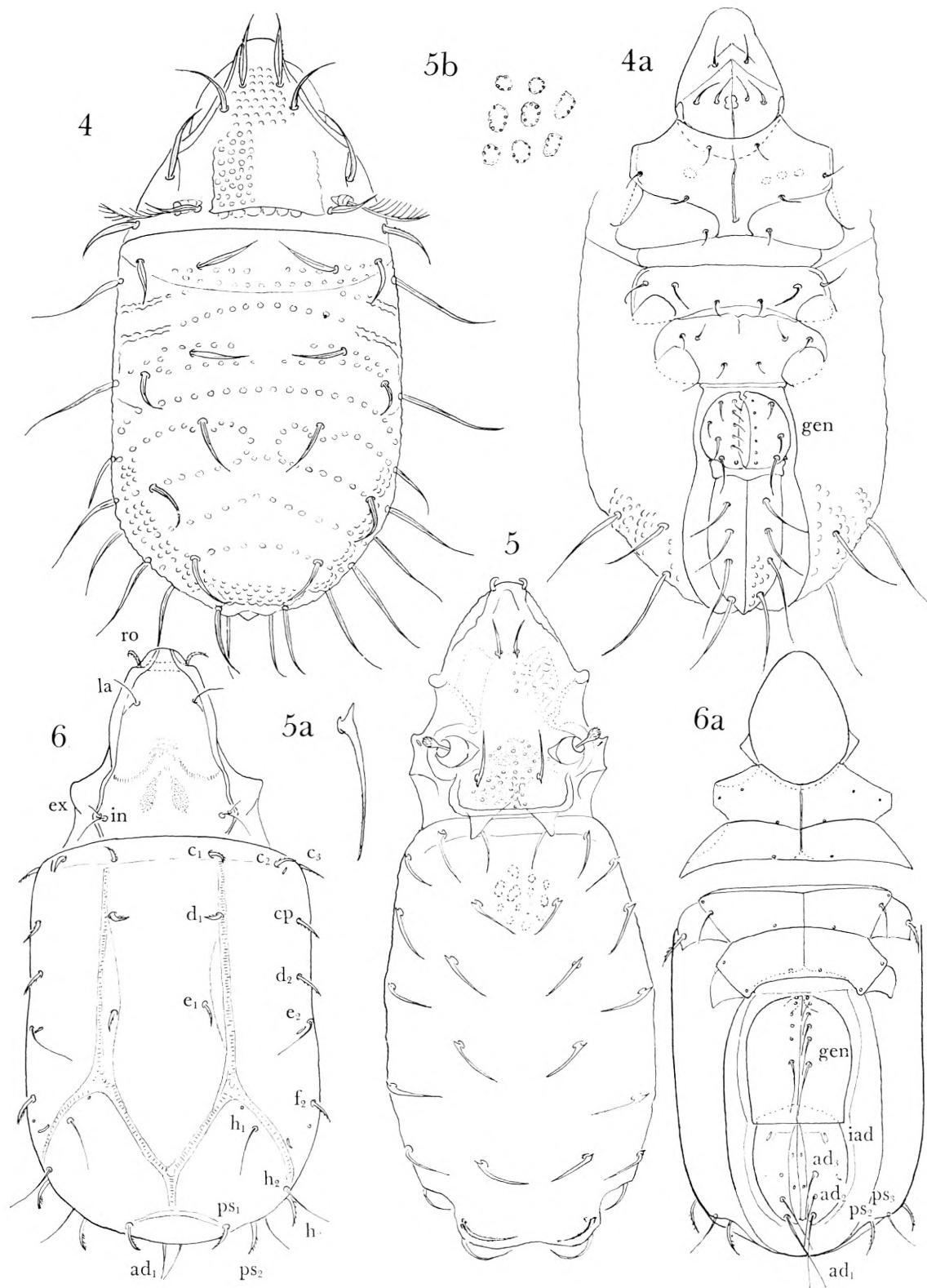


PLATE IV



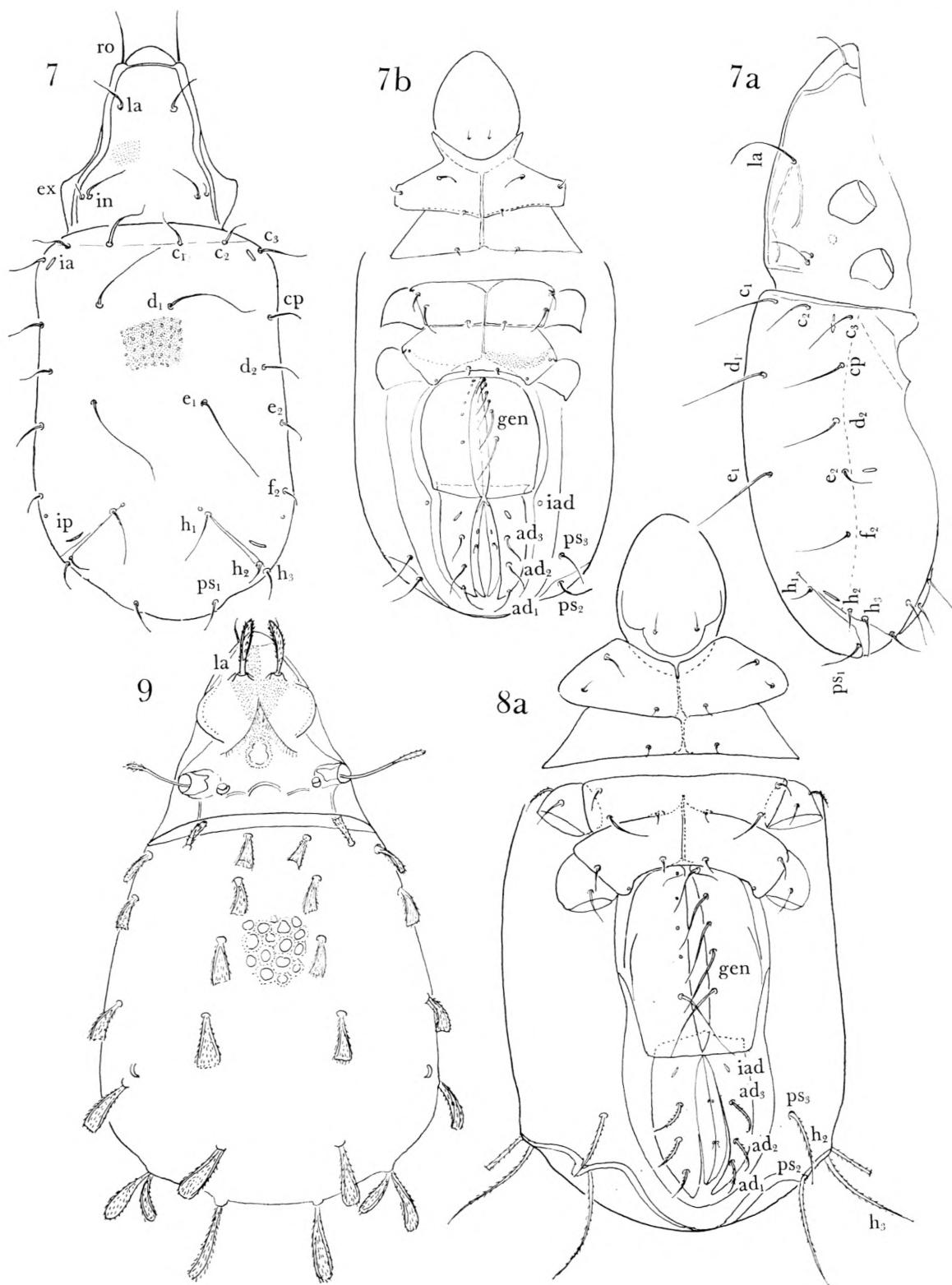
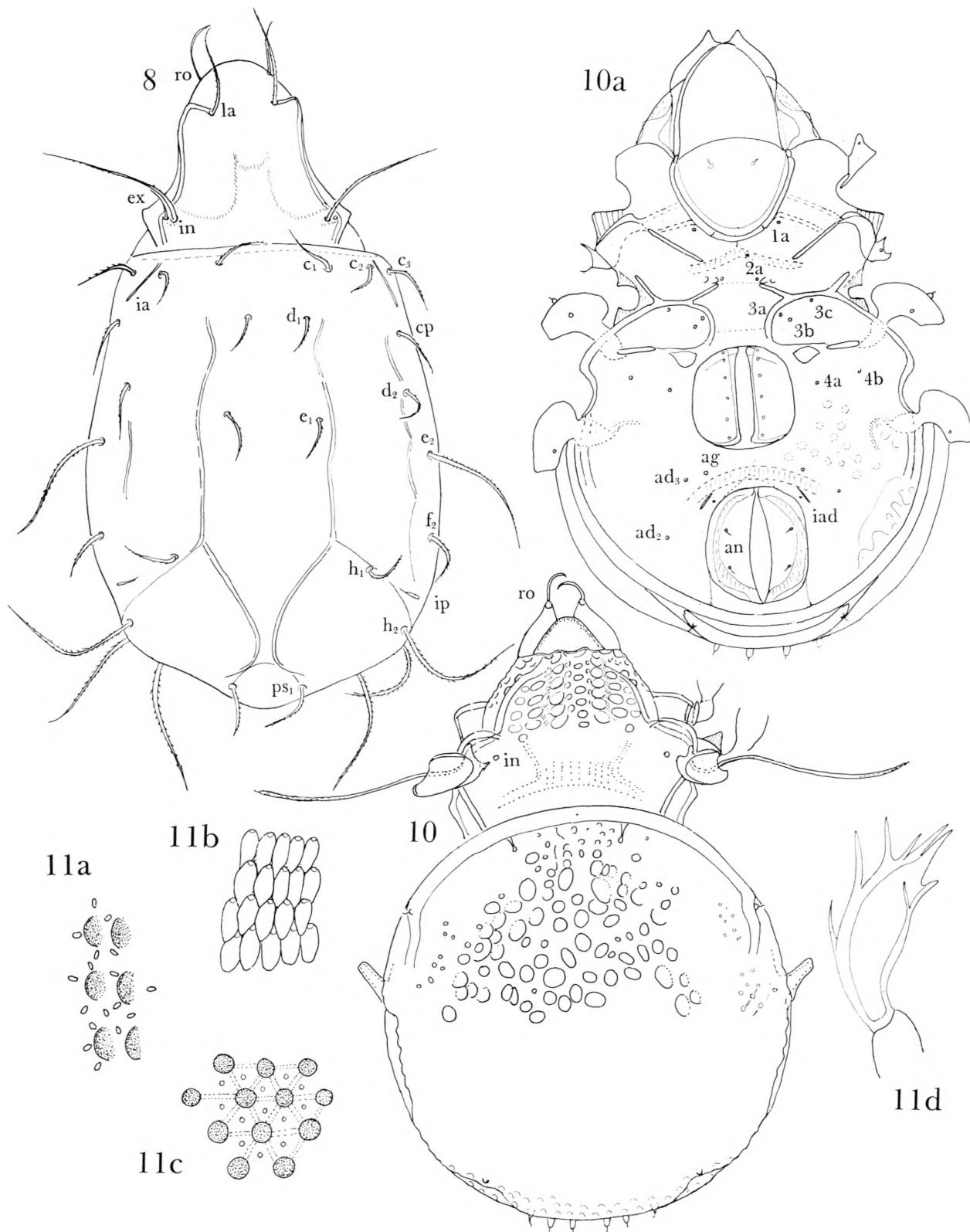


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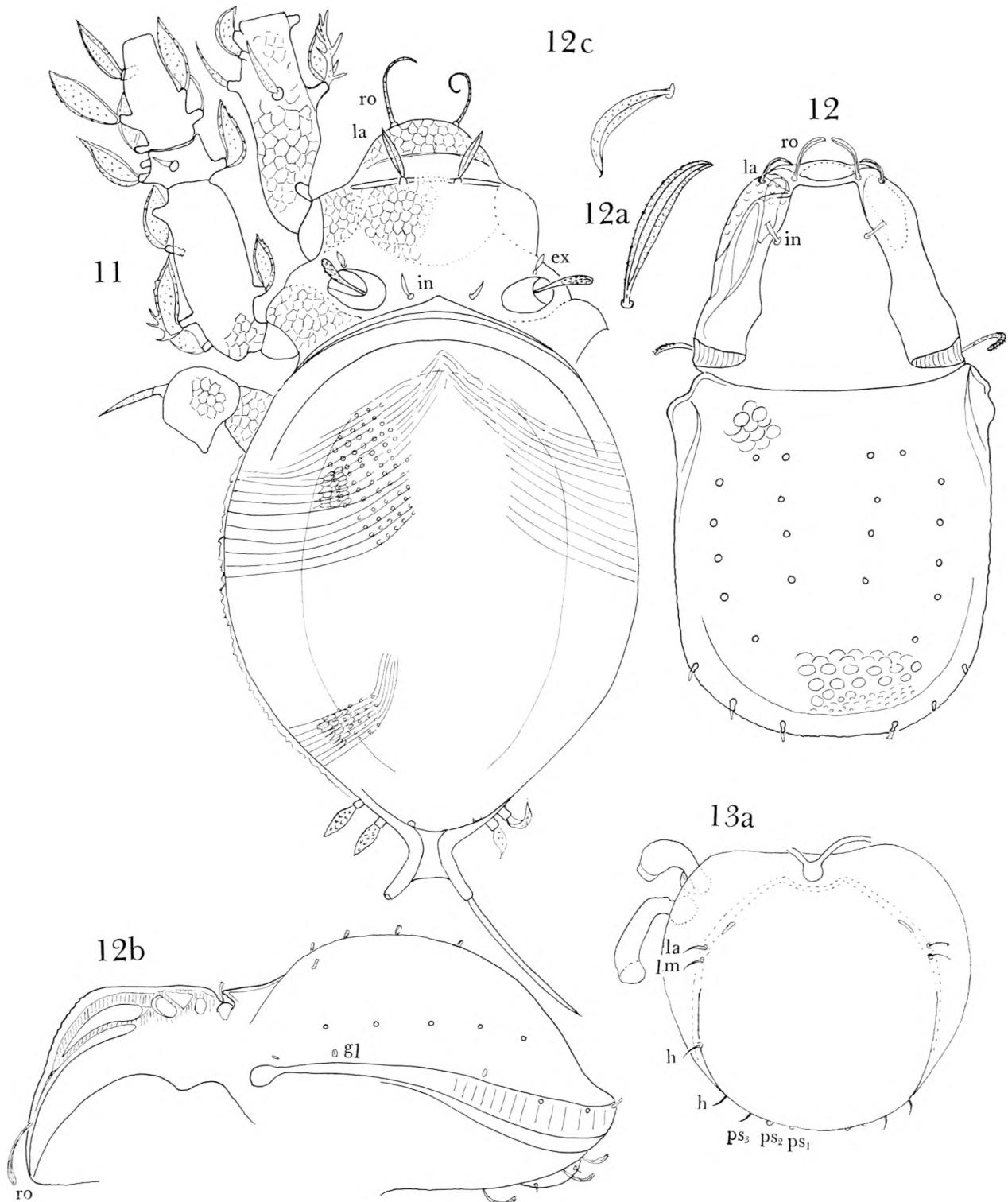
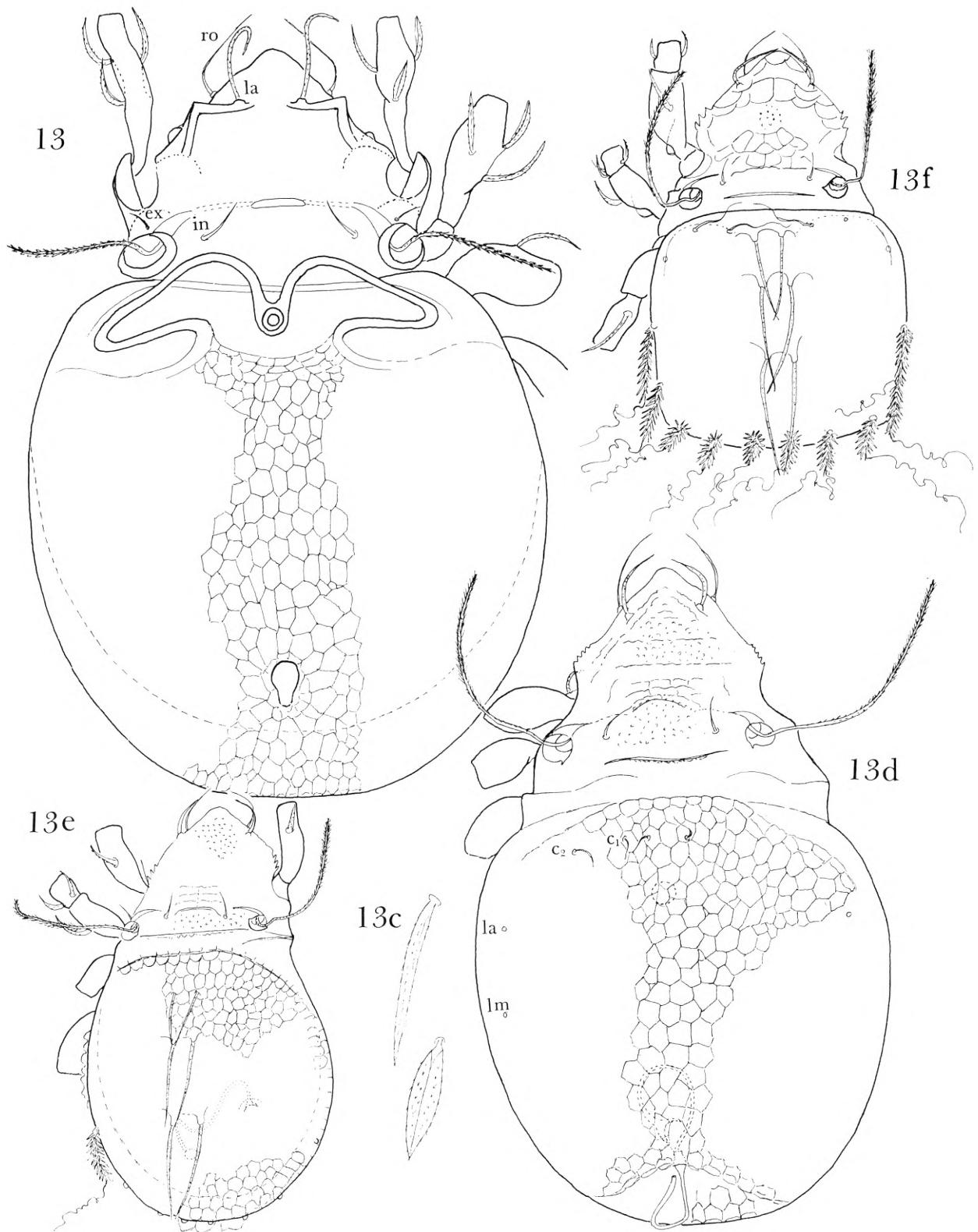


PLATE VIII



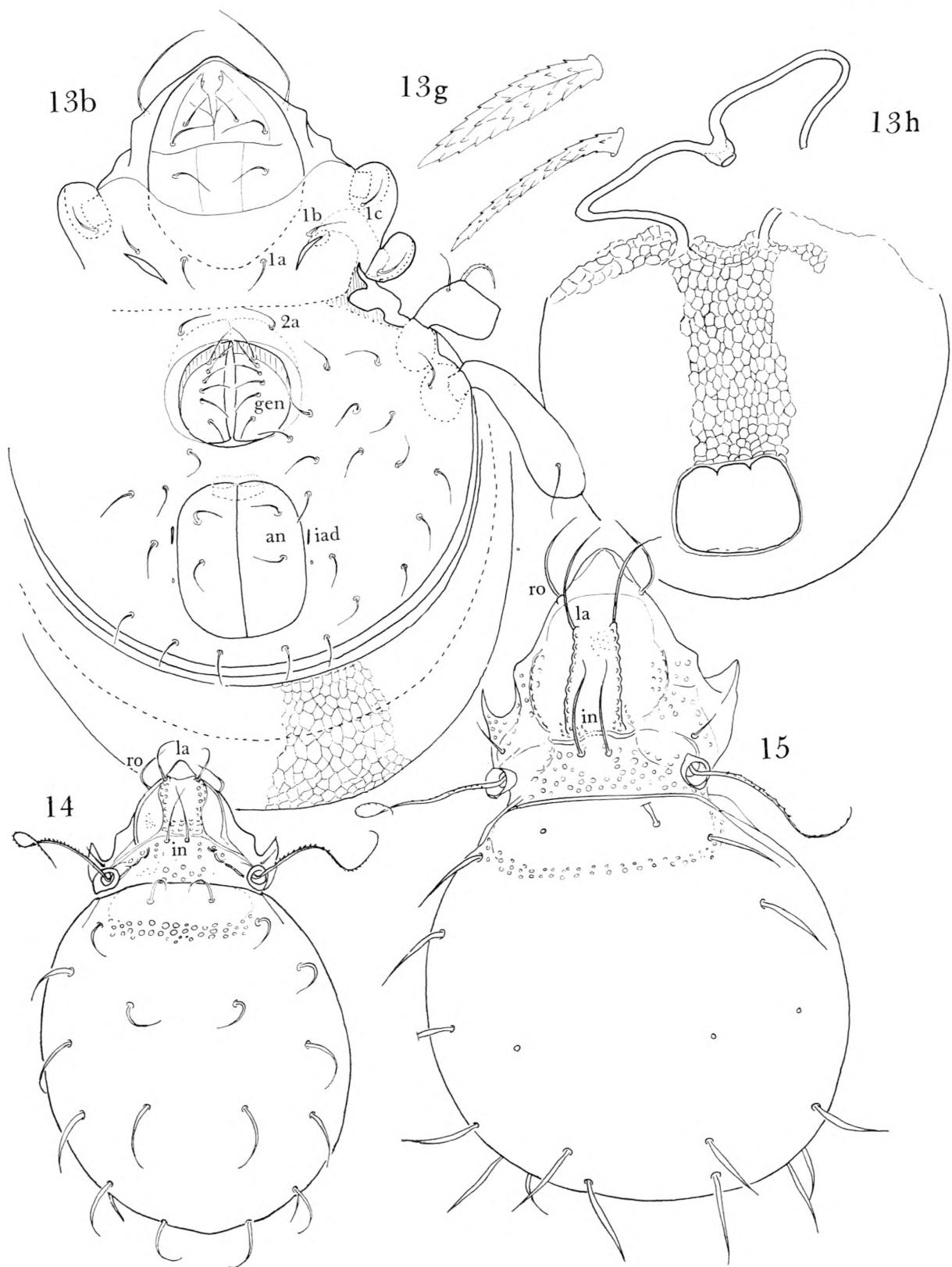
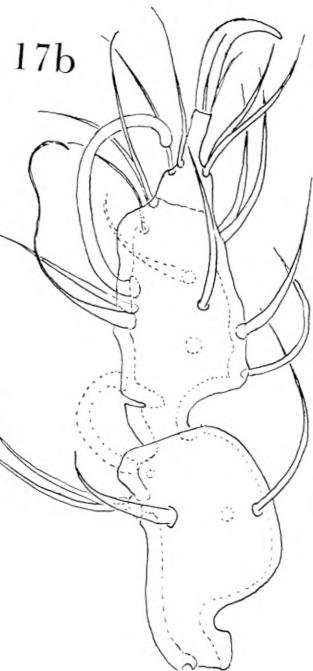
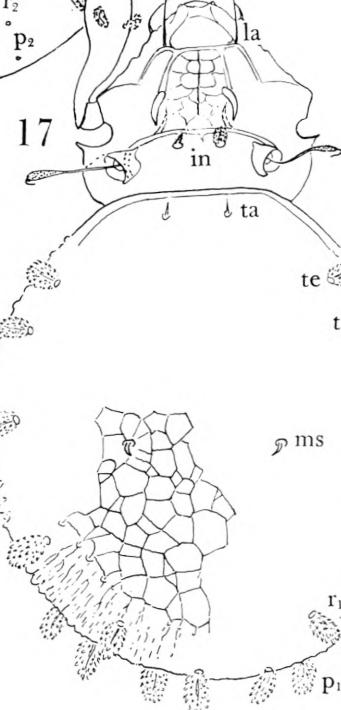
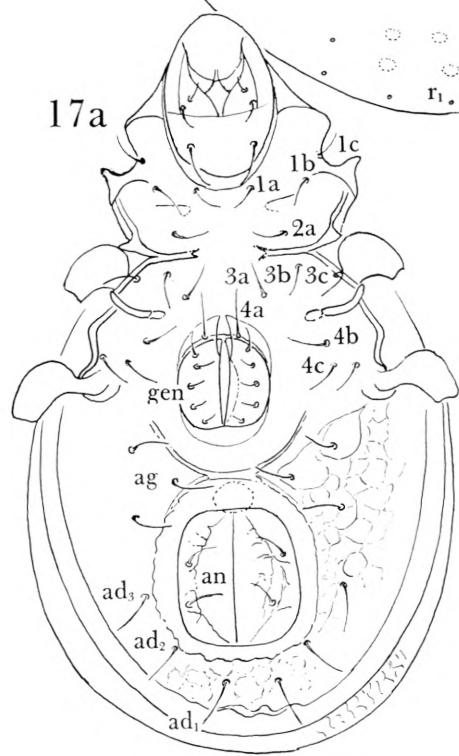
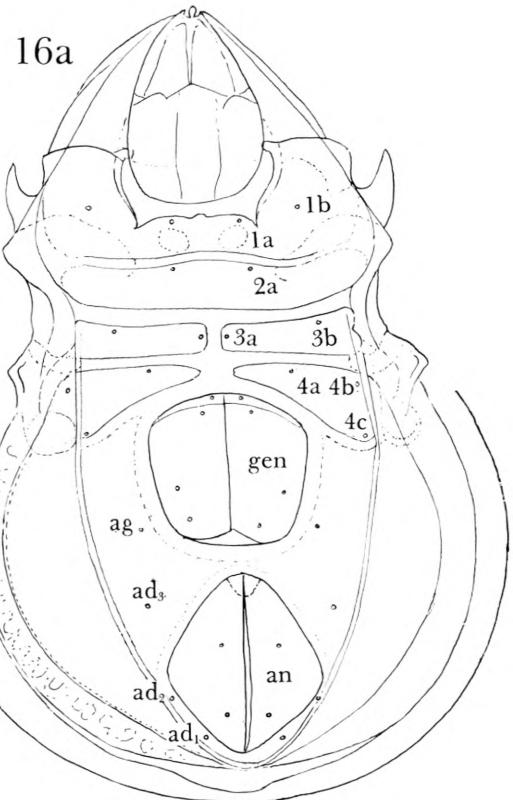
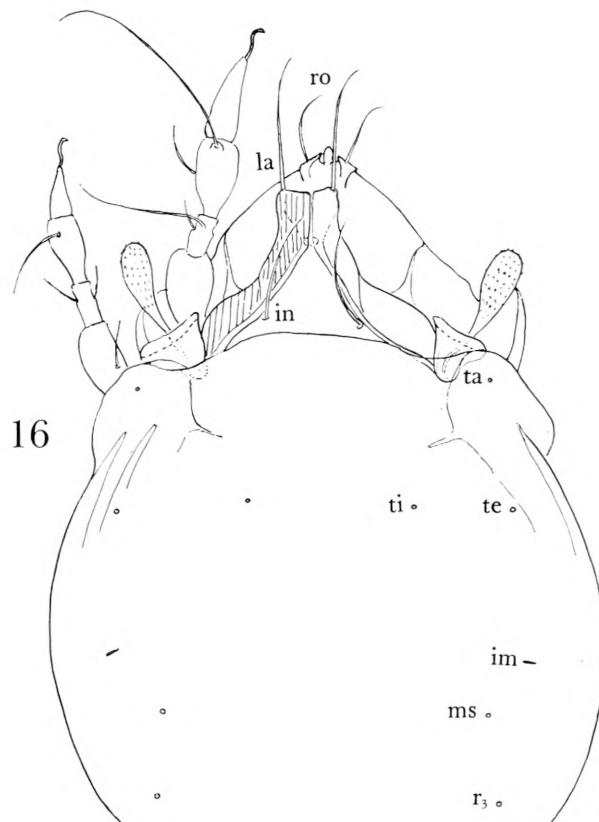


PLATE X



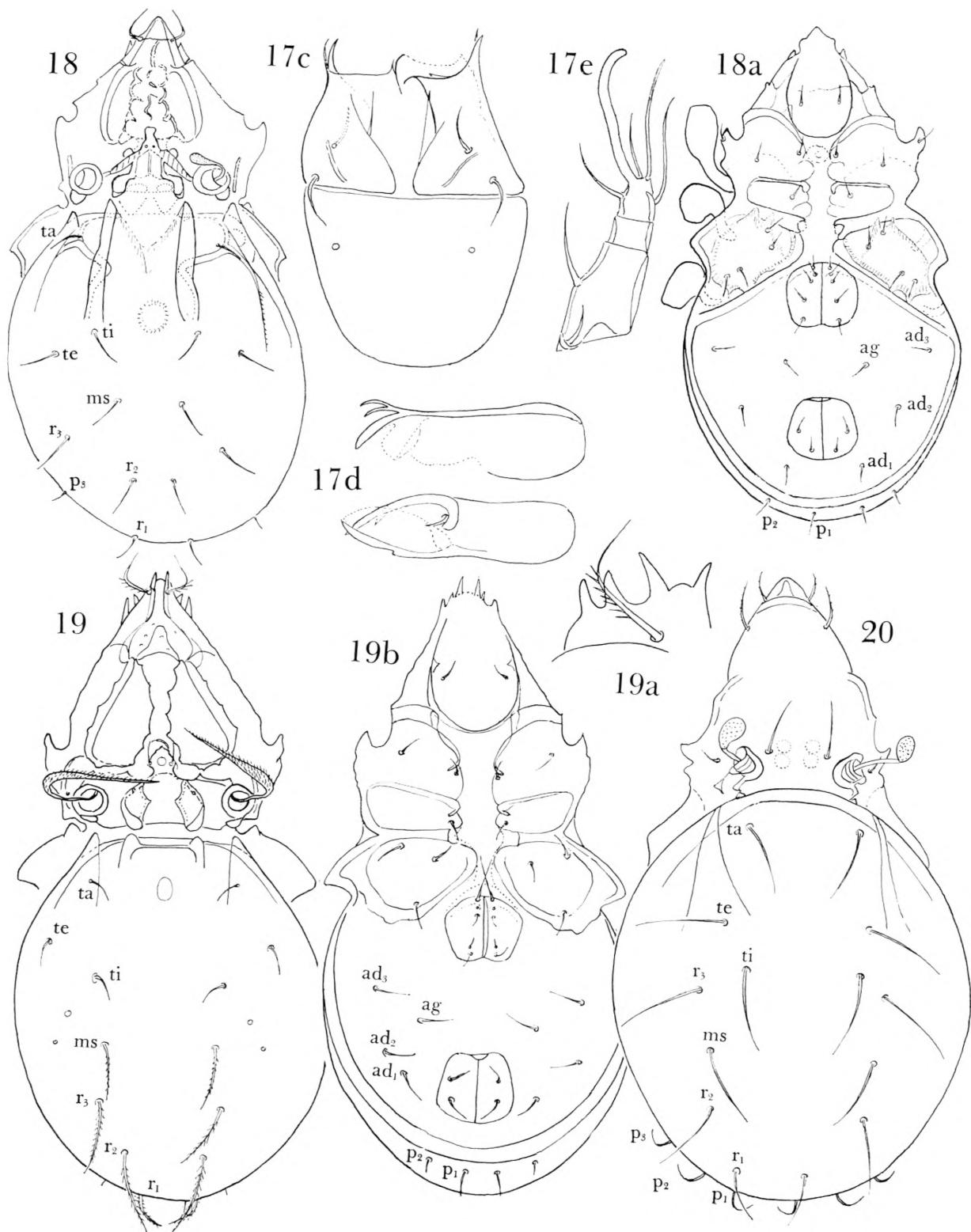
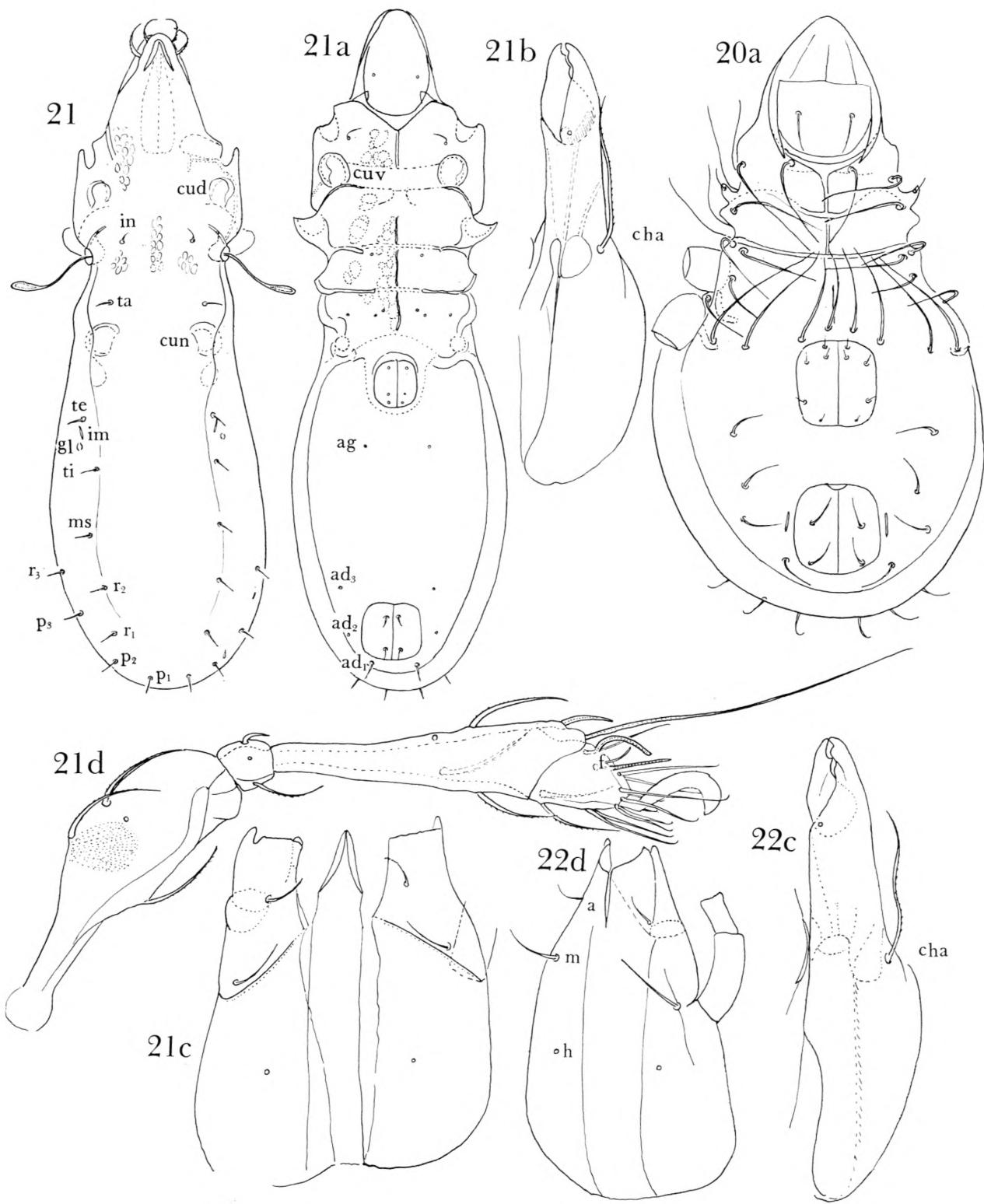


PLATE XII



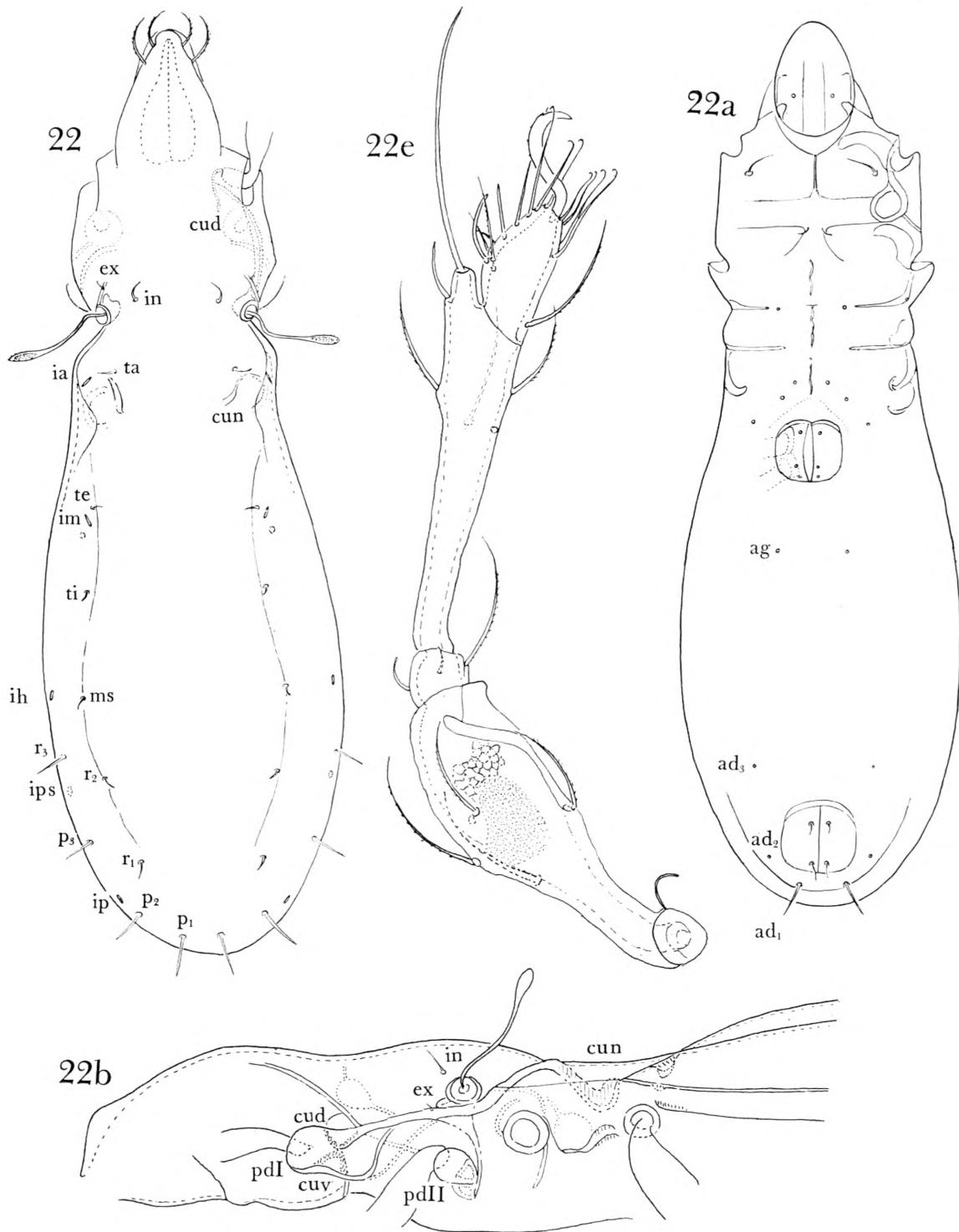
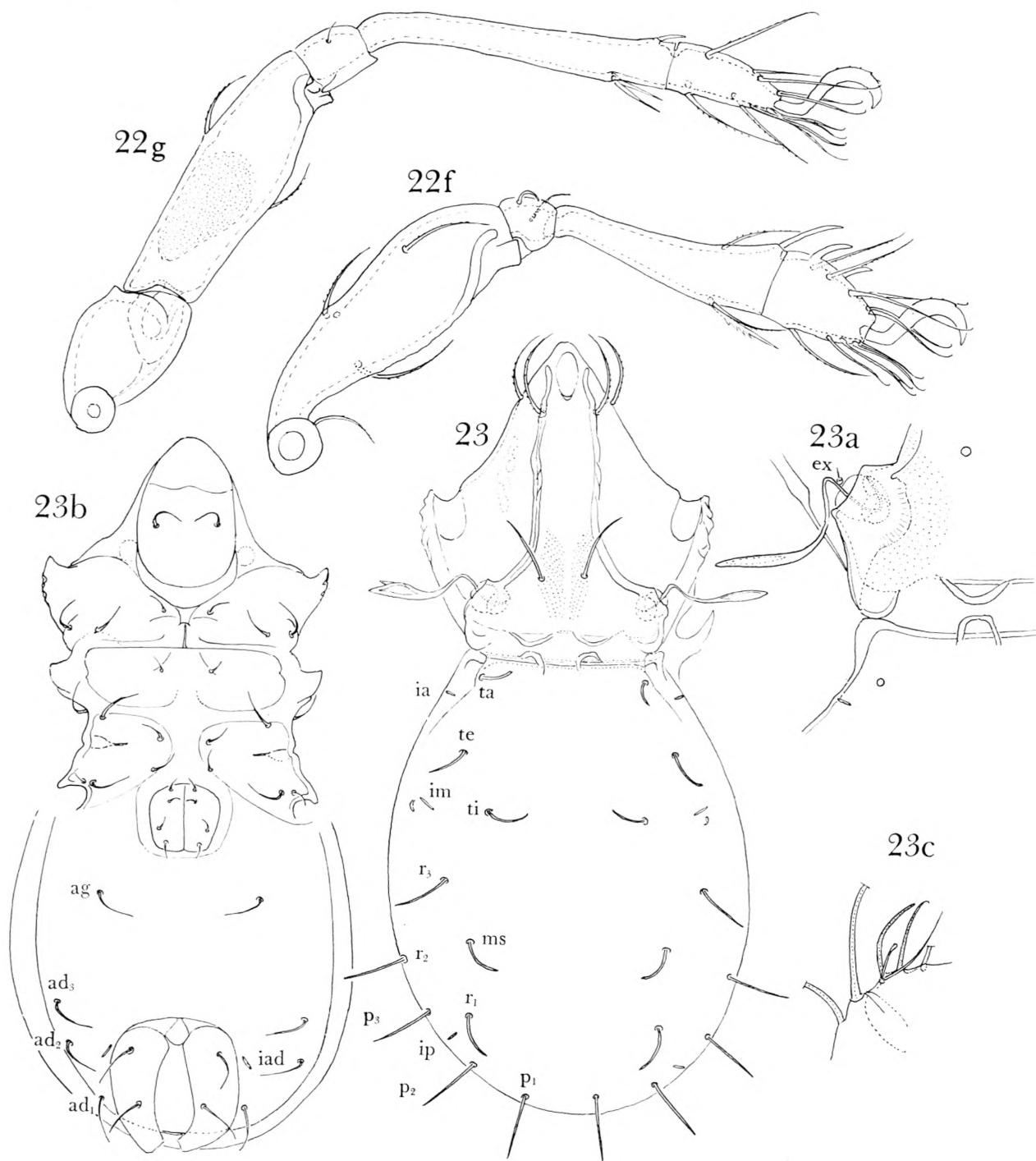


PLATE XIV



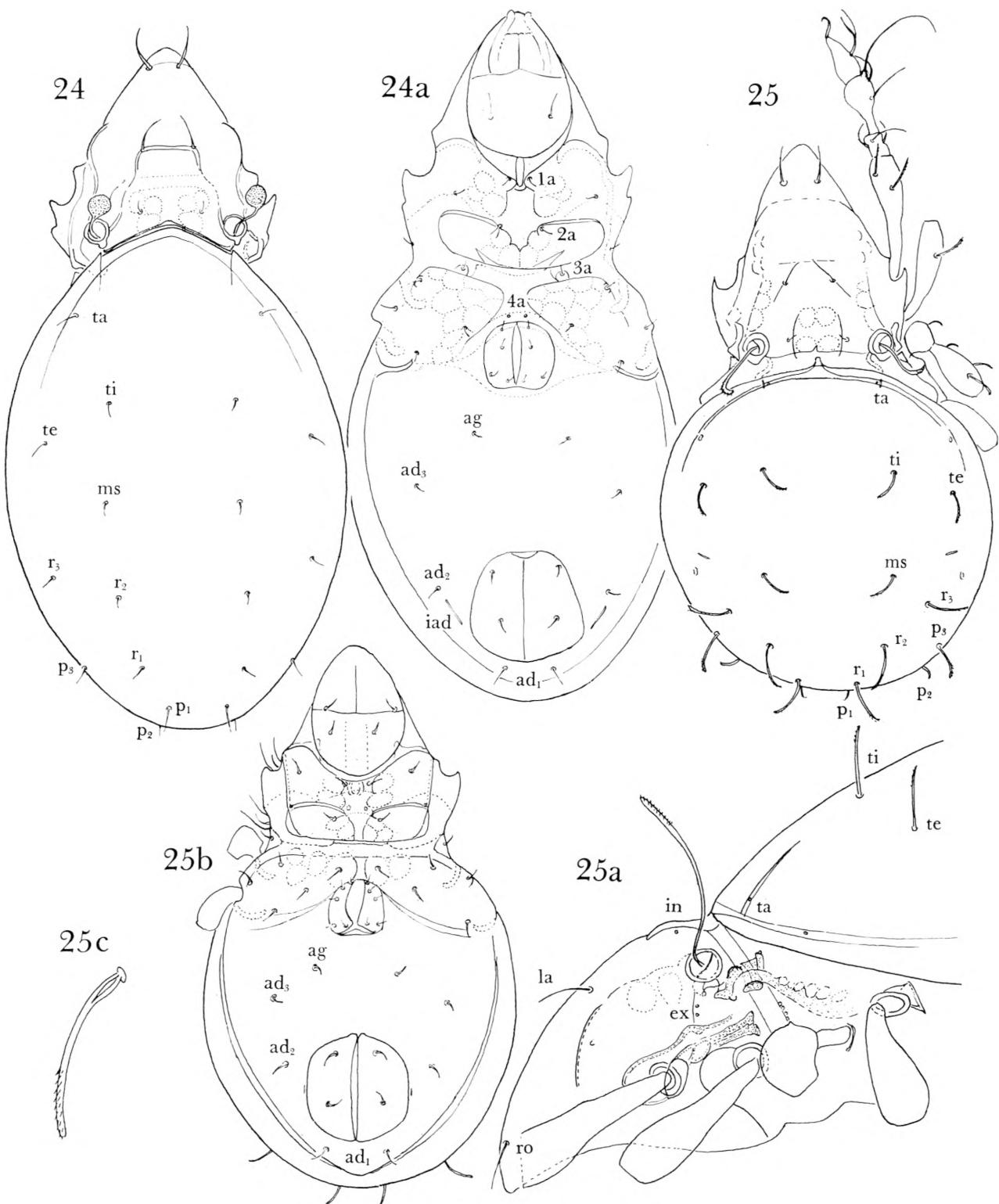
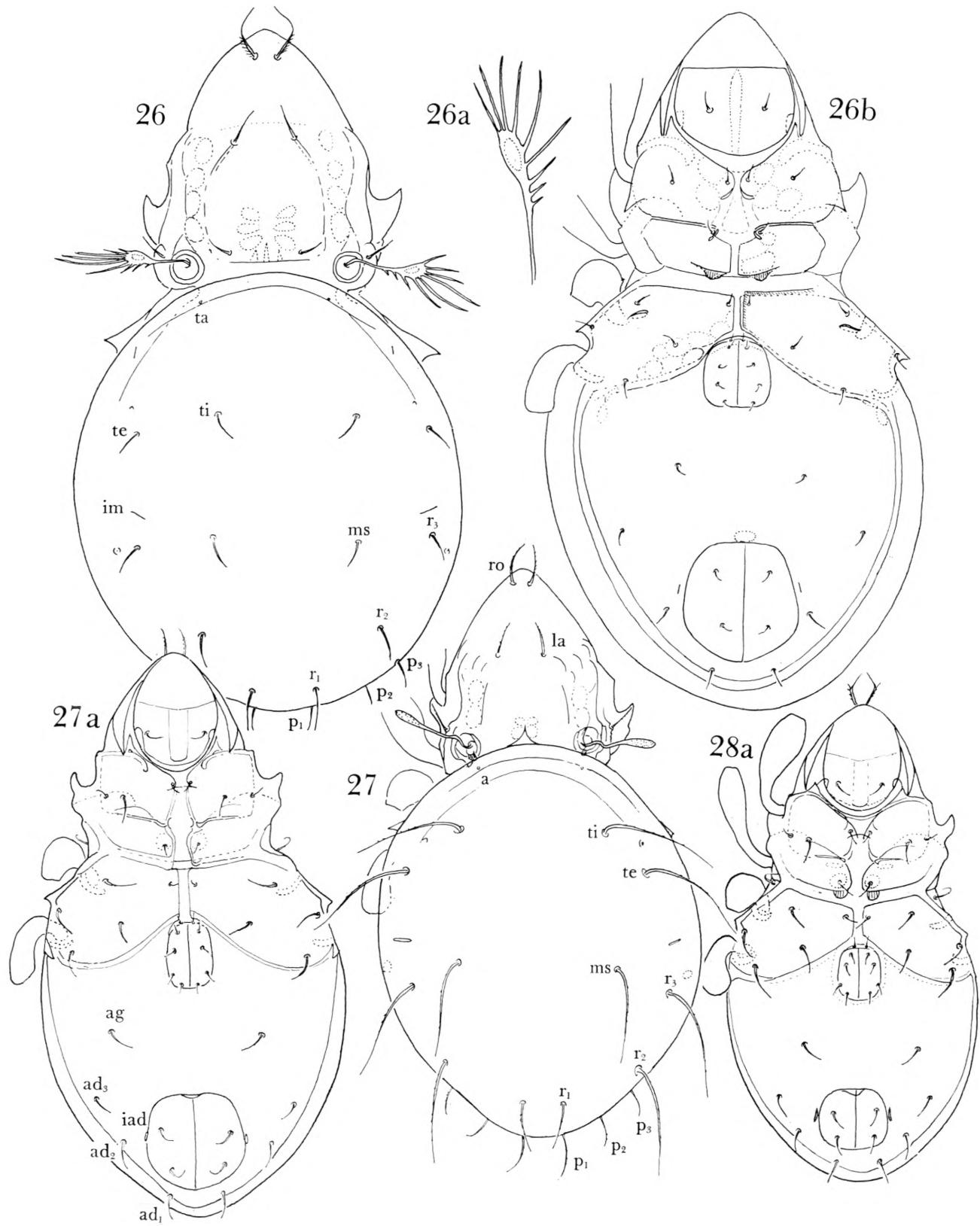


PLATE XVI



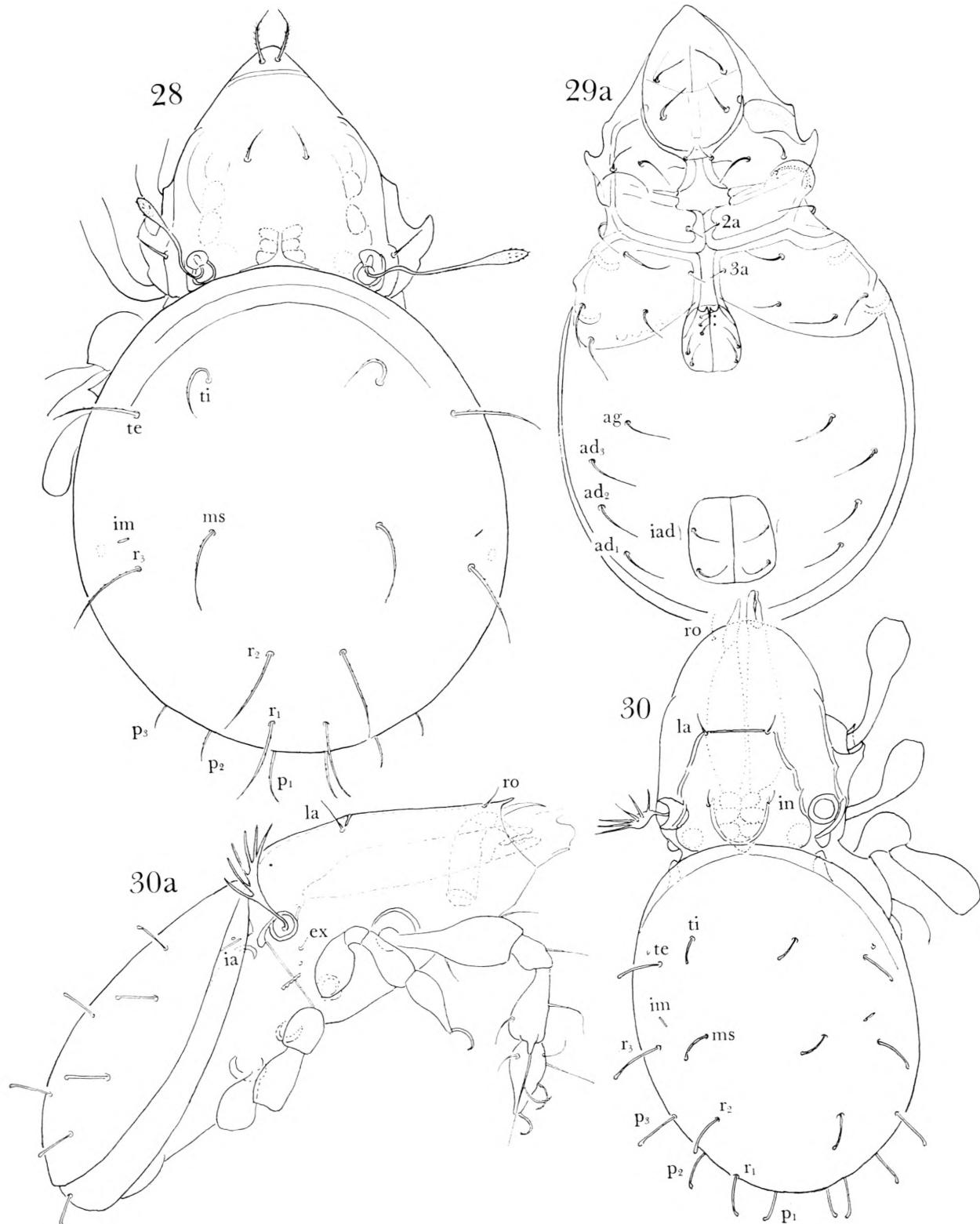
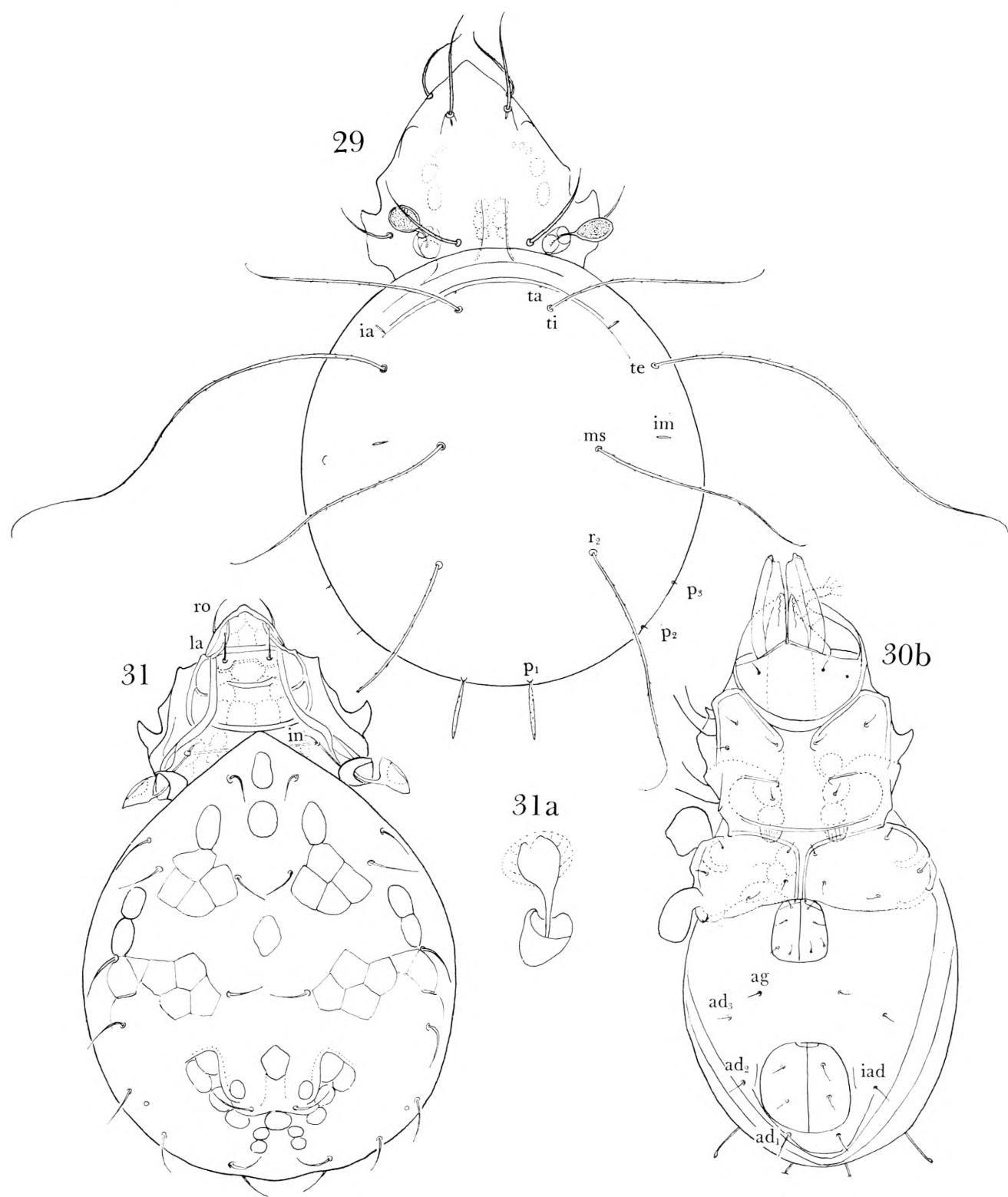
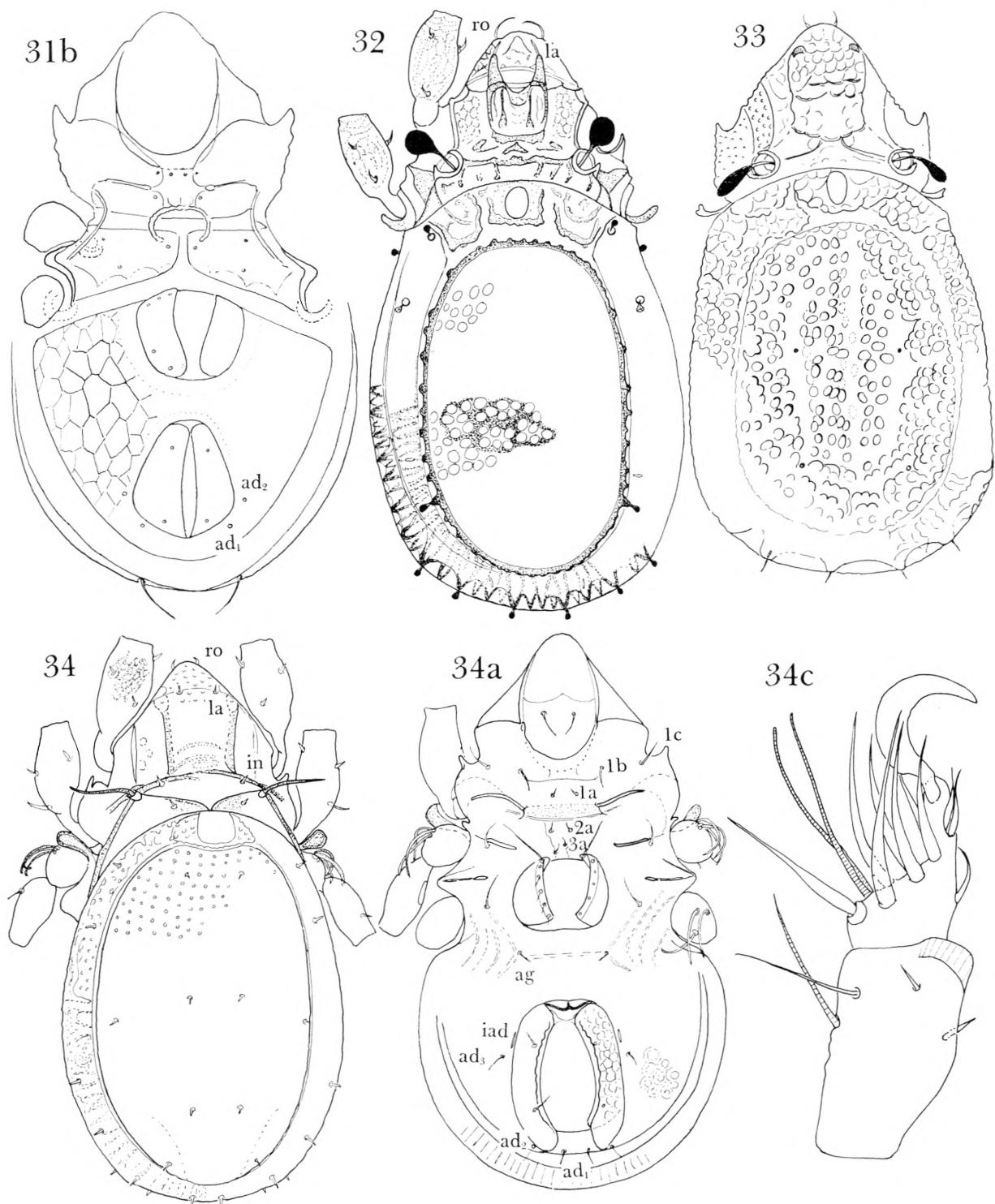
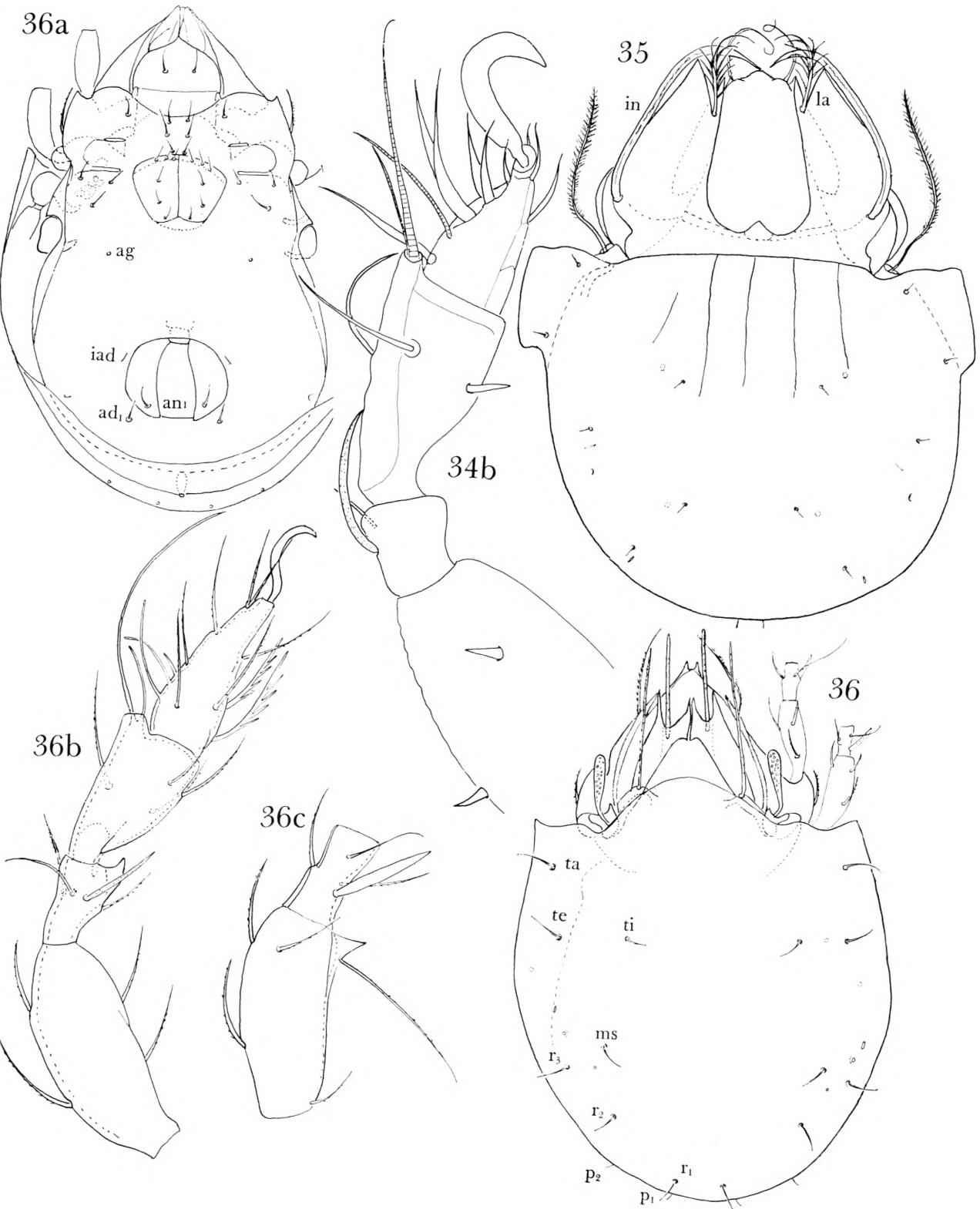


PLATE XVIII







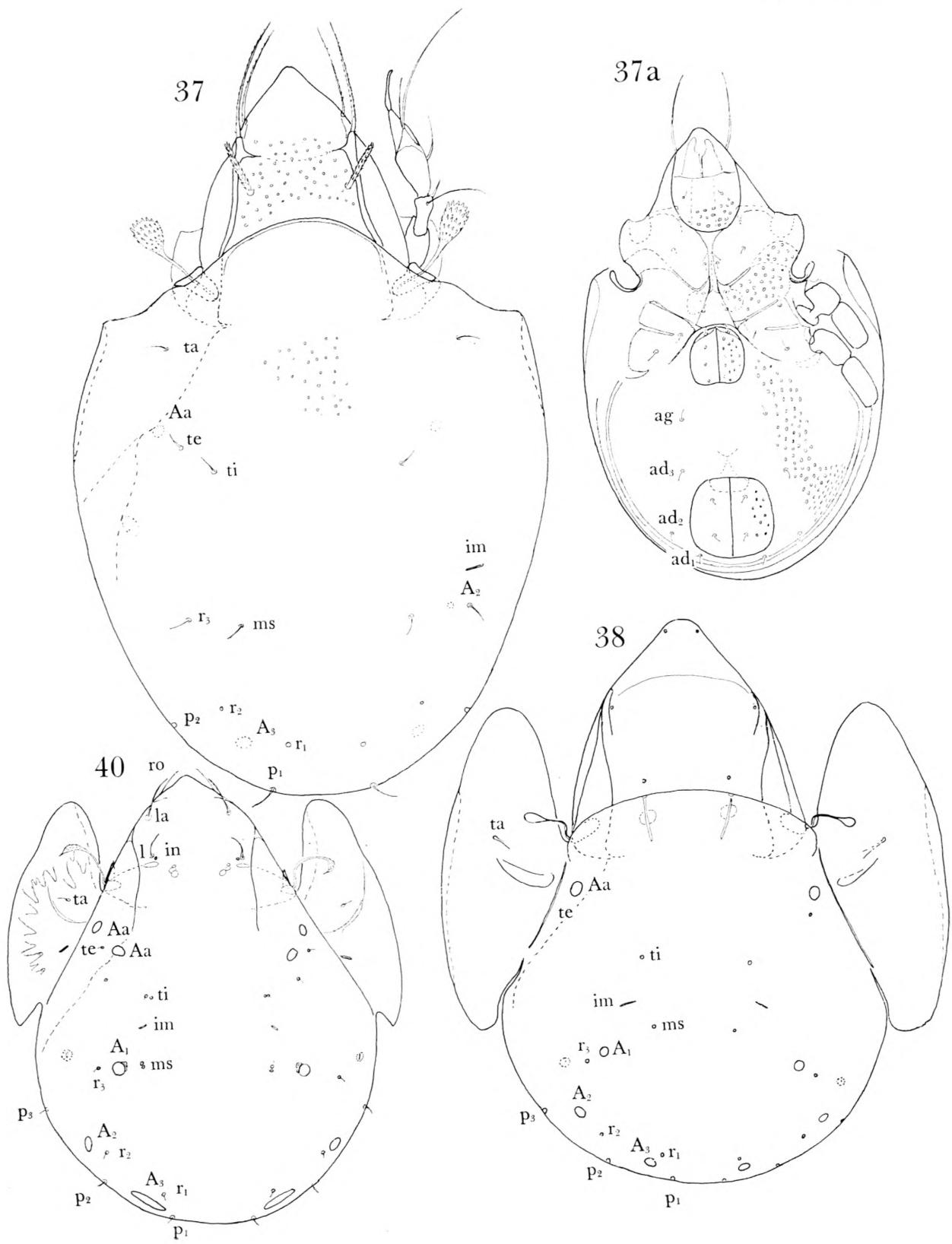
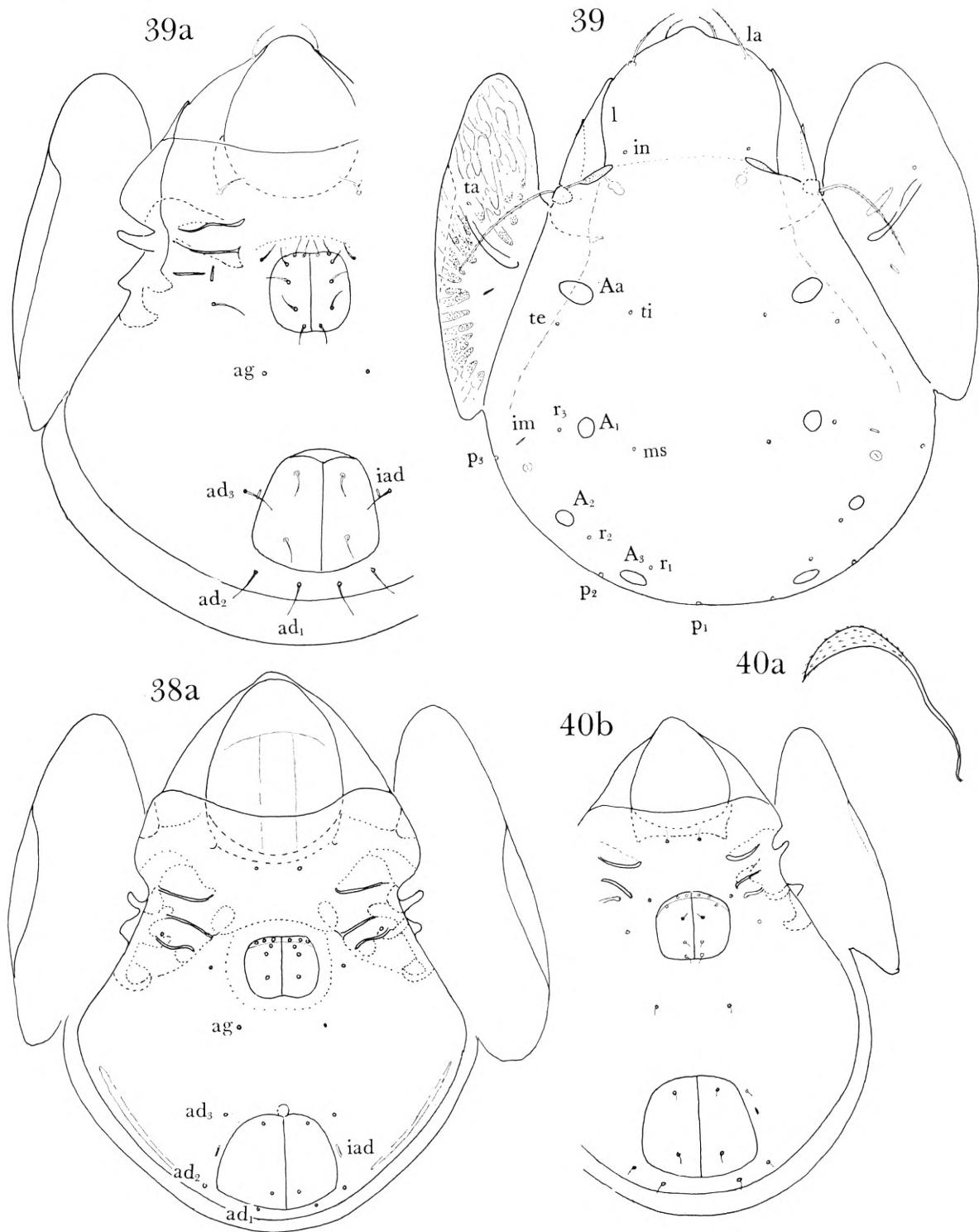


PLATE XXII



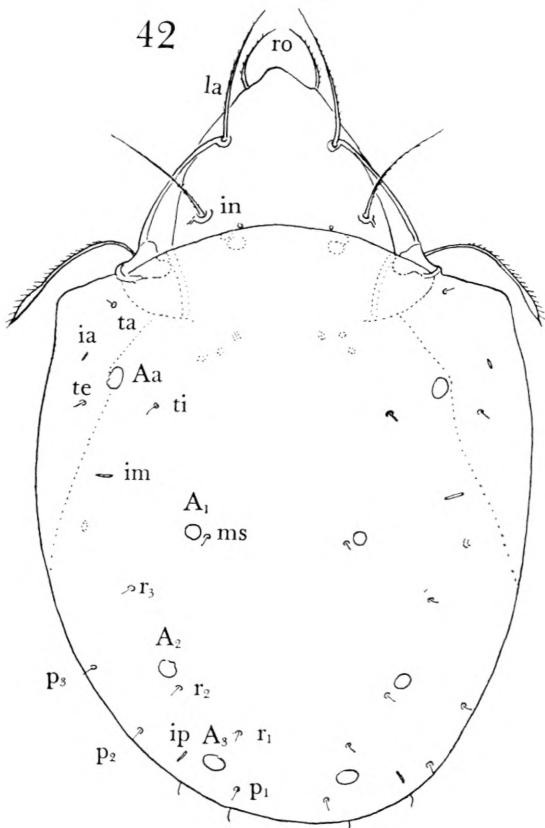
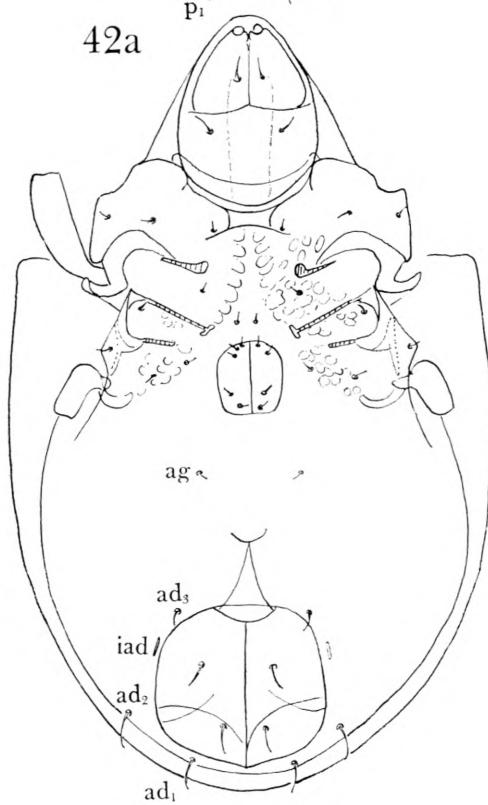
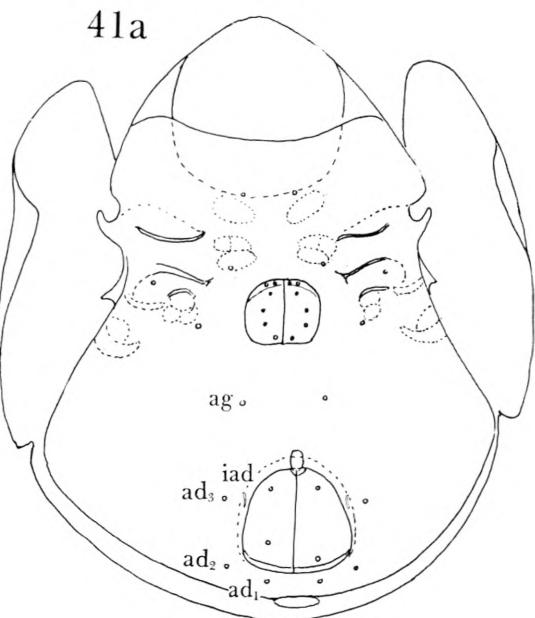
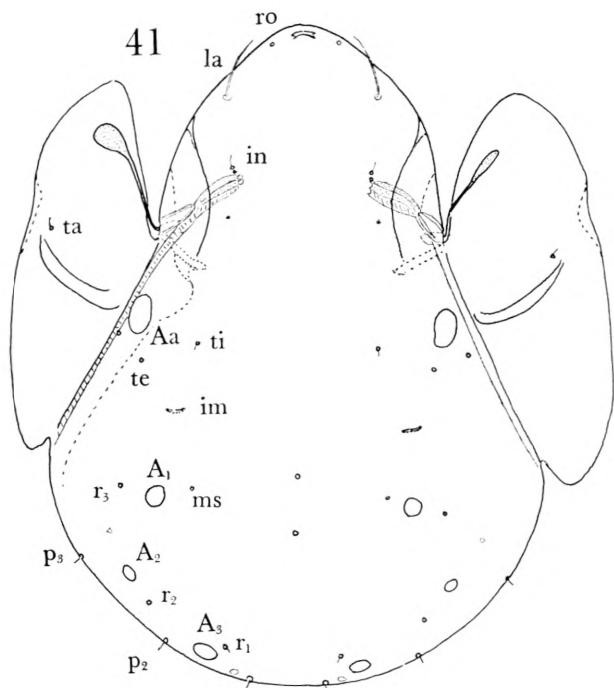
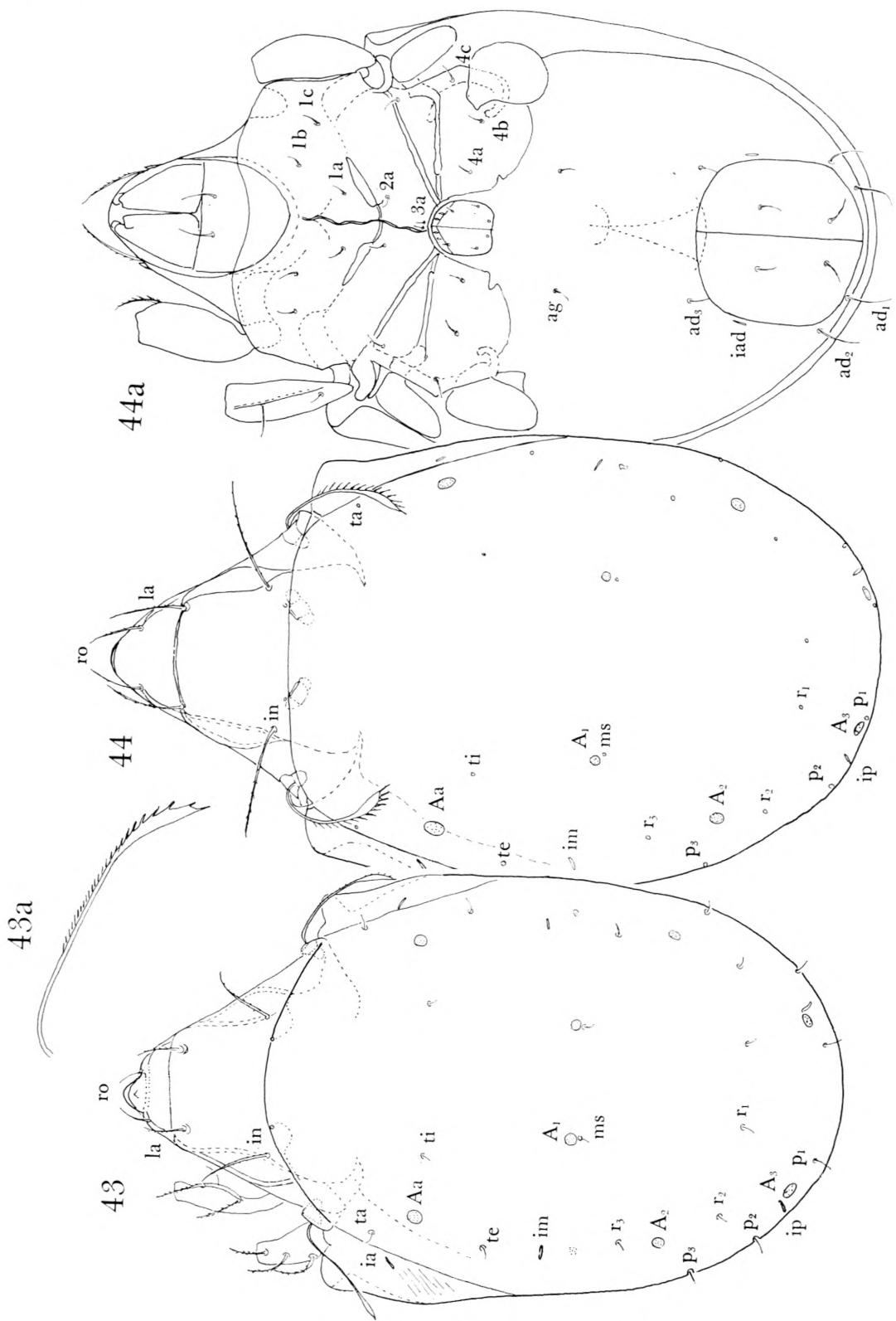


PLATE XXIV



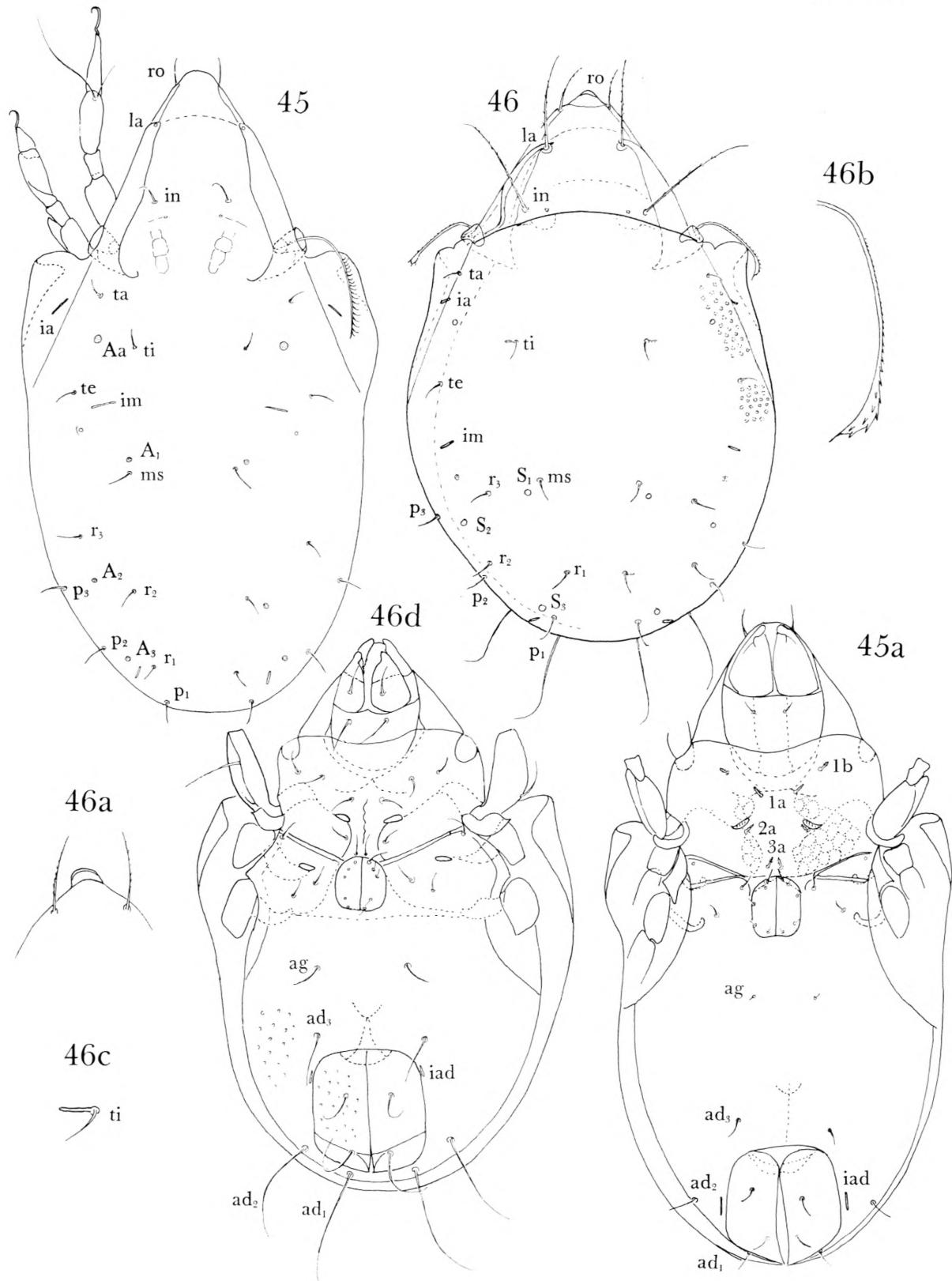
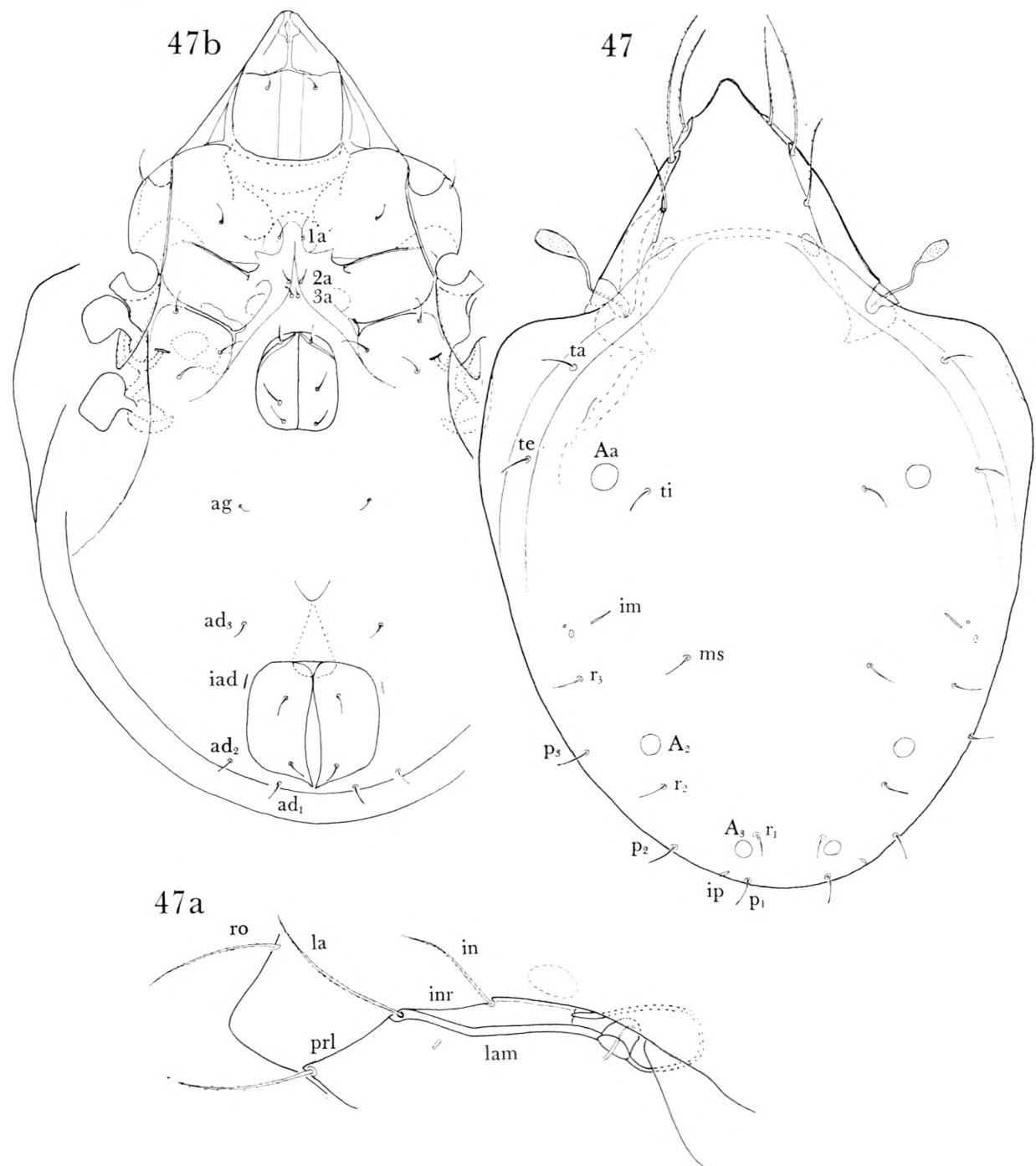


PLATE XXVI



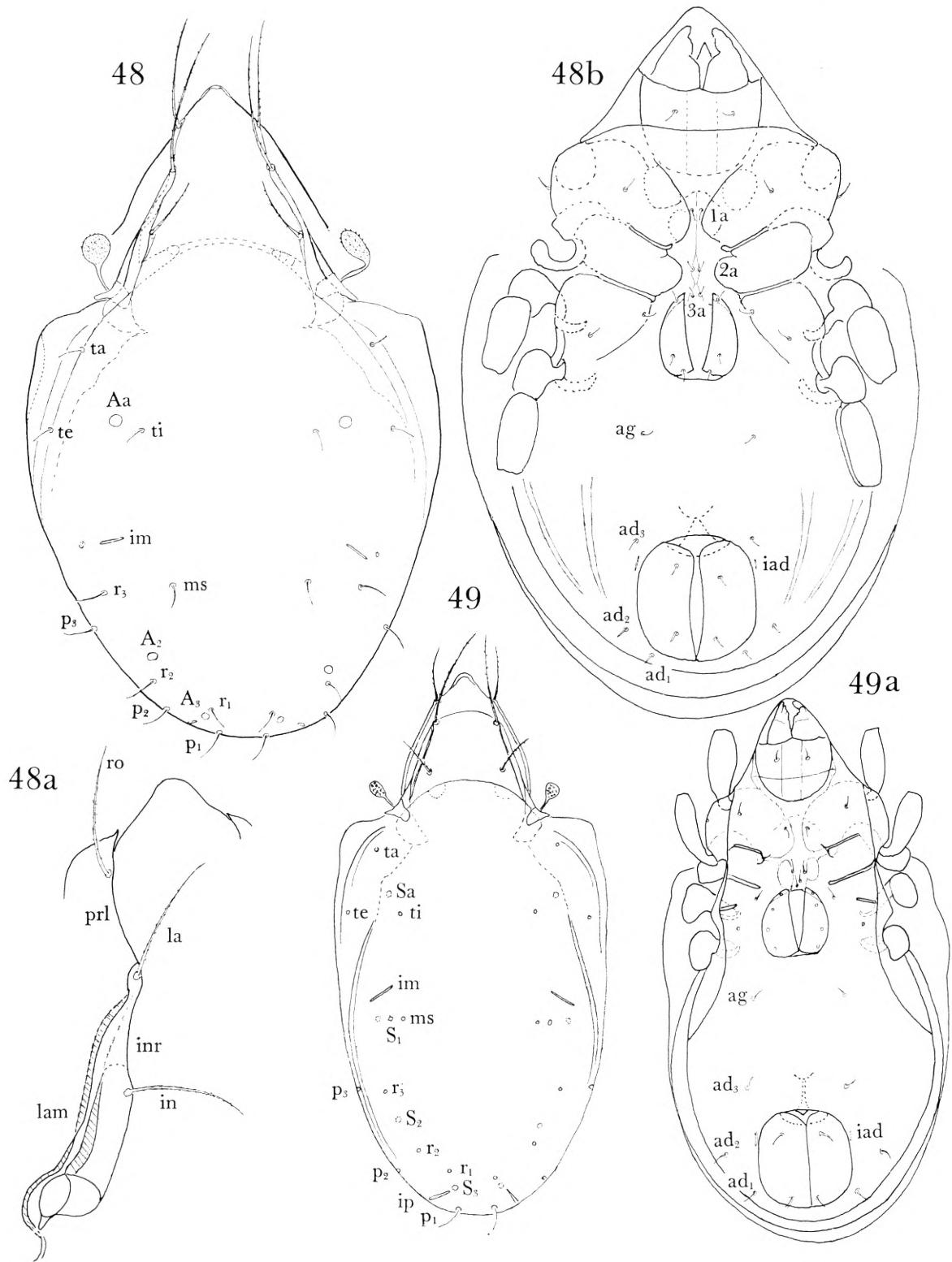
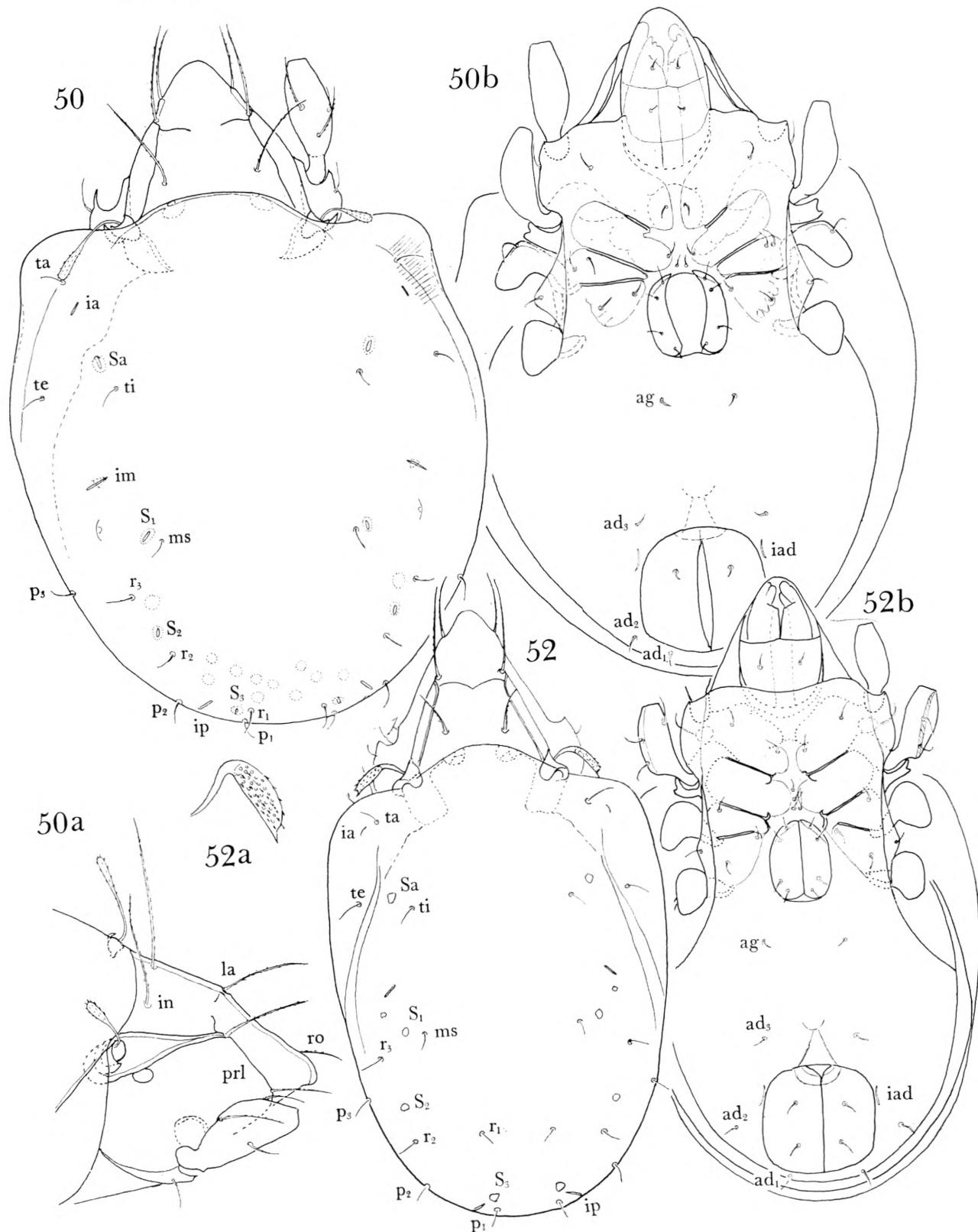
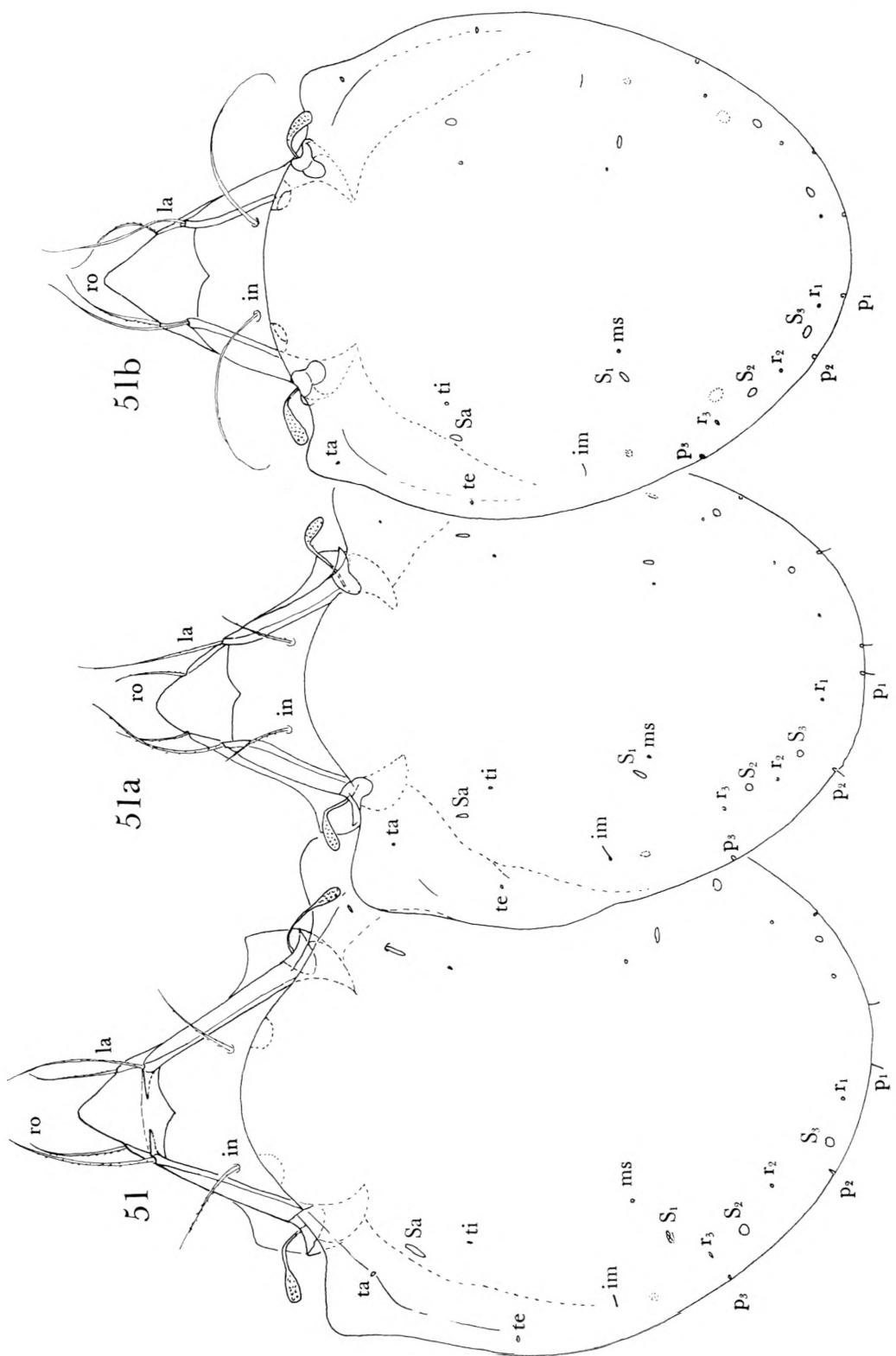
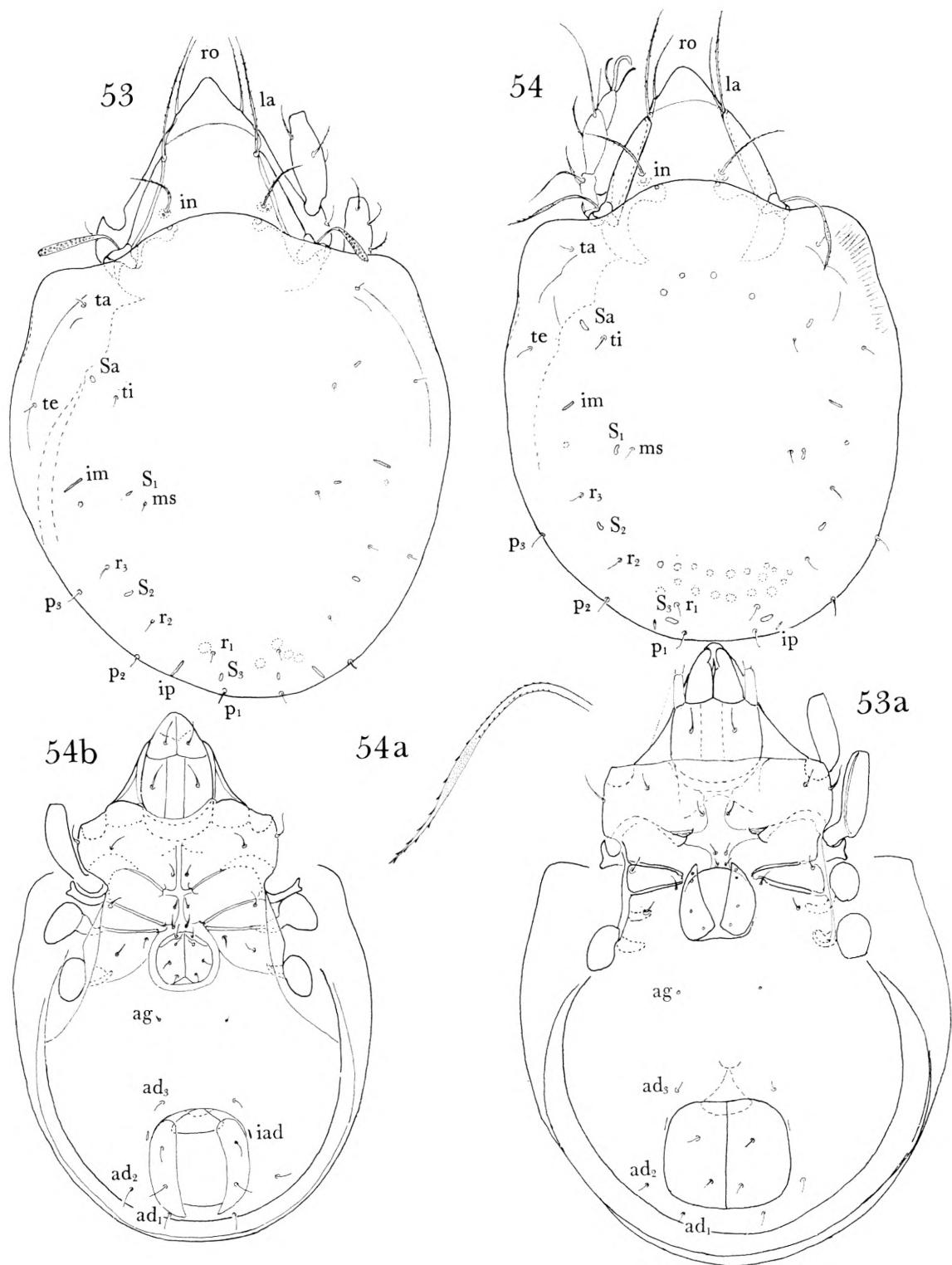


PLATE XXVIII







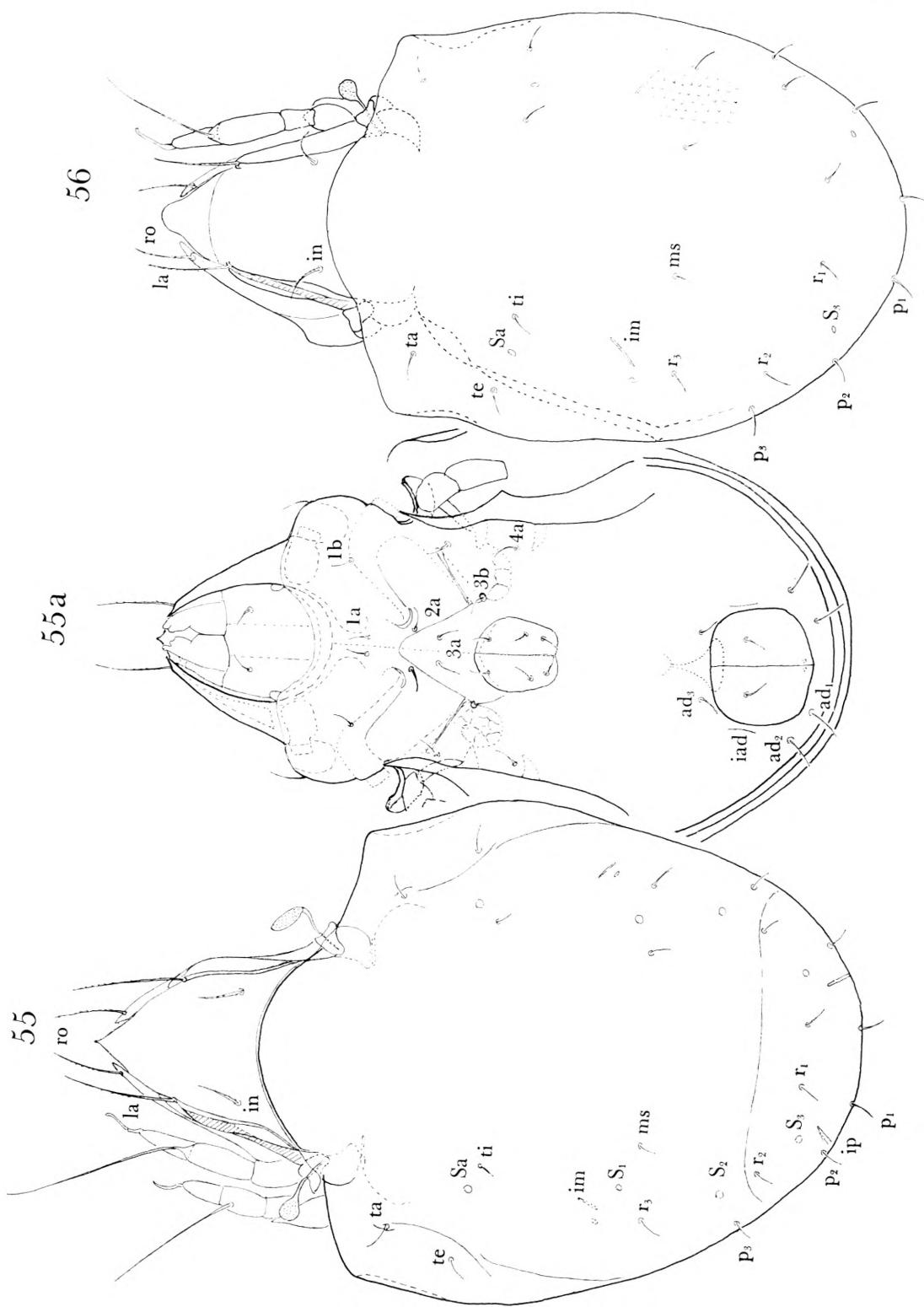
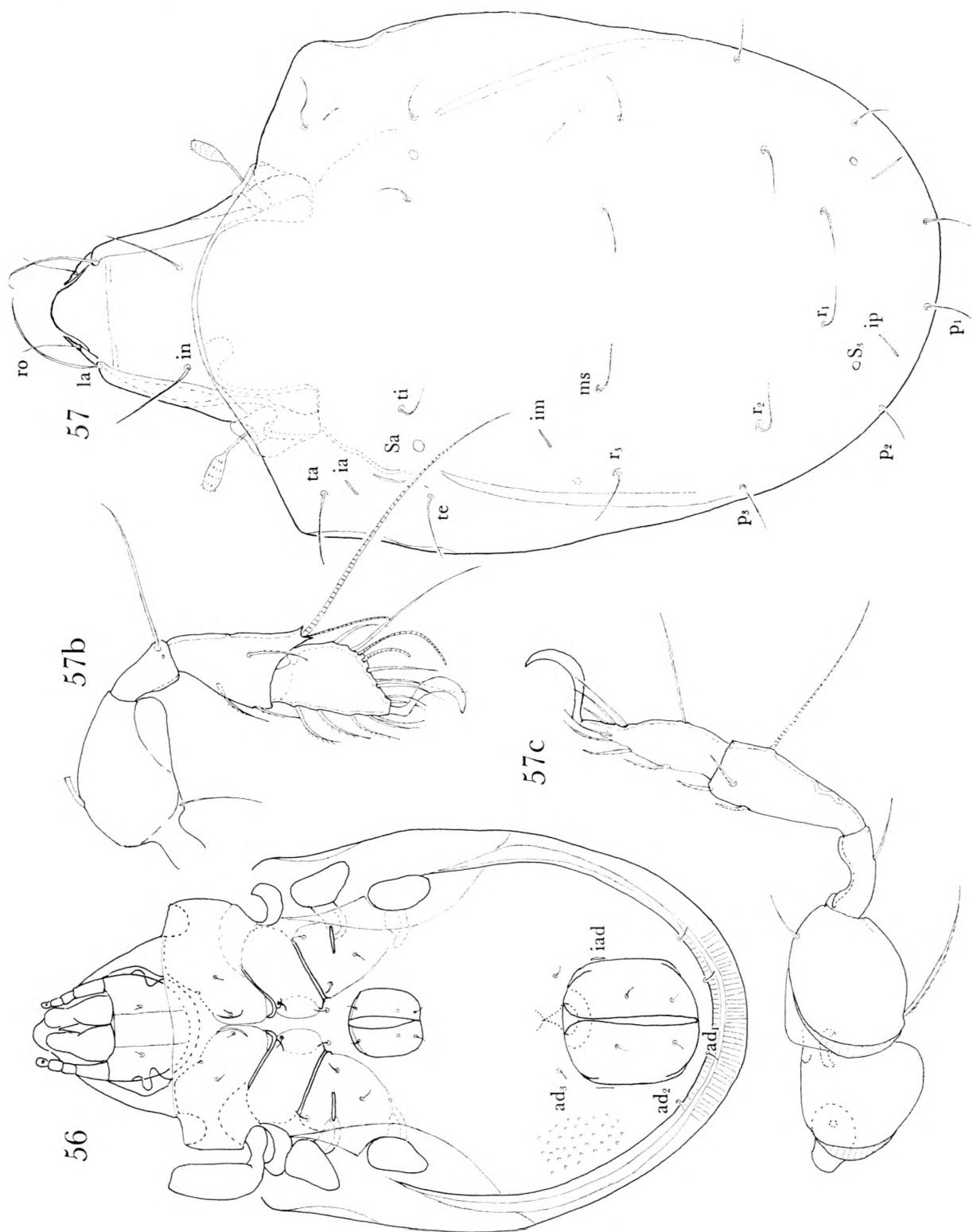


PLATE XXXII



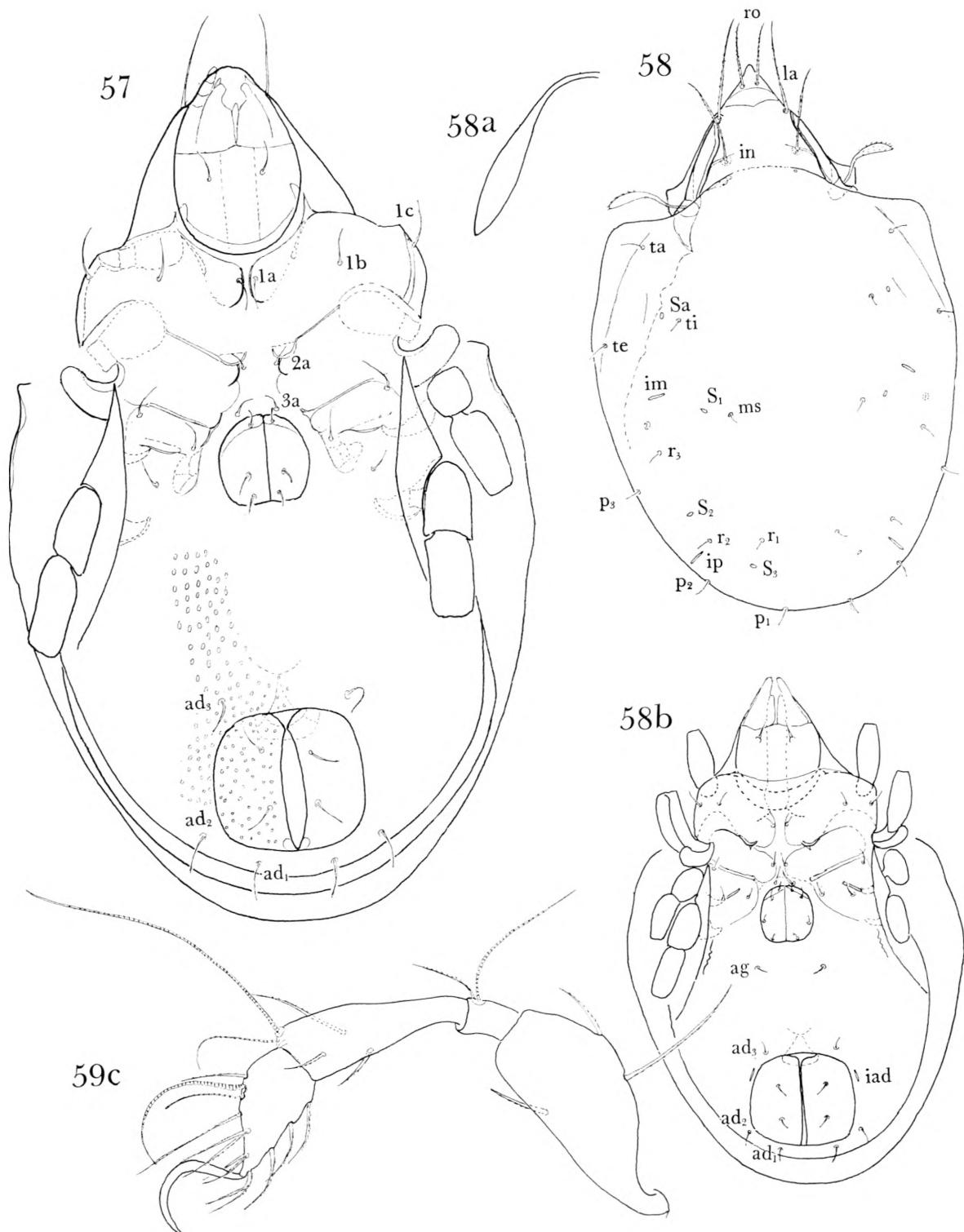
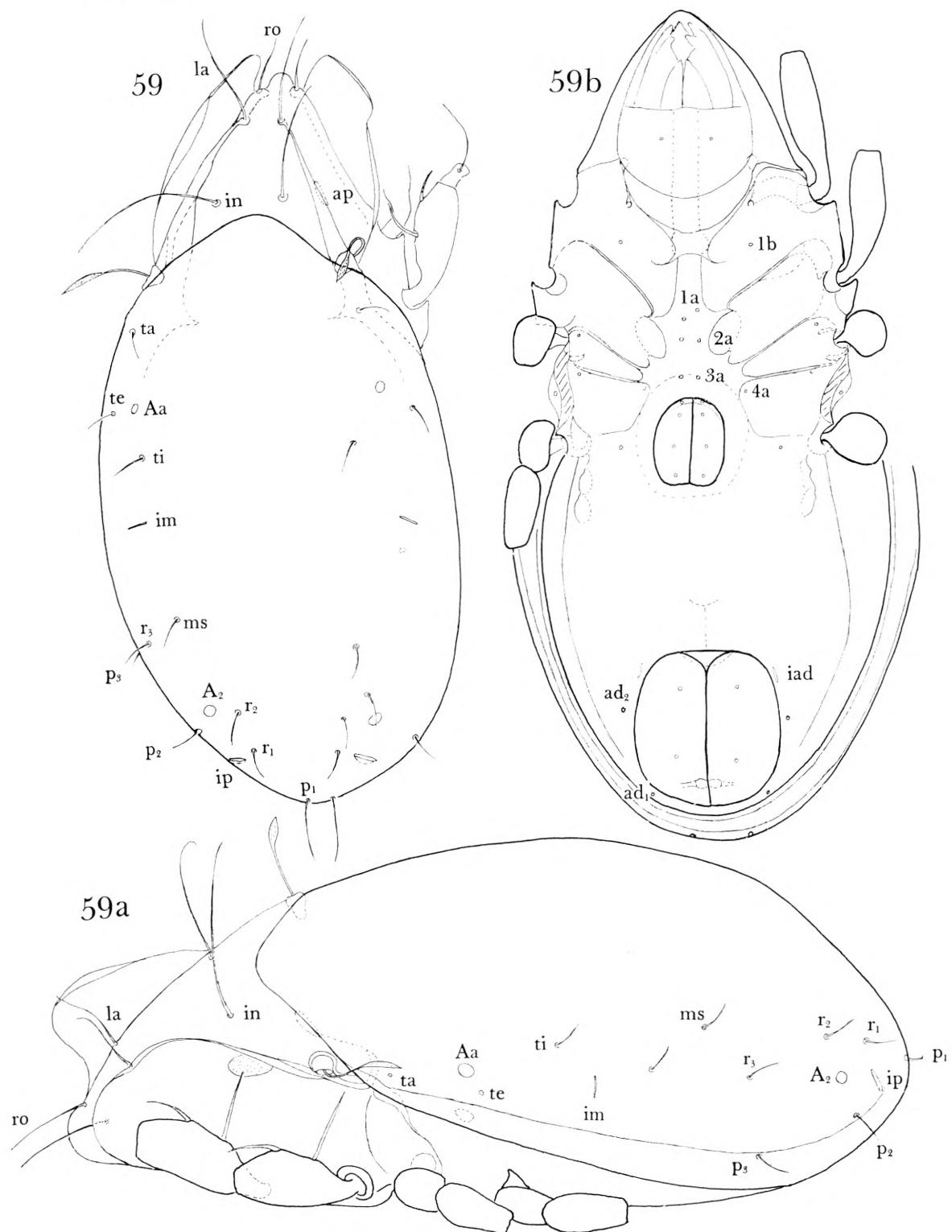
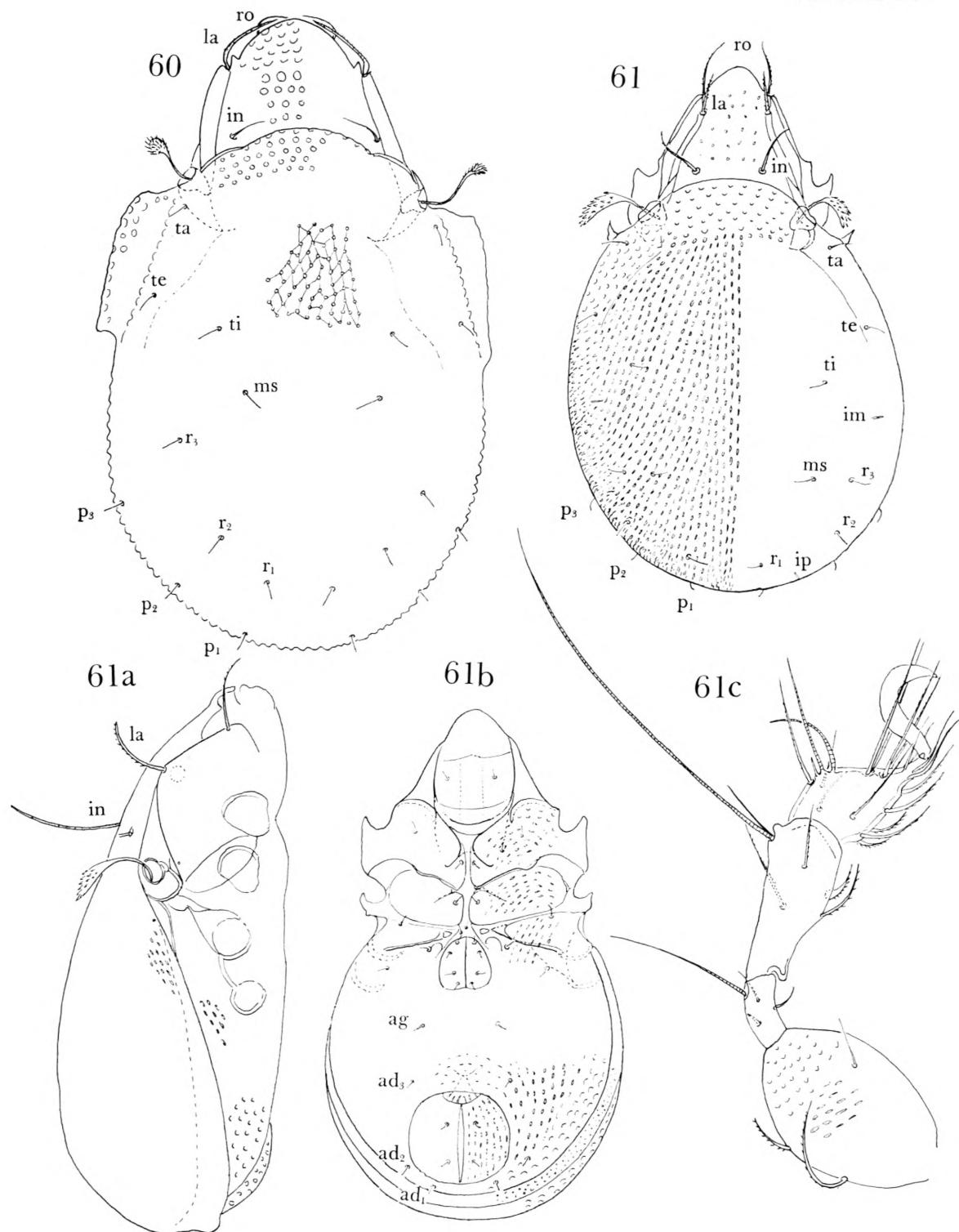


PLATE XXXIV







Det Kongelige Danske Videnskabernes Selskab  
 Biologiske Skrifter  
 Biol. Skr. Dan. Vid. Selsk.

Bind 12 (kr. 173.-)

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