Biologiske Skrifter
udgivet af
Det Kongelige Danske Videnskabernes Selskab
Bind **10**, nr. 4

Biol. Skr. Dan. Vid. Selsk. **10**, no. 4 (1959)

THE REINDEER
(*RANGIFER TARANDUS L.*)
IN DENMARK

ZOOLOGICAL AND GEOLOGICAL INVESTIGATIONS OF THE DISCOVERIES IN DANISH PLEISTOCENE DEPOSITS

BY

MAGNUS DEGERBØL AND HARALD KROG

København 1959
i kommission hos Ejnar Munksgaard

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Selskabets sekretariat og postadresse: Dantes Plads 5, København V.

The address of the secretariate of the Academy is:

Det Kongelige Danske Videnskabernes Selskab,
Dantes Plads 5, Köbenhavn V, Denmark.

Selskabets kommissionær: Ejnar Munksgaard's Forlag, Nørregade 6, København K.

The publications are sold by the agent of the Academy:

Ejnar Munksgaard, *Publishers,*
6 Nörregade, Köbenhavn K, Denmark.

BIOLOGISKE SKRIFTER

UDGIVET AF

DET KGL. DANSKE VIDENSKABERNES SELSKAB

BIND 10

KØBENHAVN

I KOMMISSION HOS EJNAR MUNKSGAARD

1958—59

INDHOLD

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Synopsis

In Denmark well over 200 finds of prehistoric reindeer are known; particularly comprising antlers but also skeleton parts, and fragmentary skulls are represented. Of special interest is a complete skeleton from the Early Dryas period, the only extant subfossil skeleton. It is a remarkable fact that – with the exception of a few glacial finds – all these discoveries belong to the late-glacial period (especially the Dryas periods), as demonstrated by pollen-analysis and stratigraphy. This occurrence in time together with ecological and anatomical evidence clearly shows that the prehistoric Danish reindeer were typical tundra animals. There is a considerable variation in the shape of the antlers, but the "arcticus" type of antlers is dominant, just as in the reindeer from late-glacial sites in Holstein. In several skull characters, however, the Danish reindeer might indicate affinity to the European reindeer, *R. t. tarandus*.

The subfossil Danish reindeer were large animals with larger teeth than in recent reindeer. The many shed antlers prove that the reindeer stayed in Denmark even during the winter months. This agrees with the fact that the snow cover was moderate. At the end of the Yonger Dryas period, the temperature seems to have risen so quickly that the immigration of the forest could not keep pace with the climatic improvements. Denmark thus was still an open country, but the summer temperature was fairly high, passing 13–14° C. This might indicate that the quickly rising temperature still more than the changing vegetation caused the early disappearance from Denmark of reindeer.

Printed in Denmark
Bianco Lunos Bogtrykkeri A-S

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I. ZOOLOGICAL PART

By Magnus Degerbøl

Introduction

The bogs of Denmark are very rich in subfossil bones. This is due to the fact that most Danish bogs have a fairly high calcium content and conditions therefore are favourable to the preservation of bones. In Southwest Jutland only the bogs are so acid that animal bones cannot be preserved. During peat-cutting many of these bones have been unearthed and for more than a century such remains have been collected and placed in museums, especially in the Zoological Museum of the University of Copenhagen. As the formation of peat, as a rule, has not taken place until the forest advanced to Denmark, this means that the bones which have been found in the actual peat cannot be older than the beginning of the Forest period, i. e. the postglacial age proper. Animal bones from the late-glacial period or Tundra period thus must be searched for in the gyttja below the peat; therefore they will not generally be found during peat-cutting. The result is that bones of many late-glacial animals are fairly rare in our museum collections in comparison with post-glacial remains. This holds good of remains of such species as e.g. giant deer (Degerbøl 1952) and bison (Degerbøl and Iversen 1945).

An exception, however, is the reindeer, of which many discoveries are known, especially shed antlers are numerous. This indicates that the reindeer must have been common in Denmark in late-glacial times.

Besides in the Zoological Museum of Copenhagen, remains of subfossil reindeer are kept in several other Danish collections, the names of which are mentioned in "A Survey of the Material". Particularly in Bornholms Museum in Rønne a fine collection is found. Of exceptional interest is a complete skeleton from the Early Dryas period, excavated by Fyns Stiftsmuseum, Odense. For the loan of material from these collections, I beg to express my sincere thanks.

My grateful acknowledgement is due to Professor C. Arambourg, Muséum National d'Histoire Naturelle, Paris, and to Dr. K. D. Adam, Staatliches Museum für Naturkunde, Stuttgart, who gave me access to study the prehistoric reindeer material from Southern France and Schussenquelle, Württemberg, respectively. I also beg to express my cordial thanks to the Carlsberg Foundation which for many years has supported my investigations on prehistoric vertebrates from Denmark.

Last, but not least, I thank the many people who during the years have submitted subfossil bones from the whole country, and thus highly contributed to an augmentation of our knowledge of the prehistoric fauna of Denmark.

Previous Investigations

The first account of remains of *Rangifer* in Denmark was given by J. H. Reinhardt (1836—37, p. 7), who records a shed antler from marl under a peat bog near Bregentved in South Zealand. Further discoveries were mentioned by Japetus Steenstrup, but strangely enough, this author, in 1842, was of opinion that the reindeer had lived in the "oak period". Later, in 1869, he pointed out, however, that remains of this species are only rarely found in the actual peat, but more frequently in layers "far earlier than the pine vegetation", and in many instances he could on the spot place them with the greatest certainty as far back as the strata containing remains of arctic vegetation. Finally, in 1886, he totally abandoned the view that they were postglacial and stated that in all cases where reliable investigations into the discoveries had been made, the bones of reindeer had been found together with arctic plants.

In 1904 Herluf Winge published a list of all Danish localities, 57 in all, where remains of reindeer had been discovered. This author, too, was of the opinion that in nearly all cases in which information has been available, the discoveries were made in marl strata surmounted by peat. He adds, however: "Some few remains appear to have been taken from the peat itself." — Considering that the recent reindeer is not only a tundra dweller, but also a member of the boreal forest fauna there would be nothing extraordinary in the discovery of its remains in the peat proper.

In 1915 V. Nordmann more thoroughly examined these last-mentioned discoveries on the basis of the stratigraphy, and arrived at the conclusion that "of all the finds (about 75) of reindeer remains hitherto made in Denmark, only two or three: (1) from Sejrø, (2) from Onløse, S.W. of Holbæk, Zealand, and (3) from Kjellerup, S.E. of Ringe, Funen, can be said to belong to the alluvial period, the time when the tundra had given place to a more or less close vegetation of thicket and forest" (p. 8). In 1944 (p. 67) Nordmann admits that this stratigraphical investigation is insufficient for proving the alluvial existence of *Rangifer* in Denmark, these three finds belonging to the late-glacial period (cf. Nos. 97, 29, and 22, respectively). In the same publication, however, Nordmann mentions a brain-case with antlers from Rask Mølle, W. of Horsens, which presumably belonged to the transition period between the Late Dryas and the Forest period (cf. No. 39), however, also in this case it is likely that this discovery dates from the late-glacial age, belonging to the end of Zone III.

In 1943 V. Milthers (p. 149) called attention to the discovery of a part of a reindeer antler at Faurbo Knold, N.W. Zealand, found together with a skull and some bones of an *elk (Alces)*. He concluded that all these bones must be referred to a very early part of the postglacial period. However, some of the bones had been picked up from the bog before the geological investigation started, so that some uncertainty is connected with this find. According to H. KROG it may be dated back to the late-glacial period. (cf. p. 135).

A Survey of the Material

So far we know of remains of reindeer in Denmark from 214 localities. It has only been possible to date rather a small number of these late-glacial reindeer more exactly.

In Denmark only one settlement is excavated from the late-glacial period: Bromme settlement in Zealand, belonging to the Allerød period, and from this small settlement only a few fragments of reindeer antlers are known, *Alces* being the species which particularly was hunted by the people of this period (DEGERBØL 1946, p. 139). Furthermore, some implements, striking weapons or axe-handles, etc., made of reindeer antlers have beed found, according to archaeological views undoubtedly belonging to the Late Dryas period, but otherwise the dating must be based on pollen analysis and stratigraphy. (Vide H. KROG).

Remains from Glacial Deposits[1]

1. *Lundebjerg*, Try, Vendsyssel (P. CHRISTENSEN, 1947).
   (a) Proximal part of a left antler, shed, small. From gravel pit; so strongly water-rolled, that the brow tine is only indicated by a knob. The bez tine broken at base, diameters 20 × 11 mm. Beam broken just above bez tine, diameters (1) 20 × 16 mm.[2]
   (b) (C. J. BECKER *D.G.U.* 1950).
   Middle part of beam, 25 cm long; diameters 38 × 32 mm. From a gravel pit, rolled by water.
2. *Hylke*, 5 km S. of Skanderborg (E. RØRDAM BONNEVIE, 1959) upper half of *radius* (cf. table 9).
3. *Vetterslev*, Vrangstrup, 6 km S. of Ringsted (HALFDAN POULSEN, 1952).
   Small fragment of antler. From gravel pit; water-rolled.

Remains from the Glacial or Late-Glacial Period

4. *Mullerup*, N.W. of Slagelse in a gravel pit (Nationalmuseet, T. NØRLYNG).
   The upper end, 64 cm long, of a large antler, a waste piece cut off just above the back

[1] Remains from Bornholm are recorded separately, cf. p. 35.

[2] The measurements of antlers are taken in the following way: Length of beam along median face; length of brow- and bez-tine in a straight line from anterior border of beam; diameters of beam: (1) between brow- and bez-tine, (2) between bez- and back-tine, (3) between back-tine and palm; all measurements taken at middle of beam or tines, if nothing else is stated.

tine. "The cutting was made to some extent by a burin. This burin work is characteristic of the working of the antlers at Meiendorf (Hamburg Stage). This specimen was found one metre deep in a gravel pit at the western edge of Mullerup Bog (Maglemose) in Western Zealand, having of course nothing to do with the famous mesolithic find from the same bog." TH. MATHIASSEN 1938, p. 175, fig. 3. Later, however, in discussing the implements from the settelement at Bromme Mathiassen in accordance with RUST is of opinion that this piece belongs to the Late Dryas period (1946, p. 179). Cf. KROG, p. 124.
If this specimen really was found in a gravel pit at a depth of one metre it is difficult to understand that it only dates from the Late Dryas age. Is the position primarily allochtonous, the specimen must be much older, from the glacial age and thus be the oldest worked remain of reindeer in Denmark.

5. *Hodde* (Karlsgaarde canal); east side of Varde river, 15 km N.E. of Varde, Western Jutland (S. KAMMAN, 1942).
Part of right frontal with antler, broken 54 cm from rose. Rose at brow tine corroded, but no doubt this tine has been a simple prong, diameters at base 10×15 mm. Bez tine broken 28 cm from base, diameters at middle 25×23 mm, at top 32×18 mm. The broken beam is fairly straight and although 54 cm long, no back tine is indicated, presumably it has been lacking. Twelve cm above the bez tine the diameters of the beam are 36×31 mm, at the fracture at the top 48×34 mm; the posterior border with a low but strong ridge.
NORDMANN (1944, p. 36) is of the opinion that this antler is very old, belonging to the penultimate or Mindel-Riz interglacial. Should this be the case, this specimen is one of the earliest known discoveries of subfossil reindeer. This age determination seems, however, to be uncertain. — Cf. KROG p. 125. — Pl. II. Row 4, No. 5.

6. *Christiansfeld*, "Holbæk", Southern Jutland (KNUTH, TH. SCHIØTZ, 1856).
Bez tine, cut off, but presumably in recent time. In a marl pit, 5 m's below surface of the earth (HERLUF WINGE 1904)[1]. Cf. KROG, p. 126.

Remains from Late-Glacial Times

Remains from the Early Dryas Period

7. *Villestofte*, Funen (Fyns Stiftsmuseum, 1938). — Complete skeleton. (Vide p. 49).

8. *Herlev*, N.W. of Copenhagen (K. J. JØRGENSEN, 1951).
Left antler, shed; broken through "palm" or expansion of the beam. Brow tine small, broken at base. Bez tine long, broken at base of palmation, diameters in the middle 37×20 mm. Back tine very small. — Transition from Zone I to II. — Pl. I, Row 3, No. 1. Cf. KROG, p. 127.

9. *Allerød*, N.E. Zealand. (D.G.U.). — 3 fragments of antlers, from a depth of 4—6 m, discovered by the workmen (N. HARTZ 1902, p. 22—24).
   (a) Lower part of left antler, shed; beam artificially cut off and broken above bez tine (cf. RUST 1937, pl. 37). Brow tine broken at base, 20×13 mm. Bez tine palmated, 3 points, broken through base of points; length in a straight line 36 cm, along anterior curvature 39 cm, diameters 30×23 mm. Diameter of beam (1) 42×32 mm. (Fig. 1 and 2).

[1] In what follows cited as H. W. 1904.

Fig. 1. Lower part of shed antler with bez tine (Allerød, No. 9a). Beam artificially cut off and broken above bez tine; cf. fig. 2. Median view.

Fig. 2. Part of antler from fig. 1. Lateral view.

(b) Middle part of left beam with back tine, 50 cm long. Back tine 3 cm long, diameters in the middle 15 × 9 mm. Diameters of beam below back tine 53 × 38 mm, above back tine 40 × 40 mm.

(c) Part of left beam broken just below back tine and above lower tine of palm, length 45 cm. Back tine small, 1 cm long, diameters at base 11 × 7 mm. Diameters of beam between back tine and palm 40 × 31 mm. Cf. Krog, p. 127.

10. *Ruds Vedby*, 15 km N. of Slagelse, Zealand. (D.G.U. — KNUD JESSEN, 1929). — Small fragments of antler. Dug out of a brick-field: "From lower Dryas-clay at bottom of pit, clay below Allerød-stratum".

11. *Copenhagen*, from the bottom of the Sound.
In the year 1936 an implement, made of the outer half of a brow tine of a reindeer antler

Fig. 3. Antler from ORE, Falster (No. 13).

(originally published as the outer end of a beam) was discovered on the bottom of the Sound off Copenhagen, at Middelgrund, 4.5 m deep in the gravel and 12.5 m below sea level. In some reindeer, e.g. Skovborggaards bog No. 139 and Th. Wests bog No. 143, d, the shovel of the brow tine is much compressed with sharp convex lower border. The present piece is made of such a tine, almost ready for use. The convex side is only further sharpened to an edge for a length of seven cm, which indicates that the implement must have been used as a kind of knife or scraper. This specimen was dated at Zone 1 c by means of a pollen-analytical examination of a sample of layer in which it was found, made by Dr. J. IVERSEN, Danmarks Geologiske Undersøgelse (TH. MATHIASSEN 1938, IVERSEN 1942, p. 146). Cf. KROG, p. 127.

12. *Askeby*, St. Damme, Møn (S. BORK ANDERSEN, 1949).
Right antler, shed, broken through palm. Brow tine small, broken at base, diameters

Fig. 4. Upper end of antler from COPENHAGEN (No. 15). Cut off by the reindeer-hunters.

15 × 15 mm. Bez tine large with 4 points, length in a straight line, from base of tine to the fractured extremity, 40 cm, diameters 33 × 21 mm. Back tine only indicated by a ridge. Length of beam 90 cm; diameters (1) 46 × 33, (2) 33 × 30, (3) 35 × 30 mm (cylindricornis). — Palm with two large back tines, breadth of palm between 1st and 2nd tine 60 mm. — Transition between Zone I and II. Pl. II. R 3, No. 5. — Cf. KROG, p. 128.

13. *Ore*, S.E. of Stubbekøbing, Falster (H. OLSEN-PLOUG, 1941).
Antler, shed. No back tine, palm small. (Fig. 3.) — Cf. KROG, p. 128.

14. *Egebjerg* brick-field at Stenstrup, Southern Funen (H. C. ANDERSEN, D.G.U. 1930). Left antler, shed, broken below palm. Brow tine mutilated. Part of bez tine, palmated. No back tine. Length of beam 80 cm, diameters (2) 33 × 30 mm, (3) 42 × 35 mm. "Lower Dryas clay, 65 cm below Allerød-stratum (a black layer); 8 m below the surface of the earth."

II. *Remains from the Allerød Period (Zone II)*

15. *Copenhagen* (Medical factory "Novo", 1949). — The upper end of a powerful reindeer antler, cut off by the reindeer hunters. This part must be regarded as a waste piece thrown away after the lower and useful part of the beam was removed. Length 70 cm; proximal width 60 × 35 mm. Largest width of palm 102 mm. (Fig. 4).
The pollen analyst of the Zoological Museum, Mr. KROG, who has examined the excavation, has dated this specimen at the very beginning of Zone II; cf. p. 128.

16. *Rungsted*, Bukkeballevej (H. MØLLER and H. C. ROSTED. Hørsholm Museum, 1944). Left antler, shed, broken below back tine. Brow tine broken 15 cm from base, diameters 28 × 25 mm. Bez tine broken 5 cm from base, diameters 34 × 24 mm. Length of beam 40 cm, diameters (1) 55 × 35 mm, (2) 43 × 34 mm. — Cf. KROG, p. 129.

17. *Allerød*, N.E. Zealand. (D.G.U.).
Right antler, shed. Of abnormal shape. The brow tine small, broken, now only 3 cm long, diameters in the middle 13 × 14 mm. The distance between the brow tine and bez tine unusually large, 25 cm from middle of base of brow tine to middle of base of bez tine; the bez tine is extraordinarily long, 42.5 cm, in a straight line from base of tine, bifurcated. Diameters in the middle 38 × 20 mm. No back tine. Beam above middle so strongly curved that the distance from tip of bez tine to tip of beam only is 11 cm. Length of beam 128 cm, diameters (1) 40 × 39 mm, (2) 46 × 36 mm, largest breadth of the palm is 85 mm. Discovered by a workman, "from the gyttje" (N. HARTZ 1902, p. 22—24, fig. 7. A large lower tine of palm is here indicated). Pl. II. R. 1, No. 3. — Cf. KROG, p. 129.

18. *Bromme* settlement.
Two small fragments of antlers (M. DEGERBØL, in TH. MATHIASSEN 1946, p. 138).

19. *Mulstrup*, 4 km S.E. of Ringsted (CHR. PETERSEN, 1945).
Right antler, shed, broken below palm. Brow tine broken at base, diameters 21 × 15 mm. Bez tine broken 15 cm from base, 30 × 20 mm. Back tine only indicated as a faint ridge. Length of beam 65 cm, diameters (1) 40 × 32 mm, (2) 38 × 30 mm, (3) 35 × 28 mm, i.e. nearly cylindricornis. Curved ("arcticus"-type) + fragments of back tines of palm. Pl. II. R. 3, No. 4.

20. *Vissenbjerg* brick-field, Aarup, Funen (D.G.U., V. NORDMANN). Lower part of antler, shed, one side mutilated. No brow tine. Bez tine broken at base. — Allerød gytje.

21. *Idalund* brick-works, Lolland (Mineralogisk Museum, 1912).
Right antler, shed, broken. Brow tine mutilated. Bez tine broken 26 cm from base,

34 × 24 mm. Back tine partly mutilated. Length of beam 70 cm, diameters (1) 50 × 37 mm, (2) 46 × 35 mm. — Cf. KROG, p. 129.

22. *Kjellerup*, S.E. of Ringe, Funen (D.G.U., M. BRUUN 1905).
Right antler, shed, broken through base of palm. Brow tine palmated, tip partly broken, height of palmation 13 cm, length 33 cm, diameters 29 × 26 mm. Bez tine broken 39 cm from base, palmated, diameters 33 × 25 mm. Back tine small, 26 mm long, diameters 12 × 7 mm at middle. Length of beam 98 cm, diameters (1) 45 × 38 mm, (2) 42 × 34 mm, (3) 41 × 35 mm. Beam above back tine curved. Transition between Zone II and III. (Cf. p. 129). Pl. II. R. 4, No. 2 (V. NORDMANN 1915, p. 14).

23. *Sattrup* bog, Gjedved, 10 km N. of Horsens (EIGIL NIELSEN, 1949).
Left antler, shed, broken below palm. Brow tine strongly developed, broken through basis of points of palmation, length 26 cm, 25 × 20 mm. Bez tine long, length 42 cm in a straight line from base to broken point of palmation, 35 × 21 mm. Back tine well developed, 8 cm long in a straight line, 12 cm following curve. Length of beam 70 cm, diameters (1) 48 × 37 mm, (2) 41 × 33 mm above bez tine, more distally, 8 cm below back tine the beam is very broad, forming a sharp ridge as a kind of extra back tine; greatest width is here 65 (× 28) mm; below back tine 43 × 29 mm, (3) 35 × 28 mm. Strongly curved above back tine. Pl. I. R. 2, No. 3. — Cf. KROG, p. 130.

Remains from the Late Dryas Period (Zone III)

24. *Søborg*, N.W. of Copenhagen (KRÜGER JENSEN, 1926).
(a) Left antler, shed, broken. Brow tine broken at base; has presumably been well developed. Bez tine broken 10 cm from base, diameters 32 × 27 mm. Length of beam 70 cm, posterior border damaged, impossible to see if back tine has been present; diameters (1) 50 × 43 mm, (2) 50 × 38 mm, (3) at curve 65 × 40 mm): rather compressicornis. Presumably curved. Cf. KROG, p. 130.
(b) Right antler, shed, lower part with broken brow and bez tine.

25. *Isterød* — *Usserød*, by road building. (D.G.U. 1953).
Left antler, shed, broken below palm. Brow tine with large palm; length 34 cm, diameters 27 × 28 mm; width of palm about 31 cm, upper border slightly mutilated, points very small or only indicated. Bez tine broken 9 cm from base, diameters 34 × 25 mm. Back tine complete, 10 cm long, diameters in the middle 19 × 14 mm. Length of broken beam 76 cm, diameters (1) 51 × 35 mm, (2) 46 × 36 mm and (3) 46 × 40 mm. — Typical "arcticus". Pl. I. R. 1, No. 2. — Cf. KROG, p. 130.

26. *Valby*, N. of Helsinge ("Bremerlandsgaarden") N.E. Zealand (FREDE PETERSEN and H. KAPEL, 1956).
Left antler, shed, broken between back tine and palm. Brow tine broken off. Bez tine broken 15 cm from base, diameters 28 × 17 mm. Back tine small, broken at tip, now 15 mm high. Beam 56 cm long, diameters (1) 40 × 24 mm, (2) 29 × 24 mm, (3) 27 × 22 mm. Beam between bez tine and back tine fairly straight, but curved above back tine. Pl. I. R. 4, No. 5. — Cf. KROG, p. 130.

27. *Holbæk* (Holbæk Museum, 1949).
Right antler, shed, broken through palm. Brow tine broken at base of palmation, 18 cm from base; diameters 29 × 24 mm, at base of palmation 51 × 23 mm. Bez tine nearly complete, bifurcated, and these two points again bifurcated; the lower point broken at

base. Length in a straight line 34 cm, along anterior curvature 45 cm. Diameters 33 × 25 mm. Back tine well developed, complete, 13 cm long; diameters 25 × 18 mm (in the middle). Length of beam 92 cm (1) 54 × 38 mm, (2) 48 × 37 mm, (3) 43 × 33 mm. Width of palm above lower tine ca. 90 mm. Lower point of palm broken 13 cm from base, diameters 48 × 23 mm. "Tarandus" type, part of beam above back tine is curving anteriorly in its upper part. Pl. II. R. 4, No. 1. — Cf. KROG, p. 131.

Fig. 5. Antler from ONLØSE (No. 29). From Nordmann.

28. *Gørlev*, S.W. of Tissø (D. MØLLER, 1938).
Left antler with small part of frontal bone, broken below palm. Brow tine broken at base, 25 × 25 mm. Bez tine broken 27 cm from base, 29 × 26 mm. Back tine broken at base, very narrow. Length of beam 65 cm; diameters (1) 43 × 30 mm, (2) 37 × 30 mm, flattened at back tine, (3) 37 × 33 mm, nearly cylindricornis. Curved above back tine. — Late Dryas (J. IVERSEN, D.G.U.). Pl. I. R. 2, No. 5. — Cf. KROG, p. 131.

29. *Onløse*, 14 km S.W. of Holbæk, Zealand (J.B.S. ESTRUP).
Shed antler. — Pictured by NORDMANN (1915, p. 17): "The antler is still kept at the manor-house Kongsdal. — The distance in a direct line from the point of the foremost tine of the crown to the root is 1 m. Length of the beam about 1.20 m (tip broken off), circumference of the rather flat beam a little above the root 0.17 m." (Fig. 5) — Cf. KROG, p. 132.

30. *Kirke Saaby*, 12 km W. of Roskilde (H.M.V. HANSEN, 1934).
Right antler, shed; broken below palm. Brow tine broken at base, powerful, diameters

at base 30 × 30 mm. Bez tine very broad, broken through palmation, diameters 45 × 20 mm, breadth of mutilated palmation 12 cm. Back tine broken at base, has been well developed, 23 × 13 mm. Length of beam 80 cm, diameters (1) 45 × 33 mm, (2) 42 × 29 mm, (3) 40 × 28 mm. Distinctly curved above back tine. Pl. II, R. 2, No. 7.

31. *Mullerup*, N.W. of Slagelse, in a brick-field. (M. J. MATHIASSEN, 1901),
Small part of left frontal bone with part of heavy antler, broken between back tine and palm. Brow tine broken at base of palmation, length 24 cm, diameters 27 × 24 mm. Bez tine large, palmated, 4 points, broken through points, length 47 cm, diameters 30 × 26 mm.

Fig. 6. Antler from OVERGAARD (No. 38). Axe-handle.

Back tine well developed, about 9 cm long, diameters 21 × 15 mm in the middle. Length of beam 80 cm; diameters (1) 44 × 37 mm, (2) 51 × 34 mm at middle, below back tine 64 mm broad, (3) 50 × 40 mm, i. e. rather compressiform. Distinctly curved above back tine (H.W. 1904). — Pl. I. R. 1, No. 5. — Cf. KROG, p. 132.

32. *Flintemose*, near Næstved, 1942 (Herlufsholms museum 240/1942). Part of palm of antler, broken at tip and below proximal tine of palm. 5 tines; length 45 cm, width of beam between 2 lower tines 86 mm. Diameters (3) 53 × 35 mm. — Cf. KROG, p. 132.

33. *Orenæs*, Falster (O. WILHJELM, 1956).
Left antler, shed, broken below palm. Brow tine broken 23 cm from base, diameters 27 × 24 mm. Bez tine broken 22 cm from base, 33 × 24 mm. Back tine complete, 7 cm long, diameters in the middle 13 × 10 mm. Length of broken beam 98 cm, diameters (1) 44 × 34 mm, (2) 44 × 38 mm, (3) 39 × 32 mm. Typical "arcticus". — Pl. I. R. 1, No. 3. — Cf. KROG, p. 132.

34. *Rykkerup*, *Thoreby*, Lolland (KRING and MARQUARDTSEN, 1954).
Left antler, shed, broken through "palm". Brow tine broken 4 cm from base, diameters 20 × 24 mm. Bez tine 46 cm long in a straight line (56 cm following inner curvation), pal-

mated, but palm damaged, diameters 28 × 22 mm. No back tine. Length of broken beam 109 cm, diameters (1) 40 × 37 mm, (2) 38 × 36 mm, (3) 41 × 36 mm. Pl. I. R. 3, No. 2. — Cf. KROG, p. 133.

35. *Odense* (Fyns Stiftsmuseum, 1941).
Left antler, shed, broken at base of palm. Brow tine small, broken 2 cm from base, 15 × 12 mm. Bez tine broken 25 cm from base, 25 × 20 mm. Back tine well marked, broken at base, between bez tine and back tine fairly straight, 18 × 8 mm, i. e. compressed. Beam

Fig. 7. Brain-case with antlers from RASK MØLLE (No. 39).

65 cm long, diameters (1) 35 × 24 mm, (2) 28 × 23 mm, (3) 28 × 23 mm. Beam above back tine straight ("tarandus"). — Pl. I. R. 4, No. 3. — Cf. KROG, p. 133.

36. *Ejby*, 15 km S.E. of Middelfart, Funen. (EIGIL NIELSEN, 1949).
Part of small antler (cf. p. 134).

37. *Skrøbelev* (Langelands Museum, 1943).
Part of brain-case with broken antlers. Right antler broken 87 cm from rose (WINTHER 1943, with figure), (cf. p. 134).

38. *Overgaard* marl-pit, Glud, 12 km S.E. of Horsens (ERIK JENSEN, ASGER KRISTENSEN, 1943).
Left antler, shed, broken about "back tine". Brow tine cut off at base, artificially. Bez tine cut off 8 cm from base, 28 × 20 mm. Back tine absent. Length of beam 65 cm, diameters (1) 40 × 32 mm, (2) 32 × 31 mm. Beam slightly curved. (Fig. 6). Axe-handle(?) Cf. p. 134.

39. *Rask* lake pr. Rask Mølle, 15 km W. of Horsens (D.G.U. 1919).
Brain-case, broken behind *orbitae*, with lower parts of antlers. All tines are more or less broken. On the left antler the brow tine and bez tine are broken at the base, diameters

20 × 20 mm and 47 × 17 mm, respectively. On the right antler the brow tine is broken at the basis of the palmation, 15 cm from base, diameters 30 × 22 mm. The bez tine is cut off at the base. The back tine is a long longitudinal ridge. The direction of the antlers is extraordinary: The beam just above the bez tine turns backwards, and nearly in a right angle. Length of left beam 80 cm, diameters (1) 44 × 35 mm, (2) above bez tine 41 × 35 mm, at back tine 60 × 33 mm ɔ: the beam is particularly flattened at back tine, curved. — Measurements of brain-case: The distance from the *crista occipitalis* to the frontoparietal suture is 56 mm; mastoid breadth 130 mm. Heigth of *os occipitale*, from the upper border

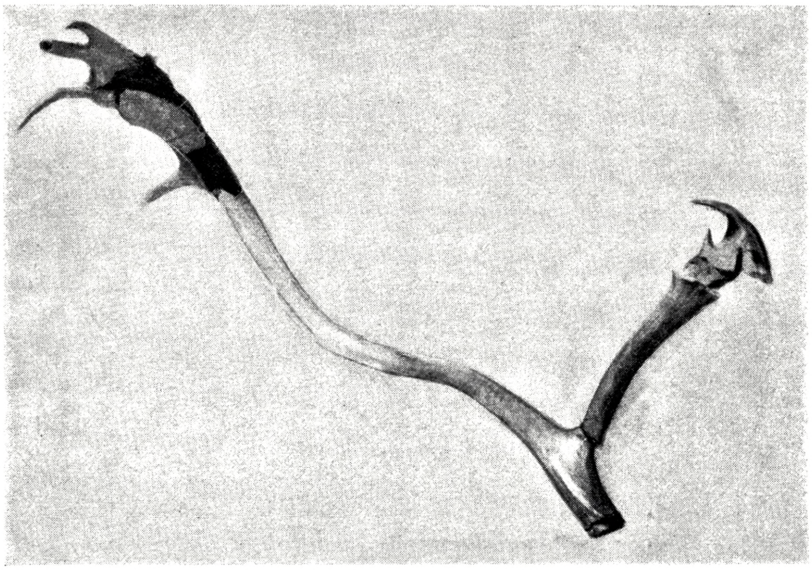


Fig. 8. Antler from Aalstrup (No. 40).

of *foramen magnum* is 57 mm, from the lower border of *for. magnum* 84 mm. Greatest width of *condyli occipitales* 72 mm. Width at incisura above *meatus acusticus* 117 mm. (Nordmann 1944, p. 68). (Fig. 7.) Cf. p. 134).

40. *Aalstrup*, *Falling*, N. of Horsens Fjord (J. Didriksen, 1948, Odder Museum).
A large antler, shed, "nearly 1.5 m long". Back tine only indicated. (Fig. 8). — Cf. p. 135.

41. *Hjorthede*, E.S.E. of Viborg.
Distal part of antler cut off, so that the lower part might be used as an implement (axe handle). The marks of the cuts are typical of the reindeer hunters. (Winge 1904, Pl. XI, fig. 4. Nordmann 1905, 1936, pp. 47 and 208. (Pollen analysis by K. Jessen). — Cf. p. 135.

42. *Fabjerg* (Winthersgaard), Lemvig. (Vendsyssels Historiske Museum 1955, 95/55). Lower part of right antler; broken between bez tine and back tine; brow tine broken (artificially) at base. Bez tine broken. By digging through a small hollow. At the end of Zone III. (Fig. 9) – Cf. p. 135.

43. *Tranebjerg*, Sandholms Mark, Samsø (J.V. Kjødt, 1924).
Right antler, shed, broken between bez and back tine. Lower part with broken brow- and bez tine. Brow tine corroded, was no doubt small, a simple prong. Bez tine broken 20 cm from base, diameters 30 × 20 mm. Beam broken 35 cm from base; diameters (1) 45 × 29 mm (2) 38 × 28 mm. — Cf. p. 135.

Fig. 9. Antler from FABJERG (No. 42).

44. *Nørre Lyngby*, Northern Jutland (D.G.U.).
Several remains of (1) quite young animal (calf), (2) young animal, juv., (3) adults.
(a) (D.G.U. 1896. K. J. V. STEENSTRUP, AXEL JESSEN).
One costa, *humerus* — upper epiphysis broken at proximal end. Least width of diaphysis 19 mm, upper epiphysis of *femur*.
(b) (D.G.U. 1913. N. HARTZ).
Small fragments of a calf: pieces of brain-case, fragments of *humerus*, lower part of *radius* without epiphysis; *femur* without upper and lower epiphysis, epiphysis of vertebra, toe joint. "Found at pole 42^{15}, about 1.55 m above freshwater clay." (JESSEN, A., and NORDMANN, V., 1915).

(c) Upper tooth, without root, of juv.
"Pole 42[15], about 1.55 m above the freshwater clay in stratified sand."
(d) Lower border of horizontal ramus of mandible, cut off.
"Pole 41—42 in the freshwater stratum."
(e) Part of costa.
"Pole 41, 95 cm above the surface of the freshwater clay, in clayey sand, about 10 cm above upper beaver-stratum."
(f) Thoracal vertebra.
"Pole 40, 75 cm above the freshwater clay."
(g) *Atlas*.
"Pole 44, 60 cm above the freshwater clay."
(h) Fragment of antler.
"Pole 44, about one metre above the freshwater clay."
(i) Fragments of antlers, thoracal vertebra, outmost toe-joint of adults, epiphysis of vertebra, *calcaneus* of calf. "1 m above the freshwater clay."
(j) Cervical vertebra.
"Pole 45, 35 cm above freshwater clay, in nethermost beaver stratum."
(k) Distal part of *tibia*.
"Pole 42, in a thin layer of gravel, directly upon the freshwater clay."
(l) (Hartz, 1914).
One costa, lower epiphysis of *tibia*, anterior part of left mandible with p2 + p3, jun.
(m) (Axel Jessen, 1917).
Pieces of brain-case, adult; lumbar vertebra, jun.; part of *ulna*, juv. (H. Winge det.).
(n) (Axel Jessen, 1924).
Atlas, adult.
"Dug out of the strongly sloping alternating layers of sand and clay, in which remains of reindeer earlier have been found."
Right *os pubis*, juv.
"Found in the material earlier dug out."
Radius and *ulna*, upper end of *ulna* broken off. (Cf. Table 9).
(o) 3 different *astragali*, *calcaneus*, innermost and midmost toe joints.
(p) (D.G.U. 1938).
Left antler, shed, broken through "palm". Brow tine 6 cm long, diameters 10 × 9 mm. Bez tine broken 16 cm from base, diameters 17 × 12 mm. No back tine. Length of broken beam 40 cm, diameters (1) 28 × 14 mm, (2) 18 × 14 mm.

According to Iversen (1942, p. 45) the freshwater clay at the bottom of the late-glacial lake at Nørre Lyngby was deposited during the Allerød period, and the sand in which the reindeer remains were found, during the Younger Dryas period.

Several implements, striking-weapons or axe handles, etc., made of reindeer antler, have been found in Denmark. The assumption formerly voiced, that these implements may have been imported into Denmark, has now been abandoned. The specimens have undoubtedly been made in Denmark in the Late Dryas period. (Cf. Th. Mathiassen 1946, p. 175):

45. *Kallerup* bog. Høje Taastrup, W. of Copenhagen (National Museum).
Proximal part of antler, the brow tine of which is nearly cut off. The total length of the specimen is 43 cm. The entire surface is very smooth and shows traces of a lashing with a thin cord. — Found 4.5 m deep in sand below peat.

This piece seems to be connected with the Ahrensburg (Lyngby) culture (Th. Mathiassen 1938, p. 175).

46. *Stedstrup*, near Holbæk (National Museum).
Part of antler.

47. *Vejleby*, 14 km SW of Frederikssund (National Museum).
Axe-handle.

48. *Store Vejle* river, 15 km S.W. of Copenhagen (JELSTRUP, 1858).
Shed antler, 69 cm long. Brow tine cut off.

49. *Odense* Kanal (National Museum).
Axe-handle.

50. *Tranebjerg, Isle of Samsø* in the Kattegat (Samsø Museum).
Axe-handle.

51. *Nørre Lyngby*, North Jutland (Vendsyssels Historiske Museum).
Axe-handle.

52. *Horsens Fjord*, Jutland (National Museum).
Axe-handle.

53. *Fovrup*, West of Aabenraa, Southern Jutland (Museum, Kiel).
Axe-handle.

54. *Rimmer*, on the coast of Nissum Bredning, Jutland (National Museum).
Handle of a knife (TH. MATHIASSEN p. 151; Pl. XII).

55. *Skaftelev*, Nordrup, N.N.E. of Slagelse, Zealand (National Museum).
Harpoon head.
"Both the material and the shape make it probable that this specimen dates from the Late Dryas period (TH. MATHIASSEN 1941, p. 127). Cf. furthermore nos. 38 and 134.

Remains from the Late-Glacial Period (but no exact dating within this Period)

Zealand

56. *Vollerslev*, Thurøgaard, pr. Østervang, 13 km E.S.E. of Ringsted (N. TROENSEGAARD, 1934).
(a) Right antler, shed, nearly complete. Brow tine palmated, length in a straight line 28 cm; diameters in the middle 30 × 20 mm; greatest width of palmation 12.5 cm; palmation with 4 points. Bez tine palmated, large, 35 cm; diameters 29 × 25 mm; 4 points. No back tine. Palm with 5 tines; besides a small one indicated proximally. Length of beam 130 cm, tip of distal tine or end of beam broken; presumably the total length of the undamaged beam would have been 140 cm. Diameters of beam (1) 60 × 38 mm, (2) middle of beam 52 × 34 mm, greatest width of palm between 2. and 3. tine 57 mm. Curved. Pl. II. R. 1, No. 6.
(b) Left antler, shed, broken through palm. Brow tine broken in the middle; diameters 24 × 23 mm. Bez tine broken at base of palmation, length of incomplete tine 32 cm, diameters 28 × 20 mm. Back tine well developed, broken 2 cm from base 20 × 17 mm. Length of broken beam 105 cm. Diameters (1) 42 × 32 mm, (2) 38 × 33 mm, (3) 38 × 33 mm. Beam between bez tine and back tine fairly straight, but distinctly curved above back tine ("arcticus" type). Both specimens are late-glacial (J. IVERSEN, D.G.U.). Pl. I. R. 2, No. 2.

57. *Karrebækstorp*, 10 km S.W. of Næstved (P. Poulsen, 1939).
Right antler, shed. Brow tine broken at base, small. Bez tine broken 8 cm from base, 36 × 21 mm. Back tine absent. Of palm two tines present, otherwise broken. Length of beam, from base of burr to broken end of beam 115 cm. Diameters (1) between burr and bez tine 43 × 35 mm, (2) middle of beam 37 × 35 mm. Between 1. and 2. tine of palm 53 × 33 mm. Beam rounded (cylindricornis), evenly curved. Pl. II. R. 1, No. 1.

58. *Karrebæk* (Jagt- og Skovbrugsmuseet 1945, Valdemar Olsen).
Left antler, shed, broken below palm. Brow tine broken 6 cm from base, 25 × 22 mm. Bez tine with two large points, top broken off just in front of 2. point; broken 30 cm from base, 31 × 19 mm. Back tine complete, 5 cm long, diameters at middle 14 × 10 mm. Length of beam 69 cm, diameters (1) 37 × 30 mm, (2) 37 × 28 mm, (3) 38 × 25 mm. Fairly compressiforme.

59. *Fugbæk, Køng* 1940 (Herlufsholms museum, 35/1940).
Left antler, shed, broken just above back tine. Brow tine a simple prong, broken 6 cm from base, 13 × 14 mm. Bez tine broken 25 cm from base, 20 × 16 mm. Back tine nearly complete, small, 2 cm long, in the middle 8 × 6 mm. Length of broken beam 38 cm, (1) 34 × 23 mm, (2) 29 × 21 mm, posterior border sharp, fairly straight about bez tine.

60. *Hundstrup* bog, at Snesere brook. 1945 (Herlufsholms museum 53/1945).
Right antler, shed, broken between palm and back tine. Brow tine broken 13 cm from base, 20 × 20 mm. Bez tine broken 22 cm from base, 25 × 20 mm. Back tine damaged (artificially?), ridge-formed. Length of broken beam 72 cm, (1) 39 × 27 mm, (2) 32 × 26 mm, below back tine 50 × 27 mm, (3) 32 × 30 mm.

61. *Baarse*, Lundby (R. A. Olsen, D.G.U. 1917).
Left antler, shed, broken below palm. Brow tine broken at base of palmation, length 23 cm, diameters 21 × 19 mm. Bez tine long, palmated, length in a straight line 39 cm, diameters 28 × 22 mm. Back tine complete, 8 cm long, diameters at middle 16 × 20 mm. Length of beam 75 cm; diameters (1) 53 × 35 mm, (2) 44 × 36 mm, (3) 36 × 36 mm. Beam strongly curved above back tine. — Pl. I. R. 2, No. 1.

62. *Bøgesø*, S.E. of Næstved (D.G.U. 1925).
Fragment of bez tine.

63. *Fuglebjerg*, S.W. of Sorø (Jagt- og Skovbrugsmuseet, P. Schack).
♀, left antler, shed, broken below back tine. Brow tine, small, complete, 7 cm long, 9 × 9 mm. Bez tine broken 13 cm from base, 19 × 16 mm. Length of broken beam 35 cm, diameters (1) 31 × 22 mm, (2) 22 × 20 mm.

64. *Ringsted* river, Holtegaarden, Allindemagle (E. Rasmussen, 1934).
Right antler, shed, broken below palm. Brow tine (?), burr severely mutilated. Bez tine broken at base. Back tine large, broken 7 cm from base, diameters at tip 25 × 15 mm. Length of beam 80 cm; diameters (1) 47 × 43 mm, (2) 42 × 38 mm, (3) 45 × 36 mm ɔ: cylindricornis. Distinctly curved above back tine. Pl. II. R. 2, No. 5.

65. *Køge Bay*, below submarine bog (1935, 1936, 1941, 1943, 1947, 1948, 1949, 1954).
For many years a sand-pump has been working in Køge Bay. In special areas off Solrød and Køge Sønakke a submarine bog was discovered below the sand. From the sand below the bog many reindeer bones together with bones of several other animals were unearthed. Of reindeer was found:

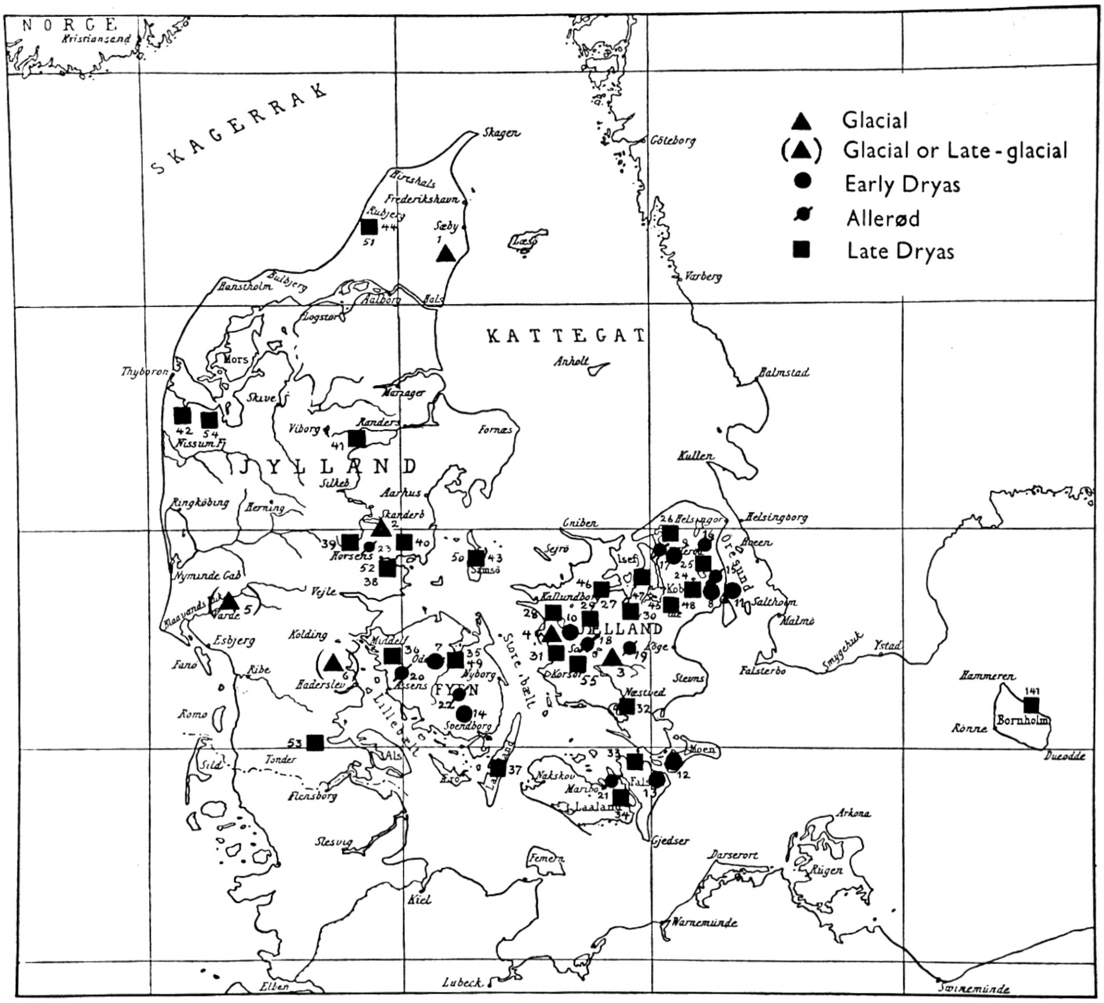


Fig 10. Map showing the dated finds of reindeer (*Rangifer tarandus*) in Denmark.
1 Lundebjerg, Vendsyssel. 2 Hylke. 3 Vetterslev. 4 Mullerup. 5 Hodde. 6 Christiansfeld. 7 Villestofte. 8 Herlev. 9 Allerød. 10 Ruds Vedby. 11 Copenhagen. 12 Askeby. 13 Ore. 14 Egebjerg. 15 Copenhagen. 16 Rungsted. 17 Allerød. 18 Bromme. 19 Mulstrup. 20 Vissenbjerg. 21 Idalund. 22 Kjellerup. 23 Sattrup. 24 Søborg. 25 Isterød. 26 Helsinge. 27 Holbæk. 28 Gørlev. 29 Onløse. 30 Kirke Saaby. 31 Mullerup. 32 Næstved. 33 Orenæs. 34 Rykkerup. 35 Odense. 36 Ejby. 37 Skrøbelev. 38 Overgaard. 39 Rask Mølle. 40 Aalstrup. 41 Hjorthede. 42 Fabjerg. 43 Tranebjerg. 44 Nørre Lyngby 45 Kallerup. 46 Stedstrup. 47 Vejleby. 48 Store Vejle Aa. 49 Odense. 50 Samsø. 51 Nørre Lyngby. 52 Horsens Fjord. 53 Fovrup. 54 Rimmer. 55 Skaftelev. 141 Søhjem.

(a) 3 km off Solrød, 4 km off Mosede (E. Wagner, 1935).
Metacarpus; lower part of right antler, shed, ♀. Brow tine absent. Bez tine broken 7 cm from base, 16 × 11 mm. Beam broken 12 cm from base, (1) 21 × 15 mm, (2) 18 × 15 mm.

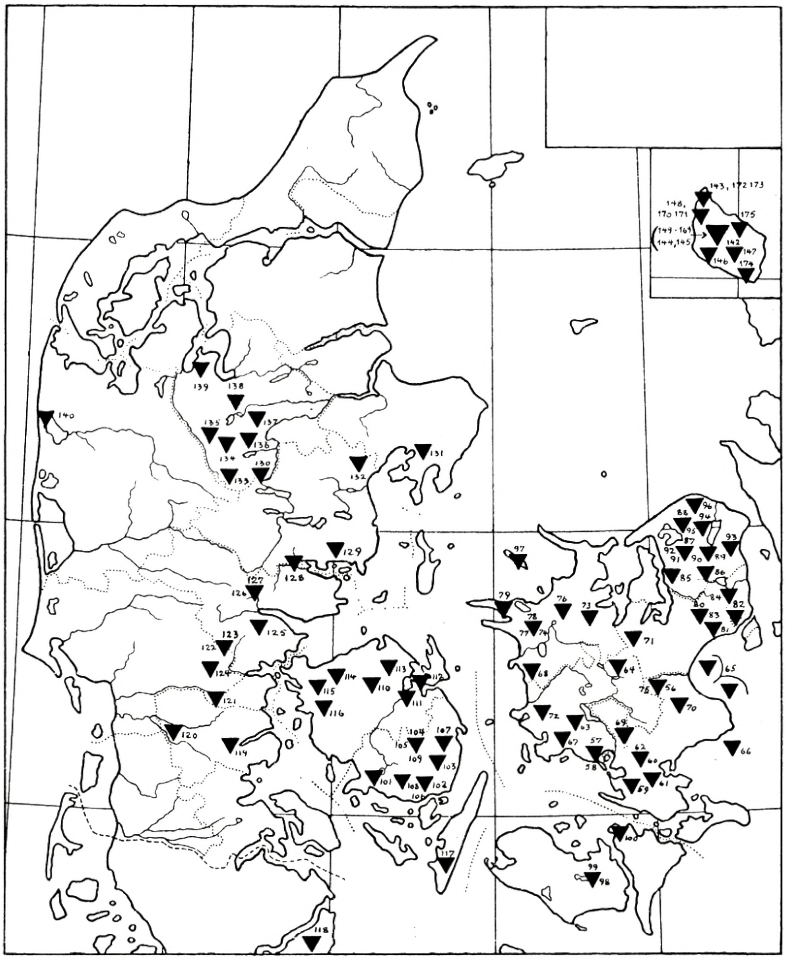


Fig. 11. Map showing finds of late-glacial reindeer (*Rangifer tarandus*) in Denmark (but no exact dating within this period).

56 Vollerslev. 57 Karrebækstorp. 58 Karrebæk. 59 Fugbæk. 60 Hundstrup. 61 Baarse. 62 Bøgesø. 63 Fuglebjerg. 64 Ringsted. 65 Køge Bugt. 66 Felskov Rev. 67 Basnæs. 68 Mullerup. 69 Vridsløse. 70 Thurebyholm. 71 Risbanke. 72 Ellermose. 73 Løvenborg. 74 Jordløse. 75 Hvalsø. 76 Faurbo. 77 Kjelleklintegaard. 78 Værslev. 79 Refnæs. 80 Hove Aa. 81 Lille Vejle Aa. 82 Damhus Aa. 83 Taastrup. 84 Vintappergaarden. 85 Oppesundby. 86 Bedstrup. 87 Pøle Aa. 88 Ramløse. 89 Damsholt. 90 Hillerød. 91 Karlsberg Sø. 92 Strødam. 93 Kokkedal. 94 Maarum. 95 Nejede. 96 Søborg. 97 Sejrø. 98 Røgbølle. 99 Lolland. 100 Gaabense. 101 Grønderup. 102 Skjerninge. 103 Slædbæk. 104 Egeskov. 105 Herringe. 106 Hvidkilde. 107 Brudager. 108 Gudme. 109. Langkilde. 110 Nellemose. 111 Seden. 112 Dræby. 113 Serup. 114 Tevring. 115 Ejby. 116 Aarup. 117 Southern Langeland. 118 Skovby, Skansen (now Germany). 119 Haderslev. 120 Gram. 121 Østerbygaard, Vamdrup. 122 Egholt. 123 Jordrup. 124 Andst. 125 Linnet. 126—127 Jelling. 128 Horsens. 129 Glibinggaard. 130 Silkeborg. 131 Kalø Vig. 132 Trige. 133 Bølling Sø. 134 Ungstrup. 135 Hvam. 136 Skavngaardsmose. 137 Brandstrup. 138 Viborg. 139 Højslev. 140 Thorsminde. 142 Vallensgaards mose. 143 Risegaard, Olsker. 144. 145 Klemensker. 146 Aaremyre. 147 Almindingen. 148 Rutsker. 149—169 Klemensker. 170, 171 Rutsker. 172—173 Olsker. 174 Poulsker. 175 Rø (176—214 Bornholm, not on map).

(b) (E. Wagner, 1936).
♂. Proximal part of *scapula*, 2 *humeri* (from the same animal), proximal part of *radius* (51 × 29 mm; breadth of articulation surface 46 mm), *tibia*, prox. part of *metatarsus*, *calcaneus* (total length 102 mm).

(c) (E. Wagner, 1941).
Fragment of antler. Posterior part of *mandible* with m 2 and m 3, *vertebra cervicalis*, upper end of *radius* jun. ad., *calcaneus*.

(d) (E. Wagner, 1943).
Fragment of antler, ♀, *antebrachium* (middle part), 1. and 3. phalanx.

(e) Off Solrød (G. Olafsson, 13/6 1947).
Lower part of antler, worked, longitudinal cut. Proximal part of *scapula*, 3 *metacarpi*, distal part of *metacarpus*, prox. part of *metatarsus*, distal part of *tibia*, fragment of *epistropheus*.

(f) Off Køge Sønakke (E. Wagner, 4/10 1947).
Prox. part of *scapula*, distal part of *humerus* (greatest width 46 mm), prox. part of *ulna*, *metacarpus*, middle part of *femur*.

(g) 3 km off Vallø (Hög Henriksen, 20/10 1947).
From *calf:* distal part of *femur* – epiphysis, parts of 2 *tibiae* of the same animal (prox. part – epiphysis; distal part – epiphysis), *metatarsus* – distal epiphysis, 2 *vertebrae*.
From a young animal ♂: *atlas*, *epistropheus*, *humerus* – prox. epiphysis (distal breadth 49 mm), *metacarpus* – distal epiphysis.
Adult animal: distal part of *humerus* (greatest breadth 48 mm), *metatarsus*.

(h) Off Solrød (G. Olafsson, 21/10 1947. At 8 m depth).
Fragments of antler, 2 fragments of *atlas*, part of thoracal vertebra, prox. part of 2 *scapulae*, distal part of *humerus*, *radius* – distal epiphysis (greatest breadth 44 mm), 3 prox. parts of *metacarpi*, distal part of *metacarpus*, fragment of pelvis, fragment of *tibia*, part of *calcaneus*, water-rolled; 1. and 2. toe-joint.

(i) G. Olafsson, 8/5 1948).
Fragments of antler and proximal parts of 2 *scapulae*.

(j) Off Solrød (G. Olafsson, 9/8 1948).
Below 2 m sand.
Lower part of shed antler, part of *scapula*, *humerus*, *tibia*, *metatarsus*, proximal part of *metacarpus*, water-rolled.

(k) Off Køge Sønakke (H. A. C. Jacobsen, 30/8 1948).
♀, 2 cervical *vertebrae*, *os sacrum*, *tibia*, 2 *metatarsi* belonging to the same animal.

(l) (G. Olafsson, 11/1 1949).
One *costa*, distal part of *tibia* (greatest breadth 39 mm), water-rolled.

(m) Off Solrød (G. Olafsson, 18/10 1949).
1. toe-joint; some *vertebrae*.

(n) Off Solrød (G. Olafsson, 20/8 1954).
6 fragments of antler, several water-rolled (1: lower part of left antler with small part of pedicle i. e. unshed. Brow and bez tine broken at base. Beam broken between bez and back tine; diameters (1) 29 × 14 mm, (2) 21 × 15 mm. Hind border between brow and bez tine sharp. Young animal. — 2: part of palm of young animal. — 3: part of beam with broken brow and bez tine. — 4: 3 fragments of antler). Anterior part of right *mandible*, broken posteriorly behind m 2. 4 cervical *vertebrae* and one dorsal *vertebra* of adult specimen; fragments of 2 *vertebrae*. Proximal part of 2 left *scapulae*. Complete *metacarpus* ad., water-rolled; part of distal end. 4 parts of *metatarsi* (lower half, 2 parts of diaphyses, part of upper end). Part of *antebrachium*, left;

upper end and most of *ulna* broken off, ad. — Upper half of *radius*, juv., 2 innomiate bones right, ad.

The animal bones brought to light together with the reindeer bones are of mixed origin; unearthed from the peatbog or from the stratum beneath the peat, i.e. representing animals from the forest as well as from the tundra. Besides reindeer the following species are represented: horse (no doubt wild horse), *(Equus caballus)*, elk *(Alces alces)*, urus *(Bos primigenius)*, wild boar *(Sus scrofa ferus)*, red deer *(Cervus elaphus)*, roe *(Capreolus capreolus)*, hare *(Lepus* sp.*)*. Of birds bones of grouse *(Lagopus albus)*, great auk *(Pinguinus impennis)*, swan *(Cygnus* sp.*)*, and goose *(Anser* sp.) have been identified.

66. *Felskov Rev*, S. of Rødvig (55°12′N, 12°20.5′S) (Morten Petersen, "Storebjørn", 1936).
Left antler with small part of frontal bone, broken between back tine and palm. Brow tine small, broken at tip, 4 cm long; diameters 12 × 12 mm. Bez tine broken 11 cm from base, diameters 25 × 21 mm. Back tine small, broken at base, 9 mm broad anterior-posteriorly. Length of beam 70 cm, diameters (1) 38 × 31 mm, (2) 36 × 29 mm, (3) 33 × 27 mm. Fairly straight. Pl. I. R. 4, No. 4.

67. *Basnæs*, S. of Skelskør (P. H. Hansen, 1949).
Left antler, lower part with broken brow- and bez-tine.

68. *Mullerup*, N.W. of Slagelse (M. J. Mathiassen, 1901), in a brick-field.
Small part of right frontal with lower part of antler. Brow tine broken at base. Bez tine broken 9 cm from base, 35 × 17 mm. (1) 34 × 30 mm (H.W. 1904).

69. *Vredsløse*, 3 km N. of Næstved (N. Holten, Traustedt, 1884).
Left antler, shed, broken through palm. Brow tine palmated, broken at tip, 34 cm from base, diameters 28 × 23 mm; height of (broken) palmation 21 cm. Bez tine complete, length in a straight line 40 cm, following median curvature 46 cm, diameters 36 × 20 mm, palmated with 4 tines, height of palmation 17 cm. Back tine well developed, 9 cm long, diameters in the middle 25 × 14 mm. Length of beam, very large, 133 cm. Diameters (1) 55 × 36 mm, (2) 49 × 34 mm, (3) 46 × 35 mm. i.e. fairly broad. Lowest back tine of palm small, a knob, no other back tines of palm seen, although distance from the said knob to broken surface of palm is 26 cm. — Pl. I. R. 3, No. 3.
In clay below peat. In the clay Steenstrup found leaves of *Dryas* (H.W. 1904).

70. *Thurebyholm*, Bregentved, 15 km S.W. of Køge (Ulrich, 1836).
Antler (Reinhardt 1836—37, p. 7, H.W. 1904).

71. *Risbanke*, Gørslev, 10 km E.S.E. of Ringsted (Thanning, 1852).
(a) (♀) Right antler, shed, broken below palm. Brow tine broken 9 cm from base, diameters 16 × 13 mm. Bez tine broken at base. Back tine well developed, broken 24 mm from base, diameters 18 × 6 mm, compressed. Beam 65 cm long, diameters (1) 28 × 19 mm, (2) 22 × 18 mm, (3) 20 × 16 mm. (Steenstrup 1853 p. 25, H.W. 1904). Pl.II. R. 3, No. 7.
(b) Right antler, shed, broken below palm. Brow tine missing? Bez tine broken 6 cm from base, diameters 30 × 19 mm. Back tine small, originally about 3 cm long, diameters 11 × 8 mm. Length of beam 90 cm, diameters (1) 40 × 30 mm, (2) 42 × 32 mm; just below back tine 52 × 32 mm i.e. cylindricornis, but a little broadened below back tine with sharp posterior border. Strongly curved above back tine. (H.W. 1904). Pl. II. R. 1, No. 5.

72. *Ellermose*, between Gjerlev and Slotsbjergby, 5 km S. of Slagelse (L. P. Fenger, 1853).
Right antler, broken above burr and below back tine. Bez tine broken 20 cm from base,

diameters 29 × 22 mm. Length of beam 50 cm, diameters (1) ?, (2) 39 × 29 mm. — In clay below 1 m peat. (Steenstrup, 1853 p. 25, H.W. 1904).

73. *Løvenborg*, 7 km S.W. of Holbæk (J. P. Petersen, 1899).
Left antler, shed, broken below palm. Proximal part of beam damaged. Back tine well marked, broken 2 cm from base, diameters 20 × 14 mm. Length of beam 70 cm, diameters (1) ?, (2) 43 × 33 mm, (3) 38 × 34 mm. Curved above back tine.

74. *Jordløse*, N. of Tissø lake (D.G.U. 1940).
Left antler, shed, broken below palm. Brow tine broken 15 cm from base, bifurcated, diameters 24 × 19 mm. Bez tine long, partly palmated, length 35 cm, diameters 28 × 23 mm. No back tine, but sharp posterior border. Beam rather straight, slightly curved, length 84 cm, diameters (1) 47 × 35 mm, (2) 41 × 37 mm, (3) below palm 43 × 31 mm. In clay 1 m below peat. Pl. I. R. 4, No. 6.

75. *Hvalsø*. Sonnerupgaard (S. Jensen, 1943).
Left antler, shed, broken just above back tine. Brow tine broken 12 cm from base, 15 × 20 mm. Bez tine broken 16 cm from base, 23 × 18 mm. Back tine broken at base, 22 × 13 mm. Length of broken beam 36 cm. Diameters (1) 35 × 26 mm, (2) 30 × 27 mm, (3) 30 × 27 mm.

76. *Faurbo Knold*, Snertinge pr. Jyderup (D.G.U., Knud Jessen, 1920).
Lower part of left antler, shed. Brow tine broken 14 cm from base, diameters 25 × 24 mm. Bez tine broken 18 cm from base, diameters 29 × 23 mm. Beam broken 13 cm above bez tine, diameters (1) 45 × 31 mm, (2) 41 × 30 mm.
Found together with a skeleton of *Alces alces*. (V. Milthers 1943, p. 149. Cf. Krog p. 135).

77. *Kjelleklintegaard*, 10 km S.E. of Kalundborg (H. P. Carlsen, 1881).
(♀) Right antler, shed, complete, small. Brow tine broken 4 cm from base, diameters 15 × 11 mm. Bez tine broken at base, diameters 20 × 9 mm. Back tine well developed, broken, 16 × 7 mm at base. No palm, i.e. beam nearly of the same width from base to tip. Length of beam 50 cm, diameters (1) 32 × 26 mm, (2) 21 × 15 mm, (3) 19 × 14 mm; greatest width at "palm" 24 mm.
Found in clay below peat; 2 m below the surface; about 30 cm above the sand bottom.

78. *Værslev*, 7 km E.S.E. of Kalundborg (Bølling, 1847).
Left antler, shed, broken above back tine. Brow tine broken 9 cm from base, 26 × 26 mm. Bez tine broken 20 cm from base, 30 × 27 mm. Back tine only indicated, ridge-formed. Length of beam 58 cm, diameters (1) 48 × 37 mm, (2) 36 × 34 mm (Steenstrup 1848, p. 6. — H.W. 1904).

79. *Refnæs*, Skambæk Mølle (Christiansen, Edv. Lehmann, 1905).
(a) Left antler, shed, broken through back tine. Brow tine broken at base, 26 × 16 mm. Bez tine broken 10 cm from base, 19 × 16 mm. Back tine ridge-formed. Beam broken 36 cm from base; diameters (1) 38 × 25 mm, (2) 28 × 25 mm.
(b) (S. Christiansen, 1909).
Left antler, shed, broken just above bez tine. Brow tine broken at base, 23 × 22 mm. Bez tine broken 9 cm from base, 31 × 22 mm. Beam broken 12 cm from base, diameters (1) 50 × 34 mm.

80. *The Hove* river, Nybølle (Vilhelm Johansen, 1945).
Left antler, shed; broken below palm. Brow tine broken 13 cm from base, diameters

20 × 22 mm. Bez tine broken 28 cm from base, diameters 20 × 18 mm. Back tine well marked, 2 cm long, 12 × 9 mm in the middle. Length of beam 70 cm, diameters (1) 38 × 30 mm, (2) 29 × 27 mm, (3) 27 × 23 mm, i.e. cylindricornis. Strongly curved above back tine, but then rather straight; beam below back tine straight. Pl. I. R. 4, No. 1. — Cf. p. 136. Found at a depth of 2 m' in gravel below peat.

81. *The Lille Vejle* river, 10 km S.W. of Copenhagen (Poul Sørensen, 1910).
Right antler, shed; broken below palm. Brow tine bifurcated, broken at base of points, length 20 cm, diameters 26 × 23 mm. Bez tine broken, length 27 cm, diameters 28 × 22 mm. Back tine absent. Length of beam 75 cm, diameters 33 × 32 mm i.e. typical cylindricornis. Beam rather straight. + part of broken beam. Pl. II. R. 4, No. 3.

82. *The Damhus* river, W. of Copenhagen (F. Bieht, 1942).
Right antler, shed, broken just below palm. Brow tine broken 17 cm from base, diameters 42 × 42 mm. Bez tine broken through base of palmation, length 42 cm, diameters 23 × 20 mm. Back tine well developed, broken at base, 22 × 12 mm. Length of beam 85 cm, diameters (1) 38 × 31 mm, (2) 32 × 28 mm, (3) 30 × 25 mm, i.e. cylindricornis. Distinctly curved above back tine, part below back tine rather straight. Pl. II. R. 3, No. 2.

83. *Taastrup*, W. of Copenhagen (D.G.U. 1917).
♀ Right antler, shed, broken through "palm". Brow tine 7 cm long, 9 × 10 mm. Bez tine broken 19 cm from base, 17 × 10 mm. Back tine high up on the beam, 28 mm long. Length of beam 47 cm, diameters (1) 25 × 18 mm, (2) 18 × 15 mm, (3) 22 × 12 mm.

84. *Vintappergaarden*, S. of *Lyngby*, 10 km N. of Copenhagen (K. A. Larsen 1862, 1863).
(a) Shed antler (H.W. 1904).
(b) Right antler, shed, broken below palm. Brow tine broken at base, very small. Bez tine broken 26 cm from base, diameters 31 × 22 mm. Back tine rather small, 3.5 cm long. Length of beam 90 cm, diameters (1) 41 × 31 mm, (2) 40 × 30 mm, (3) 39 × 36 mm, i.e. nearly cylindricornis. Curved above back tine. Pl. II. R. 2, No. 3.

85. *Oppesundby*, 4 km S.E. of Frederikssund (Jørgen Mogensen, 1859).
Antler. (H.W. 1904).

86. *Bedstrup pr. Lynge* (P. Bodilsen, 1935).
Right antler, shed, broken through distal part of palm. Brow tine small, 3 cm long, diameters 12 × 13 mm. Bez tine large, 35 cm long (following anterior curvature 50 cm), diameters 27 × 25 mm. Back tine only indicated by a prominence. Length of beam 110 cm, diameters (1) 41 × 38 mm, (2) 40 × 34 mm, (3) 40 × 33 mm. Diameters of palm between 2. and 3. tine 52 × 32 mm, between 3. and 4. tine 55 × 34 mm, i.e. cylindricornis. Distinctly curved. — Pl. II. R. 1, No. 4.

87. *The Pøle* river, E. of Arresø lake (D.G.U., Kjædegaard, 1923).
♀ Lower part of small antler, shed. Diameters (2) 14 × 12 mm. Found below 160 cm gravel with big stones.

88. *Ramløse* pr. Helsinge (Mineralogisk Museum, 1883).
Lower part of shed antler, small. "In marl below peat".

89. *Damsholt*, Bregnemose 7 km E. of Hillerød (Steenstrup, 1856).
♀ Right antler, shed, small, broken 5 cm above back tine. Brow tine almost complete, a simple prong, 16 cm long, diameters 12 × 8 mm. Bez tine missing. Back tine well marked; 1 cm long, 10 × 4 mm. Length of beam 30 cm, diameters (1) (2) 15 × 13 mm (H.W. 1904).

90. *Hillerød* (Lowzow, 1858).
Antler. (H.W. 1904).

91. *Karlsberg* lake, Hillerød (Sønnichsen, 1891).
Parts of 2 antlers. (H.W. 1904).

92. *Strødam*, Hillerød (D.G.U., Sylvest, 1923).
♀ Left antler, shed. No brow tine. Bez tine broken 7 cm from base, diameters 17 × 10 mm. Length of beam 25 cm, diameters (1) 26 × 17 mm, (2) 20 × 17 mm.

93. *Kokkedal*, Jellerødsgaard (Jagt- og Skovbrugsmuseet, Hans Danielsen, 1943).
(a) Part of frontlet with antlers, broken below palm. — Right antler: Brow tine missing. Bez tine broken 17 cm from base, 27 × 25 mm. Back tine very small, a knob. Length of beam 85 cm, strongly curved above back tine. Diameters (1) 48 × 37 mm, (2) 41 × 34 mm, (3) 37 × 32 mm. — Left antler: Brow tine broken 19 cm from base, 24 × 22 mm (was no doubt palmated). Bez tine broken 22 cm from base, 28 × 25 mm. Back tine complete, 1 cm long, 18 × 9 mm. Beam 95 cm long, strongly curved above back tine, (1) 62 × 40 mm, (2) 40 × 37 mm (below back tine 53 × 22 mm).
(b) ♀, left antler, shed, broken between back tine and palm. Brow tine probably missing (part of beam here corroded). Bez tine broken 18 cm from base, diameters 18 × 16 mm. Back tine broken 1 cm from base, diameters 15 × 17 mm. Length of broken beam 44 cm, diameters (1) 29 × 19 mm, (2) 21 × 18 mm, (3) 20 × 20 mm.

94. *Maarum*, 10 km N. of Hillerød (Holten, 1870).
Small part of brain-case with part of right antler, broken below back tine. Brow tine broken 8 cm from base, 20 × 26 mm. Bez tine broken 14 cm from base, 36 × 21 mm. Beam broken 20 cm from base, diameters (1) 50 × 36 mm, (2) 45 × 36 mm (H.W. 1904).

95. *Nejede*, 8 km N.W. of Hillerød (Jagt- og Skovbrugsmuseet, 1943).
(a) Left antler, shed, broken below palm. Brow tine strongly developed, broken 14 cm from base, 28 × 28 mm (no doubt palmated). Bez tine broken 5 cm from base, 31 × 25 mm. Back tine absent. Length of beam 72 cm, diameters (1) 47 × 37 mm, (2) 43 × 36 mm, (3) 43 × 32 mm.
(b) Part of right frontal with antler, broken below palm. Brow tine absent? Bez tine broken 7 cm from base, 27 × 20 mm. Back tine broken at base, 30 × 10 mm. Length of beam 60 cm, diameters (1) 37 × 32 mm, (2) 35 × 31 mm, (3) 33 × 29 mm. Typical "arcticus".

96. *Søborg* bog, Gilleleje (Peter Larsen, Gilleleje Museum No. 61, 1941).
Part of brain-case with broken antlers. Mastoid breadth 125 mm, breadth at incisura behind *meatus acusticus* 115 mm; breadth of brain-case at sutura frontotemporalis 100 mm. Height of brain-case from lower border of *for. magnum* 82 mm. Left antler in its lower part so severely corroded that nothing is seen of brow- and bez-tine. Back tine absent. Beam broken below "palm". Length 80 cm. Diameters in the middle 36 × 36 mm.

Sejrø

97. *Svale Klint* (A. Pedersen, 1902, Mineralogisk Museum).
Part of shed antler.
(N. Hartz, 1902, p. 45. H.W. 1904 and V. Nordmann 1915, p. 8. Cf. p. 136).

Lolland

98. *Røgbølle* lake, S.S.E. of Maribo (Wichfeld, 1847).
Antler. (H.W. 1904, Steenstrup 1848, p. 6).

99. *Lolland*, bog (Wichfeld, Engestofte 1867).
(a) Left antler, shed, broken between back tine and palm, posterior border split open. Brow tine partly broken at base, diameters 24 × 24 mm. Bez tine broken, 10 cm, diameters 25 × 19 mm. Back tine well marked, 45 mm long, diameters 13 × 10 mm at middle. Length of beam 70 cm; diameters above back tine 37 × 38 mm, i.e. cylindricornis. Distinctly curved above back tine ("arcticus").
(b) ♀, right antler, shed, broken below palm. Brow tine broken 5 cm from base, diameters 16 × 13 mm. Bez tine broken 8 cm from base, diameters 14 × 11 cm. No back tine. Length of beam 44 cm; diameters (1) 25 × 19 mm, (2) 21 × 17 mm, (3) 20 × 15 mm.

Falster

100. *Gaabense*, N.W. of Stubbekøbing (Worsaae, 1853).
♀? Left antler, shed, broken 10 cm above back tine, small. Brow tine broken 13 cm from base, 17 × 15 mm. Bez tine broken 25 cm from base, 21 × 16 mm. Back tine well developed, broken 2 cm from base, 23 × 19 mm (in the middle). Length of beam 48 cm, diameters (1) 51 × 22 mm (this width is so great because brow- and bez-tine are issued close together), (2) 25 × 20 mm, (3) 23 × 20 mm. (H.W. 1904). Pl. I. R. 4, No. 2.

Funen

101. *Grønderup*, 5 km. E.N.E. of Faaborg (E. Hansen, 1896).
Right antler, shed, broken between back tine and palm. Brow tine palmated, tip partly broken, length 35 cm, diameters 26 × 23 mm, height of palmation 26 cm. Bez tine nearly complete, palmated, only lower border of palmation damaged, length 50 cm (in a straight line), along median curvature, 60 cm, diameters 30 × 23 mm. Back tine well marked, 75 mm long, diameters in the middle 15 × 11 mm. Length of beam 78 cm. Diameters (1) 60 × 33 mm, i.e. brow tine and bez tine fairly close together, (2) 40 × 31 mm, (3) 44 × 34 mm. Part of beam between bez tine and back tine fairly straight, but above back tine the beam is distinctly curved. (H.W. 1904). Pl. II. R. 3, No. 3.

102. *Skjerninge*, 10 km W. of Svendborg (Lindberg).
Antler (A picture of this antler was sent to Steenstrup). (H.W. 1904).

103. *Slædbæk* brick-field, 7 km N.N.W. of Svendborg (D.G.U.).
Right antler, shed, broken below palm. Brow tine strongly palmated, 2 lower points, 3 upper points partly broken, height of palmation 22 cm, length 35 cm, diameters 31 × 23 mm. Bez tine artificially broken at base. No back tine. Length of beam 90 cm, diameters (1) 39 × 34 mm, (2) 34 × 33 mm, (3) 40 × 33 mm, i.e. cylindricornis. Rather straight.
(V. Madsen 1903, p. 24, H.W. 1904). Pl. II. R. 4, No. 4.

104. *Egeskov*, Karlsmosen, Kværndrup, 12 km N.N.W. of Svendborg. (Gregers Ahlefeldt-Laurvig-Bille; Jagt- og Skovbrugsmuseet, 1900).
Right antler, shed, broken between back tine and palm. Brow tine broken 14 cm from base, 22 × 23 mm. Bez tine broken 28 cm from base, 29 × 23 mm. Back tine marked, but

damaged. Length of broken beam 60 cm; diameters (1) 48 × 34 mm, (2) 37 × 31 mm, (3) 42 × 32 mm.

105. *Herringe*, Volstrup mose, 4 km S.S.W. of Ringe (Jagt- og Skovbrugsmuseet, Herluf Skræp, 1949).
Left antler, shed, broken above "back tine". Brow tine broken at base, 32 × ? mm. Bez tine broken 28 cm from base, 38 × 20 mm. Back tine absent. Length of broken beam 63 cm; diameters (1) 42 × 35 mm, (2) 37 × 34 mm.

106. *Hvidkilde*, 3 km W.N.W. of Svendborg (D.G.U. 1924).
Middle part of right antler, broken between bez tine and back tine, and below palm. Back tine broken at base; diameters (1) ?, (2) 38 × 30 mm, (3) 36 × 28 mm. Strongly curved ("arcticus").

107. *Brudager*, 7 km N.N.E. of Svendborg (Broholm collection).
Part of antler. (H.W. 1904).

108. *Gudme*, 10 km N.N.E. of Svendborg.
Part of antler. (H.W. 1904).

109. *Langkilde*, 10 km N.N.W. of Svendborg.
Antler (V. Madsen 1902, p. 123). (H.W. 1904).

110. *Nellemose* mark. Langesø about 12 km N.W. of Odense (Baron Schilden Holsten, 1936).
Left antler, shed, nearly complete. Length of brow tine 30 cm, with the exception of an upper point, the palmation of this tine is ending without distinctly developed points; least diameters 23 × 22 mm; greatest width of palmation 18 cm. Bez tine very long with 3 well developed points, length in a straight line is 42 cm; following anterior curvature 52 cm; diameters 33 × 21 mm. Back tine missing. Length of beam 115 cm, diameters (1) 45 × 38 mm, (2) 37 × 33 mm; greatest width of palm 70 mm; back tine of palm large, No. 2 bifurcated. Pl. I. R. 1, No. 1. — Cf. p. 136.

111. *Seden*, 3 km N.E. of Odense (Vedel Simonsen, 1858).
Right antler, shed, lower part. (H.W. 1904).

112. *Dræby*, 9 km N.E. of Odense.
Antler (V. Madsen 1902, p. 123). (H.W. 1904).

113. *Serup* bog, 10 km N.N.W. of Odense (Vedel Simonsen, 1858).
Antler. (H.W. 1904).

114. *Tevring* bog, 12 km S.S.W. of Bogense (Vedel Simonsen, 1858).
Fragment of brain-case with antler. Strongly curved ("arcticus"). (H.W. 1904).

115. *Ejby* bog, 15 km S.E. of Middelfart (D.G.U. 1937).
Middle part of antler.

116. *Aarup* (O. Lunn, 1933).
Parts of antler (In gyttja beneath peat, at a depth of 4 m).

Langeland

117. *Southern Langeland* (Frode Lund, 1942).
Part of small antler.

Jutland

118. *Skovby*, Svansen, Gottorp Amt (Now Germany) (LEHMANN, 1864).
Small part of brain-case with powerful antlers, broken above back tines.
Left antler: Brow tine broken 2 cm from base, 22 × 20 mm. Bez tine broken 3 cm from base, 45 × 22 mm. Back tine well marked, broken at base, 30 × 14 mm. Length of beam 70 cm, diameters (1) 61 × 39, (2) 49 × 36, below back tine 59 × 36 mm, (3) 44 × 33 mm.

Fig. 12. Part of frontal with lower part of antlers. On the right antler a supernumerary tine on the front face. From SKOVBY (No. 118).

Right antler: Brow tine broken at base, damaged. Bez tine broken 17 cm from base, 37 × 20 mm. Back tine only indicated, ridge-like. On the anterior border of beam there is an extraordinary strong ridge forming a supernumerary tine, broken 1 cm from base, about 23 cm from bez tine and about 12 cm below back tine; diameters 56 × 19 mm. Most of all it looks like an anterior "back tine". Length of beam 63 cm, diameters (1) 60 × 39 mm, (2) 56 × 37 mm, below aforementioned rim 70 × 38 mm, above extra tine 51 × 35, (3) 49 × 30 mm, i.e. compressicornis. (H.W. 1904). (Fig. 12).

119. *Haderslev* (LEHMANN, 1864).
Left bez tine, 42 cm long in a straight line, diameters 28 × 23 mm, palmated, 5 tines, lower part broken; height of palmation 22 cm. (H.W. 1904).

120. *Gram*, Tiset Enge (JES M. JENSEN, 1950).
Left antler, shed; lower part with broken brow- and bez-tine.

121. *Østerbygaard*, Vamdrup, 12 km S.W. of Kolding (WARMING, 1905).
Part of brain-case with right antler.
Width of brain-case at incisura in front of *proc. mastoideus* 112 mm, mastoid width 128

mm; width of condyli 72 mm. Length from *crista occipitalis* to *foramen supraorbitale* 132 mm. (Villestofte 137 mm, Strangegaard 129 mm, and Skinderbygaard 138 mm).

Antler broken between 1st and 2nd tine of palm. Brow tine broken at base of palmation, 14 cm from base, diameters 29 × 27 mm. Also the bez tine broadens in its distal part, indicating a bifurcation or palmation, broken 26 cm from base; diameters 33 × 24 mm. Back tine complete, 33 mm long, diameters at middle 15 × 9 mm. Length of beam 1 m; diameters (1) 47 × 44 mm, (2) 52 × 35 mm, (3) 49 × 37 mm. Width of beam between 1st and 2nd tine of palm 96 mm. This powerful antler is evenly curved above back tine, typical "*arcticus*". (H.W. 1904). Pl. II. R. 1, No. 2.

122. *Egholt*, Korsvang 13 km N.W. of Kolding (Bang and A. H. Tarp, 1942).
Part of pelvis (in calcareous peat soil).

123. *Jordrup*, 15 km N.W. of Kolding (K. O. Knudsen, 1921).
Left antler, shed, broken below palm. Brow tine palmated, broken through palmation, 25 cm from base; diameters 27 × 30 mm, height of broken palmation 11 cm. Bez tine nearly complete, bifurcated, and these two main points again bifurcated, length 38 cm, diameters 30 × 18 mm, height of palmation 18 cm. Back tine a well-marked long posterior ridge, 25 mm high and about 14 mm thick at base. Length of beam 84 cm; diameters (1) 56 × 40 mm, (2) 41 × 35 mm (smallest inferior), midway between bez and back tine: 48 × 32 mm, through back tine 83 × 34 mm (largest), (3) 42 × 34 mm. Part above back tine fairly straight. In marl below peat. Pl. I. R. 3, No. 5.

124. *Andst* (E. Stendevad, 1955).
Metacarpus (cf. Table 7).

125. *Linnet*, Vejle (M. P. Buch, 1918).
(♀) Right antler, shed, broken through base of palm. Brow tine complete, a simple point, 16 cm long, 12 × 9 mm. Bez tine broken 17 cm from base. Back tine absent, only indicated by a ridge. Length of beam 60 cm; diameters (1) 29 × 20 mm, (2) 24 × 20 mm, (3) 25 × 18 mm. — Pl. II. R. 3, No. 6.

126. *Jelling*, Grejsdalen (J. Lauridsen, 1938).
(a) Right antler, shed, broken below palm. Brow tine broken 14 cm from base, 28 × 23 mm. Bez tine broken 2 cm from base, 35 × 25 mm. Back tine missing. Beam 75 cm long; diameters (1) 47 × 34 mm, (2) 40 × 36 mm, i. e. cylindricornis. Distinctly curved. (In marl-pit). Pl. II. R. 2, No. 4.
(b) Right antler, shed, lower part with broken brow- and bez-tine.
(c) Vindelev bog (Alb. Jensen, 1908).
Right antler, shed, lower part.

127. *Jelling*, Kollerupgaard (Gunnar Kristensen, M. Jensen, 1943).
Left antler, shed, broken above "back tine", brow tine very small, broken 2 cm from base, 18 × 18 mm. Bez tine broken 20 cm from base, 26 × 23 mm. Back tine only indicated by a ridge. Length of beam 50 cm; diameters (1) 30 × 21 mm, (2) 25 × 20 mm. Beam rather straight. Chewed at top by carnivores? (*Gulo?*). Cf. p. 136.

128a. *Horsens*, from a marl-pit (Erslev, 1860).
Right antler, shed, broken below palm. Brow tine broken at base, 23 × 19 mm. Bez tine broken 6 cm from base, diameters 25 × 21 mm. Back tine well developed, broken 2 cm from base, 36 × 15 mm. Length of beam 110 cm, diameters (1) 37 × 32 mm, (2) 37 × 35 mm, (3) 41 × 36 mm, i. e. cylindricornis. Strongly curved above back tine. (H.W. 1904). Pl. II. R. 2, No. 2.

Fig. 13. Upper part of antler from Ungstrup, artificially cut off. (No. 134).

128b. *Kattrup* bog, 10 km N. of Horsens.
Small part of left frontal with antler. (Eigil Nielsen, 1949).

129. *Glibing Gaard*, north side of Horsens Fjord (Søltoft, 1867).
Part of left beam, broken above bez tine and below "palm". Back tine cut off or broken artificially. Diameters below back tine 50 × 44 mm, above back tine 45 × 41 mm. Strongly curved. On beam a triangular hole. (H.W. 1904).

130. *Silkeborg* (Klüwer, 1882). Skanderborg amt.
Right antler, shed, broken below palm. Brow tine strongly developed, broken 26 cm from base. On the front, 6 cm from the base, there is an extra point, broken at the base; diameters of brow tine 26 × 18 mm. No bez tine. Back tine strongly developed, diameters at base about 34 × 14 mm. Length of beam 1 m, diameters (1) above brow tine 36 × 36 mm, (2) 40 × 34 mm, (3) above back tine 42 × 32 mm. Strongly curved above back tine. (H.W. 1904). Pl. II. R. 2, No. 6.

131. *Kalø Vig*, Egens enge (Just, 1947).
Right antler, shed, broken below palm. Brow tine well developed, broken 10 cm from base, 23 × 24 mm. Bez tine broken at base. Back tine well marked, length 45 mm, diameters in the middle 14 × 10 mm. Length of beam 70 cm; diameters (1) 42 × 38 mm, (2) 40 × 36 mm, (3) 40 × 36 mm, i. e. cylindricornis. Strongly curved above back tine. — By dredging of a brook. Pl. II. R. 3, No. 1.

132. *Trige*, Bærmose, 10 km N. of Århus (Naturhistorisk Museum, Århus 5.1.1944 J.N. 445).
Right antler, shed. Nearly complete, only tip of beam broken off. Brow tine complete,

35 cm long, palmated with 12 points; height of palmation 32 cm; diameters 30 × 25 mm. Bez tine complete, lower border concave; length in a straight line 36 cm, along anterior curvature 46 cm; diameters 29 × 24 mm. Back tine missing. Shovel with at least 8 points. Length of beam 122 cm. Diameters (1) 46 × 34 mm, (2) 37 × 34 mm, (3) 37 × 33 mm. Width between 2nd and 3rd tine of shovel 92 mm, between 3rd and 4th points 84 mm. — Pl. II. R. 2, No. 1. — Cf. p. 132.

133. *Bølling* lake, 12 km W. of Silkeborg (CHRISTIANI, 1902).
Left antler, shed, broken below "palm". Brow tine broken 11 cm from base, 23 × 23 mm. Bez tine broken 23 cm from base, 25 × 21 mm. Back tine well developed, broken 6 cm from base, 12 × 10 mm. Length of beam 95 cm; diameters (1) 45 × 36 mm, (2) 36 × 33 mm, (3) 36 × 32 mm, i.e. cylindricornis. Beam between bez tine and back tine fairly straight, curved above back tine, but then straight, "tarandus"-like. In marl. Pl. I. R. 3, No. 4.

134. *Ungstrup* bog, 16 km S.S.W. of Viborg (A. FEDDERSEN, 1877).
Upper part of left antler. (H.W. 1904). A "waste piece" cut off for the purpose of using the proximal part of the beam as an implement, but the very smooth surface might indicate that this piece too, has been used as an implement. Length 69 cm, diameters 31 × 25 mm. Evenly curved. (Fig. 13).

135. *Hvam*, 15 km S.S.W. of Viborg (A. FEDDERSEN).
(a) Small antler.
(b) Shed antler of young animal.
(c) Part of antler of young animal.
(d) *Metatarsus*. (H.W. 1904) Cf. Table 8.

136. *Skavngaardsmose*, 7 km S.S.E. of Viborg (A. FEDDERSEN).
(a) (♀) Left antler, shed, broken below palm. Brow tine a simple prong, broken 10 cm from base, 11 × 10 mm. Bez tine broken 4 cm from base, 18 × 12 mm. Back tine absent, indicated by a sharp ridge. — Length of beam 38 cm; diameters (1) 22 × 16 mm, (2) 19 × 14 mm, (3) 16 × 14 mm.
(b) ♀ Left antler, shed, broken above "back tine". Brow tine broken at base. Bez tine broken 10 cm from base, diameters 15 × 8 mm. Back tine only indicated as a sharp ridge. Length of beam 25 cm; diameters (1) 26 × 14, (2) 16 × 13. (H.W. 1904).

137. *Brandstrup*, 10 km S.S.E. of Viborg (A. FEDDERSEN).
(♀) Left antler, shed, broken below palm; very small. Brow tine 2.5 cm long, 8 × 2 mm. Bez tine broken 8 cm from base, 15 × 9 mm. Back tine absent. Length of beam 35 cm, diameters 37 × 13 mm (brow tine and bez tine close together) (2) 16 × 13 mm, (3) 12 × 10 mm. (H.W. 1904).

138. *Viborg*, marl-pit. (A. FEDDERSEN).
Part of bez tine. (H.W. 1904).

139. *Højslev*, N.E. of Skive. Marl pit at *Skovsborggaard* (A. FEDDERSEN).
Left antler, shed, broken below palm. Brow tine well developed, palmated; length of broken tine 29 cm, base of palm 6 cm broad, diameters 27 × 20 mm. Bez tine 32 cm long, bifurcated, the lower part of the palmation broken; 25 × 19 mm. Back tine rather small, broken 2 cm from base, 16 × 10 mm. Length of beam 85 cm, diameters (1) 35 × 32 mm, (2) 35 × 33 mm, (3) 37 × 31 mm. Curved above back tine. (H.W. 1904). — Pl. I. R. 1, No. 4.

140. *Thorsminde*, S.W. of Lemvig, Nissum Fjord (CHR. NIELSEN, DREWSEN, 1873).
Antler. (H.W. 1904).

Bornholm

Remains from Late Dryas Period (Zone III)

141. *Søhjem*, Østermarie sogn (Jens Jensen; Nationalmuseet 1919).
Right antler, shed, broken through palm. Brow tine broken 16 cm from base, diameters 24 × 24 mm. Bez tine double, a lower, smaller one broken 5 cm from base, diameters 14 × 13 mm, and an upper, larger one broken 11 cm from base, diameters 18 × 18 mm. Back tine absent. Length of beam 106 cm; diameters (1) 37 × 33 mm, (2) 40 × 32 mm, (3) 36 × 29 mm; breadth of palm between 1st and 2nd tine 51 mm. "*Arcticus*"
At a depth of 6 metres, below peat. Pl. IV. R. 1, No. 4. — Cf. Krog, p. 136.

Remains from Late-glacial Times (but no exact dating within this period).

142. *Vallensgaards Mose*, S. of Almindingen, Aaker Sogn (K. A. Grønwall, 1902, D.G.U.). From snail-marl.
(a) Left antler, shed; broken below palm. Brow tine broken together with part of beam. Bez tine long, bifurcated, finally with two tines to each side; 37 cm long, diameters in the middle 31 × 22 mm. Back tine well developed, broken at base. Beam strongly curved above back tine. Length of beam 75 cm. Diameters (1) 45 × 35 mm, (2) 45 × 35 mm (below back tine 57 × 39 mm i.e. flattened), (3) 42 × 42 mm, i.e. rounded again. Pl. III. R. 2, No. 5.
(b) ♀ Frontlet with antlers, broken above bez tine. *Left* antler: Brow tine broken at base, small. Bez tine broken 3 cm from base, diameters 17 × 8 mm. Length of beam 9 cm; diameters (1) 20 × 16 mm, (2) 19 × 16 mm. — *Right* antler: Brow tine broken 3 cm from base, diameters 13 × 9 mm. Bez tine broken at base. Diameters of beam (1) 22 × 16 mm, (2) 18 × 15 mm. Smallest width of skull below antlers 91 mm. (H.W. 1904).

143. *Risegaard*, Olsker (Tryde, 1883).
Left antler, shed; broken below palm. Brow tine broken 4 cm from base, 20 × 20 mm. Bez tine broken 20 cm from base; 26 × 20 mm. Back tine cut off. Length of beam 70 cm; (1) 38 × 33 mm, (2) 38 × 32 mm, (3) 34 × 34 mm. Beam straight above back tine ("tarandus"). (H.W. 1904). Pl. III. R. 3, No. 4.

144. *Klemensker*, E. of Hasle, Thor Westh's bog (Holten, 1882).
(a) Right antler, shed; broken below palm. Brow tine broken 15 cm from base; 20 × 20 mm. Bez tine broken 10 cm from base, 31 × 24 mm. Back tine well-formed, but rather small, 5.5 cm long, 13 × 10 mm (in the middle). Length of beam 75 cm, (1) 44 × 26 mm, (2) 37 × 25 mm, (3) 33 × 28 mm ("tarandus"). (H.W. 1904). Pl. IV. R. 3, No. 2.
(b) Part of brain-case with left antler, broken above back tine. Brain-case broken in front of orbit, right side of brain-case: *temporale*, *parietale* and *frontale* broken off along suture.
Mastoid breadth 65 × 2 = 130 mm; width of condyli = 75 mm. Height of *supra-occipitale*, from superior border of *foramen magnum* 59 mm, from inferior border 80 mm. Smallest width of skull, below pedicles of antlers, 62 × 2 = 124 mm. Brow tine broken 18 cm from base, 23 × 20 mm. Bez tine broken 22 cm from base, 33 × 26 mm. Back tine a broad ridge. Length of beam 65 cm, (1) 53 × 41 mm, (2) just above bez tine 41 × 37 mm, in the middle 47 × 37 mm. (H.W. 1904). Fig. 14. — Cf. Krog, p. 137.
(c) Right antler, shed, complete. Brow tine a short, simple prong, 5 cm long; diameters in the middle 11 × 11 mm. Bez tine 40 cm long, deeply bifurcated, with 3 tines,

height of palmation 167 mm; diameters 31 × 18 mm. Back tine well marked, 15 mm high, top broken. Length of beam 108 cm (in a straight line 74 cm), palm with two bifurcated back tines; diameters (1) 41 × 29 mm, (2) 38 × 28 mm, (3) 35 × 27 mm. Breadth between 1st and 2nd palm-tine 60 mm. Shape of beam nearly circular or beautifully sickle-formed. (H.W. 1904, Pl. XI, No. 2). Pl. IV. R. 1, No. 3.

Fig. 14. Part of brain-case from KLEMENSKER (No. 144).

(d) Left antler, shed, nearly complete, only tines of palm broken at tip. Brow tine flattened at outer half with sharp edges (as the knife in No. 11); length 36 cm in a straight line, along outer curvature 39 cm; diameters 21 × 25 mm; height of blade 53 mm, thickness 14 mm. Bez tine palmated with 4 tines, length 37 mm in a straight line, 42 cm along median curvature; diameters 34 × 22 mm, height of palmation 186 mm. Back tine 8 cm long, diameters at middle 21 × 16 mm. Length of beam 110 cm along median curvature, in a straight line 60 cm, i.e. highly curved. Palm broad with 6 large tines, the inferior of which is bifurcated; diameters (1) 50 × 38 mm, (2) 54 × 37 mm, (3) 40 × 36 mm. Width of palm between 1st and 2nd tine 88 mm, between 2nd and 3rd tine 86 mm. 2 circles. (H.W. 1904, Pl. XI, No. 1, and A. JACOBI 1931, Fig. 31). Pl. III. R. 1, No. 2.

145. *Klemensker*, Præstegaardsmosen (CHR. HANSEN and HOLTEN, 1882).
Left antler, shed, broken through inferior tine of palm. Brow tine broken 12 cm from

base, diameters 29 × 29 mm. Bez tine nearly complete, only inferior tine of palmation broken off; length in a straight line 58 cm, along median curvature 62 cm, diameters 38 × 30 mm. Back tine 5 cm long, 15 × 11 mm in the middle. Length of beam 94 cm; diameters (1) 52 × 43 mm, (2) 43 × 39 mm, (3) 43 × 40 mm. A powerful antler; two circles. Pl. III. R. 2, No. 1. — Cf. KROG, p. 137.

146. *Aaremyre*, Almindingen, E. of Rønne (ROSEN, 1850).
Lower part of *metatarsus* (cf. Table 8). (H.W. 1904, STEENSTRUP, 1853).

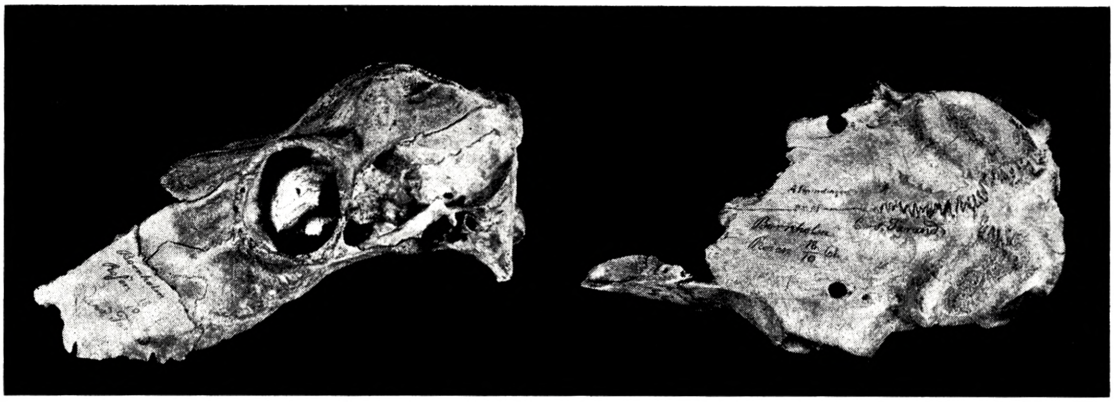


Fig 15. Part of skull from ALMINDINGEN (No. 147).

147. *Almindingen* (ROSEN, 1861).

(a) Several parts of skeleton: brain-case of which the antlers are shed, left mandible, 1st to 6th cervical vertebra, 6 thoracic vertebrae, 4 ribs, part of *sternum*. — On the left side the brain-case is broken through the *foramen infraorbitale*, in the midline just in front of the nasal base, and on the right side the orbit is partly broken. In the mandible the lower part is damaged. Regarding measurements of brain-case and mandible see Tables 1 and 2, respectively.
The lengths from the *crista occipitalis* to the *foramen infraorbitale*, from the *crista occipitalis* to the nasal base, and from the *foramen magnum* to the nasal base, which is distinctly indieated, are fairly large, 243 mm, 170 mm and 174 mm, respectively; in the Villestofte skull the respective measurements are 246, 174 and 172 mm. The mandible, however, is less powerful than in the Villestofte specimen. Accordingly the condylobasal length of the Almindingen skull must have been about the same size as that of the Villestofte specimen, perhaps a little shorter: 365—370 mm.
The great distance from base of skull to base of nasals might indicate that the nasals were fairly short. The nasal bones have been lost, but the posterior edge, the *sutura naso-frontale*, is in so far intact, that it is clearly seen that the posterior edge of the nasal bones together have formed a single and backward-turned curve, as is also the case in the Villestofte and Strangegaard specimens, and as is generally found in the Scandinavian reindeer (cf. p. 56). (Fig. 15).

(b) Small part of right frontal with lower part of antler. (H.W. 1904).

148. *Rutsker*, N.E. of Hasle, (SIERSTED, 1877).
Left antler, shed. Lower part of beam with brow tine damaged. Bez tine broken 21 cm from base, 27 × 19 mm. Back tine absent. Length of beam 55 cm, (1) 34 × 26 mm, (2) 27 × 26 mm (curved). (H.W. 1904).

The above-mentioned specimens from Bornholm are kept in the Zoological Museum of Copenhagen.

All the following finds belong to *Bornholms Museum*, Rønne.

The numbers in parenthesis indicate the numbers given by this museum. I beg to express my most cordial thanks to the curators of Bornholms Museum, Mr. AAGE I. DAVIDSEN, M. A. and Mr. ARNE LARSEN, M. A. They have given me all facilities for studying the large collection of subfossil reindeer from Bornholm, kept in Bornholms Museum, and provided much valuable information regarding the findings.

Bornholms Museum

149. *Strangegaard*, Klemensker. (The farmers THOLSTRUP and HANS ANKER). Bornholms Museum 1944, (but "discovered about 50 years ago").

A large and powerful skull, nearly complete, but the intermaxillare is absent; the orbits are damaged posteriorly (cf. Table 1). Both antlers are broken about 30 cm above the back tine. (Figs. 16 and 17).

Right antler broken below palm. Brow tine broken 24 cm from base, diameters 38 × 22 mm. At the base of the brow tine, lateral to rose, there is a small cone, 2 cm high. Bez tine broken 32 cm from base, 41 × 28 mm, width at broken tip 10 cm. Back tine 10 cm long, complete, 17 × 14 mm. Length of beam 95 cm; (1) 55 × 43 mm, (2) 50 × 41 mm (below back tine 60 × 39 mm), (3) 46 × 36 mm; "arcticus".

Left antler, broken below palm. Brow tine broken through palmation, 30 cm from base; diameters 34 × 29 mm, width of broken tip 14,7 cm. Bez tine broken 37 cm from base, diameters 35 × 26 mm, at broken tip 90 mm. Back tine absent, indicated as a ridge. Length of beam 90 cm; (1) 57 × 44 mm, (2) 47 × 39 mm, (3) 43 × 33 mm· "Arcticus". Greatest width of antlers 116 cm (cf. p. 49 and 137, and Table 1).

150. *Skinderbygaard*, Klemensker (ACHER).

Brain-case, broken through orbits. Right antler nearly straight. (Figs. 18 and 19).

Right antler. Brow tine complete, a long, but simple prong, 25 cm long, diameters 17 × 23 mm. Bez tine complete, very broad and powerful, with 5 points, length 50 cm (along anterior curvature 60 cm), diameters 56 × 28 mm; height of palmation 34 cm. Back tine placed very low, just above bez tine, length 6 cm, diameters in the middle 21 × 10 mm. Tip of beam broken off just above 3rd tine of shovel. Inferior tine 27 cm long, 54 × 23 mm; 2nd tine 30 cm, 43 × 23 mm; 3rd tine 5 cm, 36 × 16 mm. Length of broken beam 124 cm (along outer curve 129 cm); diameters (1) 50 × 41 mm (least), below bez tine 90 × 42 mm; (2) 76 × 38 mm; (3) 46 × 37 mm. Width of shovel between 1st and 2nd tine 77 mm, between 2nd and 3rd tine 63 mm.

Left antler broken just above 2nd tine of shovel. Brow tine almost complete, very powerful with a large palmation comprising 12 points, several are inward curved; length 42 cm; diameters 32 × 27 mm, width of palmation 34 cm. Bez tine with 3 points, main point broken off, length 50 cm (along anterior curvature 60 cm), diameters 37 × 24 mm. Back tine, very small, nearly a ridge; placed 20 cm from bez tine, i. e. fairly low. Length of beam 110 cm, (1) 50 × 36 mm, (2) 48 × 35 mm, (3) 36 × 35 mm.

Length of 1st tine of shovel 30 cm, 30 × 20 mm. Length of 2nd tine of shovel 18 cm, 27 × 18 mm. Width between 1st and 2nd tine of shovel 55 mm. Greatest spread of antlers 144 cm. — Cf. *Krog*, p. 137.

151. *Klemensker*, Præstegaardsmosen (Chr. Colberg).
Right antler, shed. Brow tine broken 15 cm from base; 28 × 26 mm. Bez tine complete, length 36 cm, diameters 37 × 23 mm, palmated with 6 tines; width of palmation 160 mm. Back tine well developed, compressed, length 85 mm, 25 × 11 mm. Length of beam, in a straight line 79 cm (greatest length 99 cm), following curvation 120 cm (1) 47 × 36 mm, (2) 42 × 35 mm, (3) 37 × 36 mm. Width of palm from anterior to posterior tip in a straight line 62 cm. Palm with 6 tines; the posterior of these with 2 points. Width of palm above this tine 124 mm. The shape of this antler is pronouncedly "arcticus" although the proximal part of the beam, below the back tine, is fairly straight. Pl. IV. R. 1, No. 1. — (100)

152. *Klemensker*, Nørregaard (Peter Lyster, 1926).
Right antler, shed, broken-through palm. Brow tine prong-formed. 7 cm long, 13 × 14 mm. Bez tine 37 cm, palmated, 6 points, width of palmation 20 cm, 26 × 22 mm. Back tine 6 cm, 17 × 9 mm, 8 cm above back tine a small extra back tine, 1 cm long 11 × 8 mm. Palm narrow, only two tines present. Length of beam 92 cm (straight line 73 cm) (1) 47 × 35 mm, (2) 34 × 28 mm, (3) 34 × 24 mm. Width of palm above lower tine 49 mm, "arcticus" (fairly straight). Pl. IV. R. 3, No. 1. (171)

153. *Ibid. idem.* Left antler, shed, broken between back tine and palm. Brow tine damaged, broken 9 cm from base. Bez tine broken 30 cm from base, 35 × 19 mm. Back tine complete, 8 cm, 16 × 11 mm. Length of beam 62 cm, (1) 38 × 30 mm, (2) 41 × 32 mm, below back tine 58 × 30 mm, (3) 34 × 27 mm. (170)

154. *Klemensker*, Vognsø, 5 km N.N.W. of Aarsballe (Ancher).
Left antler, shed, broken through palm. Brow tine large, very deeply bifurcated or perhaps an extra tine on lower border 7 cm from base; length 30 cm, broken at tip, 20 × 27 mm, supplementary lower tine broken 17 cm from base; 22 × 14 mm. Bez tine prong-formed, length 13 cm, 13 × 10 mm. Back tine broken at base, 21 × 12 mm. Palm broken above lower tine. Length of beam 70 cm, (1) 40 × 27 mm, (2) 31 × 28 mm, (3) 33 × 24 mm. Width of palm above lower tine 70 mm. "Arcticus", fairly straight. Pl. III. R. 3, No. 2. (50)

155. *Klemensker*, Bedegadegaardsmosen.
Left antler, shed, broken between palm and back tine. Brow tine prong-formed, broken 4 cm from base, 14 × 14 mm. Bez tine broken 20 cm from base, 26 × 17 mm. Back tine broken at base, compressed, 23 × 9 mm. Length of beam 50 cm, (1) 32 × 25 mm, (2) 30 × 22 mm, (3) 27 × 22 mm. "Arcticus", fairly straight. (151)

156. *Klemensker*.
Left antler, shed, broken above "back tine". Brow tine broken 3 cm from base, 19 × 16 mm. Bez tine broken 22 cm from base, 24 × 18 mm. Back tine absent. Length of beam 46 cm, (1) 35 × 24 mm, (2) 31 × 24 mm. "Arcticus". (94)

157. *Klemensker*.
Right antler, shed, broken below palm. Brow tine broken, 3 cm, 16 × 17 mm. Bez tine bifurcated, broken at base of bifurcation, 25 cm, 24 × 17 mm. Back tine very small, a knob. Length of beam 75 cm, (1) 44 × 26 mm, (2) 29 × 27 mm, (3) 31 × 24 mm. One circle. Pl. IV. R. 2, No. 3. (95)

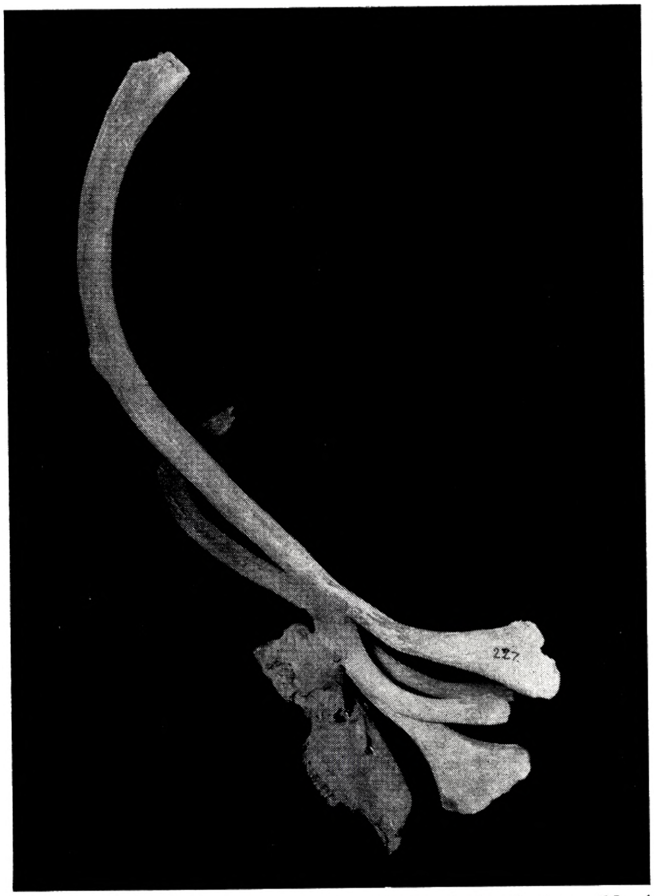


Fig. 16. Skull from STRANGEGAARD, Bornholm. Lateral view. (No. 149).

158. *Klemensker*, Dyndegaard (ANCHER).
Right antler, shed, heavily broken below back tine. Lower part damaged. Brow tine completely broken off. Bez tine broken, 20 cm, 38 × 27 mm. Length of beam 48 cm, (1) 50 × 44 mm, (2) 42 × 40 mm. (51)

159. *Klemensker*, Aarsballemosen (ANCHER).
Left antler, shed, broken between back tine and palm. Brow tine broken, 5 cm, 14 × 14 mm. Bez tine, broken, 9 cm, 22 × 15 mm. Back tine broken at base, compressed, 26 × 10 mm. Length of beam 54 cm, (1) 33 × 25 mm, (2) 27 × 21 mm, (3) 28 × 22 mm. "Arcticus". Beam between bez tine and back tine straight. Pl. III. R. 3, No. 8. (7)

160. *Klemensker* (Lyngholt).
Left antler, shed, broken between bez tine and back tine. Small. Brow tine broken at base, 13 × 14 mm. Bez tine broken, 6 cm, 22 × 14 mm. Length of beam 23 cm, (1) 26 × 20 mm, (2) 20 × 18 mm. — Discovered by digging for marl. (91)

Fig. 17. Skull from STRANGEGAARD. Frontal view. (No. 149).

161. *Klemensker* (Lyngholt).
Damaged fragment. Bez tine broken, 3 cm, 40 × 20 mm.
Discovered by digging for marl. (87)

162. *Klemensker*, Strangegaard.
Left antler, shed, broken at back tine, very small. No brow tine. Bez tine broken 7 cm, 17 × 11 mm. Length of beam 39 cm, (1) 29 × 12 mm, (2) 21 × 18 mm. (228)

163. *Klemensker*, Aarsballe.
(a) Right antler, shed, broken between bez tine and back tine. Brow tine, broken, 12 cm, 15 × 14 mm. Bez tine broken, 10 cm, 23 × 16 mm. Length of beam 27 cm, (1) 32 × 21 mm, (2) 27 × 20 mm.
(b) Left antler, shed, broken above "baek tine". Brow tine broken at base, 17 × 13 mm. Bez tine broken, 14 cm, 20 × 17 mm. No back tine. Length of beam 47 cm, (1) 28 × 22 mm, (2) 26 × 22 mm.
(c) Right antler, shed, broken between back tine and palm. Brow tine broken at base,

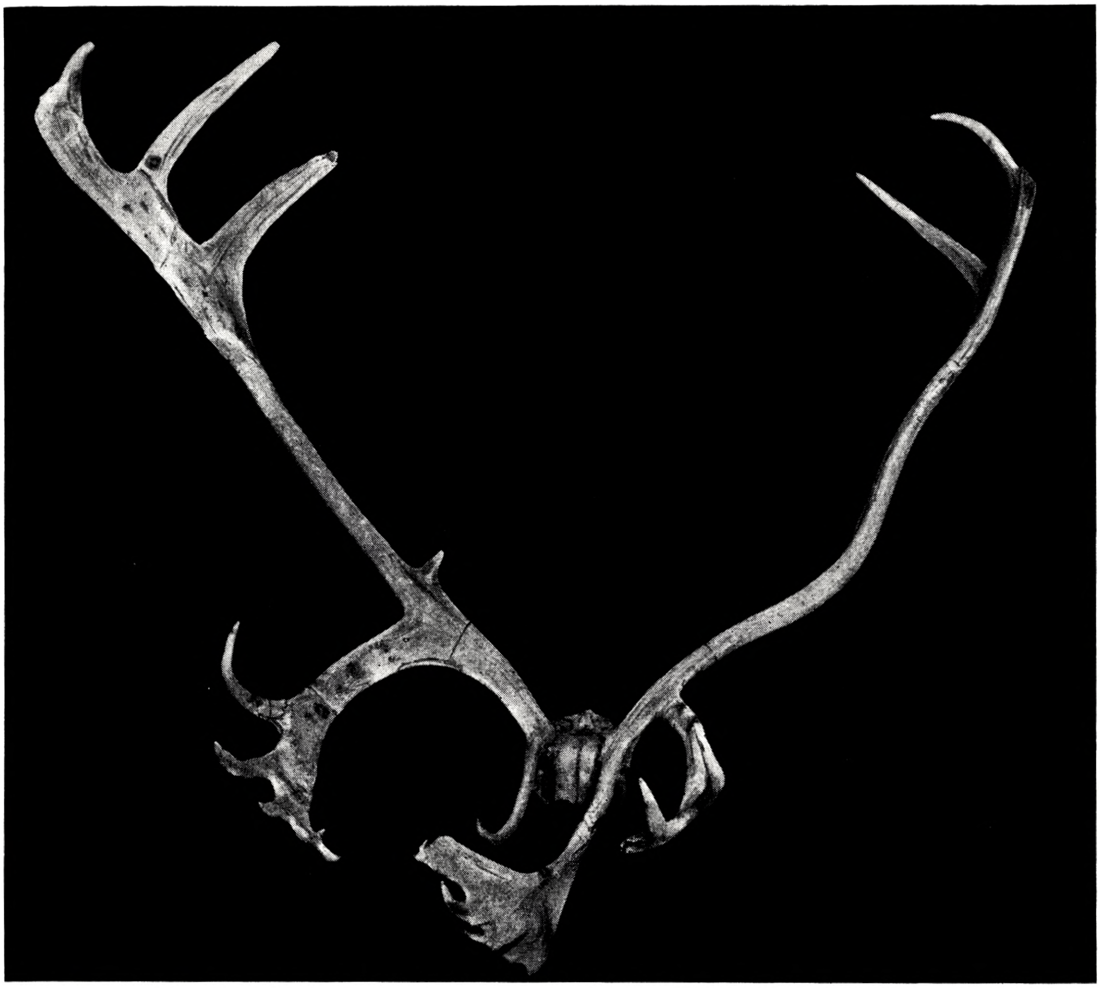


Fig. 18. Skull from SKINDERBYGAARD. Frontal view. (No. 150).

32 × ? mm. Bez tine broken, 7 cm, 44 × 18 mm. Back tine broken at base, 33 × 14 mm. Length of beam 58 cm, (1) 49 × 36 mm, (2) 47 × 30 mm, (3) 41 × 32 mm; anterior and posterior face fairly sharp. (163)

164. *Klemensker*, (ANCHER, Stangegaard).
Right frontlet with very small antler broken below back tine. Brow tine absent. Bez tine broken, 11 cm, 13 × 11 mm. Length of beam 29 cm, (1) 19 × 14 mm, (2) 17 × 13 mm. (juv.). (22)

165. *Klemensker*, Knudegaardsmose (SINIUS OLSEN).
Right antler, shed, broken between back tine and palm. Brow tine broken 13 cm from base, 20 × 18 mm. Bez tine large, broken at tip, 33 cm, 32 × 26 mm; on upper side 2 large points, broken at base, 25 and 29 mm, respectively; Back tine 6 cm, complete, 10 ×

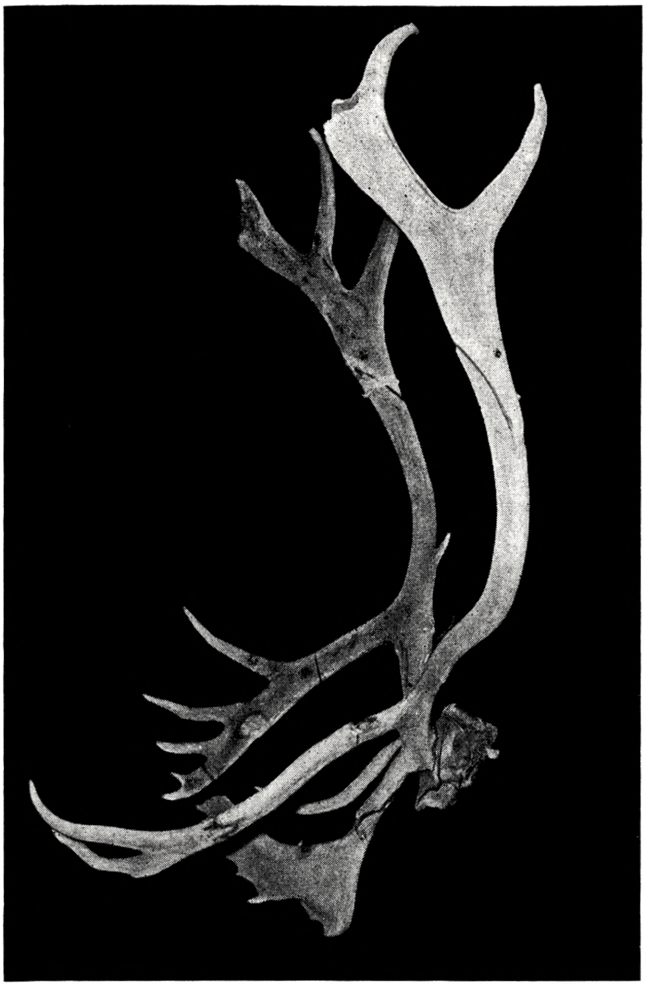


Fig. 19. Skull from SKINDERBYGAARD. Lateral view. (No. 150).

10 mm. Length of beam 54 cm, (1) 35 × 27 mm, (2) 34 × 24 mm, (3) 29 × 23 mm. "Arcticus". Pl. IV. R. 2, No. 4. — Cf. KROG, p. 137. (93)

166. *Klemensker*, Knudegaardsmose (SINIUS OLSEN).
Right antler, shed, broken below palm. Brow tine complete, 17 cm, prong-formed, compressed at tip, 14 × 11 mm. Bez tine broken 20 cm from base, 20 × 12 mm. Back tine broken 2 cm from base, 20 × 11 mm. Length of beam 50 cm, (1) 30 × 21 mm, (2) 33 × 20 mm, (3) 24 × 20 mm. "Arcticus", compressicornis. Pl. IV. R. 2, No. 6. (92)

167. *Klemensker* (BENTZEN).
Left antler, shed. Brow tine a simple prong, rather small, 40 mm, broken, diameters at tip 12 × 12 mm. Bez tine broken, 16 cm, 30 × 25 mm (in the files of Bornholms Museum: length 45 cm, palmated, 6 tines). Back tine, hook formed 57 × 24 mm, extra back tine

about 10 cm above main back tine. Palm broken at tip and damaged. Length of broken beam 115 cm, in a straight line 80 cm. (B.M.: length 128 cm), (1) 45 × 35 mm, (2) 37 × 33 mm (hind face of beam sharp and broadened below back tine: 68 mm broad) (3) 40 × 32 mm. Pl. III. R. 1, No. 1. (1)

168. *Klemensker*, Aarsballemosen (Anker).
Right antler, shed. Broken through palm. Brow tine a simple prong, broken, 6 cm long, 18 × 16 mm. Bez tine long, palmated with 5 tines, complete. Length in a straight line 37 cm, 36 × 22 mm, width of palmation 182 mm. Back tine powerful, length 12 cm, 34 × 16 mm. Powerful palm, broken above third back tine of palm; 2nd back tine of palm forked. Length of broken beam 110 cm (straight line 72), (1) 50 × 36 mm, (2) 50 × 33 mm (below back tine 78 mm broad), (3) 44 × 36 mm. Width of palm between 1. and 2. tine 80 mm, between 2nd and 3rd 83 mm.
"Arcticus", compressicornis — cylindricornis. Pl. IV. R. 1, No. 2. (146)

169. *Klemensker*, Aarsballemosen, N. of Almindingen.
Left antler, shed; broken below palm. Brow tine palmated, broken through base of palmation, length 20 cm, 28 × 26 mm. Bez tine very heavy and flat, broken through palmation, 35 cm, 37 × 25 mm, width of palmation, broken, 19 cm. Back tine compressed, 9 cm, 22 × 15 mm. Length of broken beam 77 cm, (1) 60 × 45 mm, (2) 50 × 43 mm, (3) 42 × 37 mm. Beam flattened below back tine: 65 mm. Pl. III. R. 1, No. 4. (178)

170. *Rutsker*, Pellegaard (A. Christiansen).
Right antler, shed. Brow tine long, 28 cm, 3 points, 17 × 17 mm. Bez tine long, bifurcated, broken at base of bifurcation, 32 cm, 25 × 19 mm. Back tine long, 13 cm, 13 × 13 mm. Beam pointed at tip, no real palm, only one back point, broken at base. Length of beam 82 cm (61 cm), (1) 39 × 23 mm, (2) 28 × 20 mm, (3) 28 × 21 mm. — Light antler. "Arcticus" (lower part straight). Pl. IV. R. 2, No. 7. (16)

171. *Rutsker*, bog near Rut's church (M. Jespersen).
Right antler, shed. Brow tine broken 16 cm from base, 19 × 18 mm; bez tine with 3 points, 35 cm long, 26 × 18 mm. Back tine absent or placed just as high on beam as inferior tine of palm. Presumably no real palm. Length of beam 75 cm, (1) 35 × 25 mm, (2) 27 × 24 mm. 2 circles. Pl. IV. R. 2, No. 2. (167)

172. *Olsker*, Vedbygaard (Bendtsen).
Right antler, shed, broken below palm. Brow tine a prong, complete, 12 cm, 10 × 10 mm, Bez tine bifurcated, broken at base of bifurcation, 30 cm from base, 24 × 17 mm. Back tine broken at tip, 10 cm long, 14 × 11 mm. Length of beam 60 cm, (1) 28 × 20 mm, (2) 30 × 319 mm.
"Arcticus". (3)

173. *Olsker*, Lundegaard (Jacobsen).
Left antler, shed, broken below palm. Brow tine broken, 10 cm, 20 × 23 mm. Bez tine broken, 5 cm, 33 × 20 mm. Back tine broken at base, 27 × 22 mm. Length of beam 50 cm, (1) 43 × 25 mm, (2) 35 × 25 mm, (3) 30 × 25 mm. — Cf. Krog, p. 137.
Pl. III. R. 3, No. 6. (152)

174. *Poulsker*, Dyndeby.
Left antler, shed, broken below palm. Brow tine broken 8 cm from base, 17 × 14 mm. Bez tine broken 6 cm from base, 17 × ? mm. 5 cm from the bez tine a small point is indicated. Back tine broken at base, 15 × 9 mm. Length of beam 64 cm, (1) 41 × 21 mm, (2) 25 × 20 mm, (3) 25 × 20 mm. (76)
"Arcticus".

175. *Rø*, Bondegaardsmosen.
Right antler, shed, broken below palm. Brow tine small, broken at tip, 5 cm from base, 11 × 9 mm. Bez tine broken at base, 27 × 12 mm. Back tine small, 3 cm, broken at tip, 13 × 6 mm. Length of beam 50 cm, (1) 42 × 23 mm, (2) 26 × 24 mm, (3) 27 × 20 mm. "Arcticus", lower part fairly straight. Pl. IV. R. 2, No. 5. (166)

176. *Bornholm.*
Left antler, shed, broken below palm. Brow tine a small prong, broken at base, 16 × 13 mm. Bez tine very long, 53 cm (following curvature 58 cm), palmated with 5 tines, width of palmation 18 cm, 36 × 26 mm. No back tine. Length of beam 70 cm, (1) 47 × 37 mm, (2) 41 × 37 mm. (11)

177. *Bornholm.*
Right antler, shed, broken through palm. Brow tine broken 11 cm from base, 20 × 21 mm. Bez tine broken at base, 33 × 22 mm. Back tine broken at base, 25 × 15 mm. No real palm, only inferior tine present, broken. Length of beam 90 cm, (1) 44 × 32 mm, (2) 41 × 31 mm, (3) 39 × 32 mm. Width of palm, superior to lower tine, 57 mm.
Fairly straight, "arcticus". Pl. IV. R. 2, No. 1. (12)

178. *Bornholm.*
Left antler, shed, broken above 2nd tine of palm. Brow tine a simple prong, 7 cm long, 12 × 13 mm. Bez tine broken 24 cm from base, 24 × 21 mm. No back tine. No real palm. Length of beam 78 cm, (1) 29 × 25 mm, (2) 27 × 26 mm, (3) below palm 27 × 26 mm. Width of palm between 1st and 2nd tine 42 mm. Tip of beam strongly inward curved. Pl. III. R. 2, No. 3. (177)

179. *Bornholm.*
Right antler, shed, broken below palm. Brow tine broken 11 cm from base, 19 × 18 mm. Bez tine broken 30 cm from base, 33 × 22 mm. Back tine broken at base, 25 × 10 mm. 7 cm above this back tine an extra back tine, well-formed, 7 cm long, 12 × 12 mm. Length of beam 65 cm, (1) 43 × 25 mm, (2) 37 × 27 mm, smallest in the middle 45 × 25 mm, (3) 35 × 28 mm. Beam below 1st back tine of palm: 56 × 27 mm, with sharp posterior face. Compressicornis. 2 circles. Pl. IV. R. 1, No. 5. (181)

180. *Bornholm.*
Left antler, shed, broken at top. Brow tine broken 13 cm from base, 19 × 17 mm. Bez tine 28 cm long (along anterior curvature 33 cm), bifurcated; 28 × 17 mm. No back tine. No real palm. Length of beam 76 cm, (1) 35 × 25, (2) 29 × 26 mm, (3) below palm 31 × 18 mm. Pl. III, R 3, No. 3. (14)

181. *Bornholm.*
Left antler, shed, broken below palm. Brow tine only indicated. Bez tine broken 25 cm from base, 31 × 20 mm. Back tine absent. Length of beam 69 cm, (1) 47 × 30 mm, (2) 38 × 28 mm, across ridge-formed posterior border, at position of "back tine", 46 × 29 mm. (3) below palm 36 × 27 mm. (185)

182. *Bornholm.*
Right antler, shed, broken below palm. Brow tine broadening at tip, broken 16 cm from base, 20 × 19 mm. Bez tine broken 12 cm from base, 20 × 17 mm. One cm below the bez tine an extra small and narrow point is indicated, broken at base, 17 × 6 mm. Back tine absent. Length of beam 62 cm, (1) 33 × 23 mm, (2) 28 × 22 mm, (3) below palm 26 × 20 mm. Pl. IV. R. 3, No. 4. (188)

183. *Bornholm.*
Left antler, shed, broken below palm. Brow tine simple prong, broken 3 cm from base, 13 × 12 mm. Bez tine broken 28 cm from base, diameters 26 × 20 mm, with two large points on upper border, broken; 26 and 30 mm, respectively.
Back tine complete, 9 cm long, 12 × 11 mm. Length of beam 70 cm, (1) 43 × 31 mm, (2) 30 × 29 mm, (3) 32 × 24 mm. Pl. III. R. 3, No. 1. (184)

184. *Bornholm.*
Right antler, shed, broken between palm and back tine. Base of beam strongly corroded. Bez tine broken 11 cm from base, a small point on upper border, 3 cm from base, 22 × 22 mm. Back tine broken at base, damaged. Beam strongly grooved. Length 60 cm, (1) 50 × 40 mm, (2) 35 × 31 mm, (3) 37 × ? mm.
"Arcticus". (5)

185. *Bornholm.*
Right antler, shed, broken between back tine and palm. Brow tine broken 16 cm from base, 23 × 25 mm. Bez tine broad, broken 17 cm from base, 40 × 25 mm. Back tine complete, 6 cm, 15 × 10 mm. Length of beam 60 cm, (1) 48 × 29 mm, (2) 36 × 27 mm, (3) 38 × 27 mm. Pl. IV. R. 3, No. 6. — Cf. Krog, p. 137. (190)

186. *Bornholm.*
Right antler, shed, broken between back tine and palm. Brow tine broken 8 cm from base, 17 × 17 mm. Bez tine broad broken 6 cm from base, 40 × 14 mm. Back tine broken at tip, 6 cm, 14 × 11 mm. Length of beam 61 cm, (1) 33 × 24 mm, (2) 29 × 23 mm, (3) 24 × 20 mm. Pl. IV. R. 3, No. 7. – Cf. Krog, p. 137. (15)

187. *Bornholm.*
Right antler, shed, broken below palm. Brow tine broken 12 cm from base, 18 × 16 mm. Bez tine broken 24 cm from base, 26 × 15 mm. Back tine broken at base, 24 × 10 mm. Beam 50 cm long, (1) 31 × 20 mm, (2) 28 × 17 mm, (3) 21 × 20 mm. Pl. IV. R. 3, No. 9. (17)

188. *Bornholm.*
Left antler, shed, broken at or below back tine. Brow tine broken 12 cm from base 14 × 14 mm. Bez tine broken 14 cm from base, 20 × 17 mm. Length of beam 42 cm, (1) 31 × 25 mm, (2) 26 × 24 mm. (186)

189. *Bornholm* (Lansemyr, Kumblehøj, Lind).
Left antler, shed. Tip of palm broken. Brow tine broken at base, simple. Bez tine palmated, broken at base of palmation, length 30 cm, 27 × 25 mm (B.M.: with 4 points). Back tine well-formed, 58 mm, 12 × 14 mm. Palm with three very powerful back tines. Length of beam 113 cm (80 cm) (B.M.: length 126 cm), (1) 42 × 33 mm, (2) 38 × 32 mm, (3) 38 × 32 mm. Width of palm between 1st and 2nd tine 58 mm, between 2nd and 3rd tine 59 mm. Part of beam above back tine straight. Lateral face of beam below back tine concave. Pl. III. R. 3, No. 5. (10)

190. *Bornholm.*
Right antler, shed, broken through palm. Brow tine small, prong-formed, broken at base. Bez tine broken 25 cm from base, 29 × 22 mm. Back tine fairly large, 13 cm, 19 × 15 mm. Palm broken above 1st back tine. Length of beam 87 cm (77 cm) 46 × 37 mm, (2) 36 × 34 mm, (3) 38 × 31 mm. Width above 1st tine of palm 60 mm. "Arcticus", but fairly straight. Pl. IV, R. 3, No. 3. (183)

191. *Bornholm.*
Left antler, shed, broken above back tine. Very powerful. Brow tine broken 18 cm from base, 33 × 34 mm. Small extra tine 3 cm long, between brow tine and bez tine. Bez tine very broad, broken at base of palmation, 26 cm, 48 × 29 mm. Back tine well marked, 43 mm long, 16 × 14 mm. Length of beam 62 cm, (1) 64 × 43 mm, (2) 50 × 42 mm. — Cf. fig. 35, p. 85. (224)

192. *Bornholm.*
Left antler, shed, broken below palm. Brow tine broken at base, small 15 × 16 mm. Bez tine broken 13 cm from base, 25 × 14 mm. Back tine absent. Beam abnormal shaped above "back" tine. Length of beam 57 cm, (1) 34 × 25 mm, (2) 33 × 22 mm. (192)

193. *Bornholm.*
Left antler, shed, broken below back tine. Brow tine broken 14 cm from base, 27 × 27 mm. Bez tine broken, 3 cm, 30 × 23 mm. Length of beam 46 cm, (1) 43 × 35 mm, (2) 38 × 32 mm. (189)

194. *Bornholm.*
Left antler, shed, broken below back tine. Brow tine, broken, 16 cm, 28 × 26 mm. Bez tine broken, 14 cm, 36 × 24 mm. Length of beam 45 cm, (1) 48 × 39 mm, (2) 40 × 46 mm. (182)

195. *Bornholm.*
Left antler, shed, broken at base of palm. Lower part of beam damaged. Back tine only indicated as a ridge. Length of beam 80 cm, (1) ?, (2) 42 × 37 mm, (3) 42 × 37 mm. Pl. III. R. 2, No. 2. (2)

196. *Bornholm.*
Right antler, shed, broken above back tine, small. Brow tine broken at base, 16 × 12 mm. Bez tine broken at base, 30 × 14 mm. Back tine indicated by a ridge. Length of beam 40 cm, (1) 36 × 20 mm, (2) 23 × 20 mm. (19)

197. *Bornholm.*
Right antler, shed, broken below palm. Very small. Brow tine broken, 8 cm, 15 × 10 mm. No bez tine. Back tine indicated by a ridge. Length of beam 34 cm, 17 × 15 mm. (195)

198. *Bornholm.*
Right antler, broken above back tine. Very small. Brow tine broken at base, 13 × 11 mm. Bez tine broken, 7 cm, 15 × 11 mm. Length of beam 28 cm, (1) 20 × 17 mm, (2) 19 × 14 mm. (197)

199. *Bornholm.*
Base of beam with part of abnormal brow tine, broken 10 cm from base, very high, 43 mm, and narrow, 9 mm. On lower face an extra point. 1 cm above brow tine an extra small point. (198)

200. *Bornholm.*
♀ ad. Left part of frontlet, with nearly obliterated sutures, very small. Antler broken between bez tine and back tine, small. Brow tine broken, 4 cm, 13 × 10 mm. Bez tine broken at base. Length of beam 18 cm, (1) 24 × 17 mm, (2) 18 × 16 mm. (200)

201. *Bornholm.*
♀ ad. Right part of frontlet of very small animal. Antler broken above bez tine. Brow tine broken at base, 10 × 7 mm. Bez tine broken, 5 cm, 18 × 10 mm. Length of broken beam 8 cm (1) 21 × 15 mm. (202)

202. *Bornholm.*
Left part of frontlet with lower part of antler, very small. Brow tine absent. Bez tine broken at base, 22 × 9 mm. Length of broken beam 12 cm, (1) 21 × 16 mm, (2) 19 × 14 mm. (203)

203. *Bornholm.*
Part of left antler, broken through palm. Brow tine absent. Bez tine long, complete with 3 points, length 42 cm, 31 × 23 mm. Back tine complete, 5 cm, 24 × 12 mm. Palm with a single tine. Length of beam 115 cm, (1) 42 × 34 mm, (2) 44 × 33 mm, (3) 38 × 32 mm. Width of palm 46 mm.
One circle. Pl. III. R. 1, No. 3. (180 + 187)

204. *Bornholm.*
Lower damaged part of right antler. Bez tine broken, 10 cm, 40 × 28 mm. Length of broken beam 45 cm, (1) 50 × 40 mm, (2) 42 × 35 mm. (20)

205. *Bornholm.*
Right antler, shed, broken below back tine. Brow tine broken, 5 cm, 22 × 13 mm. Bez tine broken, 11 cm, 21 × 12 mm. Length of broken beam 30 cm, (1) 38 × 14 mm, highly compressed. (2) 24 × 15 mm. (194)

206. *Bornholm.*
Right antler, small, broken about "back tine". Brow tine broken at base, 10 × 7 mm. A small extra point 1 cm below bez tine, 1 cm long, 10 × 7 mm. Bez tine broken, 12 cm, 15 × 13 mm. No back tine. Length of beam 44 cm, (1) 26 × 18 mm, (2) 20 × 17 mm. (6)

207. *Bornholm.*
Right antler, shed, broken above back tine. Brow tine broken 20 cm from base, 23 × 25 mm. Bez tine palmated, broken through palmation, 34 × 23 mm. On upper side of bez tine springs at base a supplementary tine 10 cm long. Back tine broken, 33 × 17 mm. Length of broken beam 61 cm, (1) 48 × 37 mm, (2) 46 × 33 mm, (3) 44 × 34 mm. Beam below back tine 53 mm broad.
Fairly straight. (Cf. fig. 36, p. 87). (13)

208. *Bornholm.*
Right antler, shed, broken below palm. Brow tine very small, broken at base, 10 × 11 mm. Bez tine broken 17 cm from base, 25 × 20 mm. Back tine absent. Length of beam 54 cm, (1) 34 × 26 mm, (2) 30 × 24 mm.
"Arcticus". (193)

209. *Bornholm.*
Right antler, shed, broken below palm. Brow tine broken at base, 16 × 13 mm. Bez tine broken 16 cm from base, 21 × 15 mm. Back tine absent. Length of beam 54 cm, (1) 33 × 23 mm, (2) 27 × 23 mm.
"Arcticus". (8)

210. *Bornholm.*
Left antler, shed, broken below palm. Brow tine broken 16 cm from base, 25 × 24 mm. Bez tine broken 30 cm from base, 30 × 24 mm. Back tine small, 4 cm, 12 × 14 mm. Length of beam 80 cm, (1) 45 × 35 mm, (2) 37 × 37 mm, (3) 39 × 34 mm.
Pl. III. R. 2, No. 4. — Cf. Krog, p. 138. (179)

211—213. *Bornholm.*
Fragments of lower part of antler. (196, 199, 18)

214. *Bornholm.*
Part of palm. (201)

Zoological Investigations of the Material

The Danish material may naturally be grouped into four parts: (1) a complete skeleton and skull with antlers from Villestofte, (2) a nearly complete skull with antlers, and parts of skulls (a brain-case with antlers and a fragmentary skull without antlers) from Bornholm, (3) skeletal parts, and (4) antlers.

Although *Rangifer tarandus* was abundant in prehistoric Europe and distributed as far south as northern Spain, the Mediterranean coast, and the Alps, undamaged remains of this species are rare, since most of the material has come from settlements where the bones are greatly fragmented, split open to take out the marrow or converted into implements. — Only a few complete, or fairly complete skulls and some complete mandibles are recognized, and as far as I know, not a single complete skeleton has been examined.

Therefore special interest must be ascribed to the Danish material and especially to the Villestofte skeleton and the skulls and brain-case from Bornholm.

The first known find of *Rangifer* is from the Pleistocene period, the species being unknown in the Pliocene. The first find of *Rangifer* is from Süssenborn, near Weimar, Central Europe, from the antepenultimate glaciation or Mindel glaciation (Phase II, Zeuner 1945, p. 255), but the animal was then of rare occurrence.

Many authors are of opinion that the reindeer immigrated into Europe from the more continental N.E. According to Jacobi (1931), and some other writers, however, the reindeer of the European Pleistocene originated in North America. — This question together with other problems: the systematic position of the animals, barren-ground reindeer *versus* woodland reindeer, etc., will be discussed in connection with the description of the Danish material.

The Complete Skeleton from Villestofte and the Skulls and Brain-case from Bornholm

The earliest discovery of reindeer of real zoological importance in Denmark after the glacial period is a complete skeleton from Villestofte 6 km N.W. of Odense, Funen. This unique specimen was excavated in 1938 by Fyens Stiftsmuseum. According to Dr. Johs. Iversen, Danmarks Geologiske Undersøgelse, it belongs to Zone I c, the Early Dryas period. (Milthers 1940, p. 103; vide Krog p. 126).

This skeleton represents a powerful animal. The shoulder height of the mounted skeleton is 113 cm, length of head and body 173 cm. Measurements of the single skeletal parts are recorded in Tables 1–16. For the sake of comparison some measurements of recent and subfossil reindeer are added.

Comparison with the Scandinavian Reindeer

Skeleton. According to Lönnberg (1909) there were originally two different forms of wild reindeer on the Scandinavian peninsula, a large woodland type and a smaller tundra or mountain form. The type of *Rangifer tarandus tarandus* (Linn.)

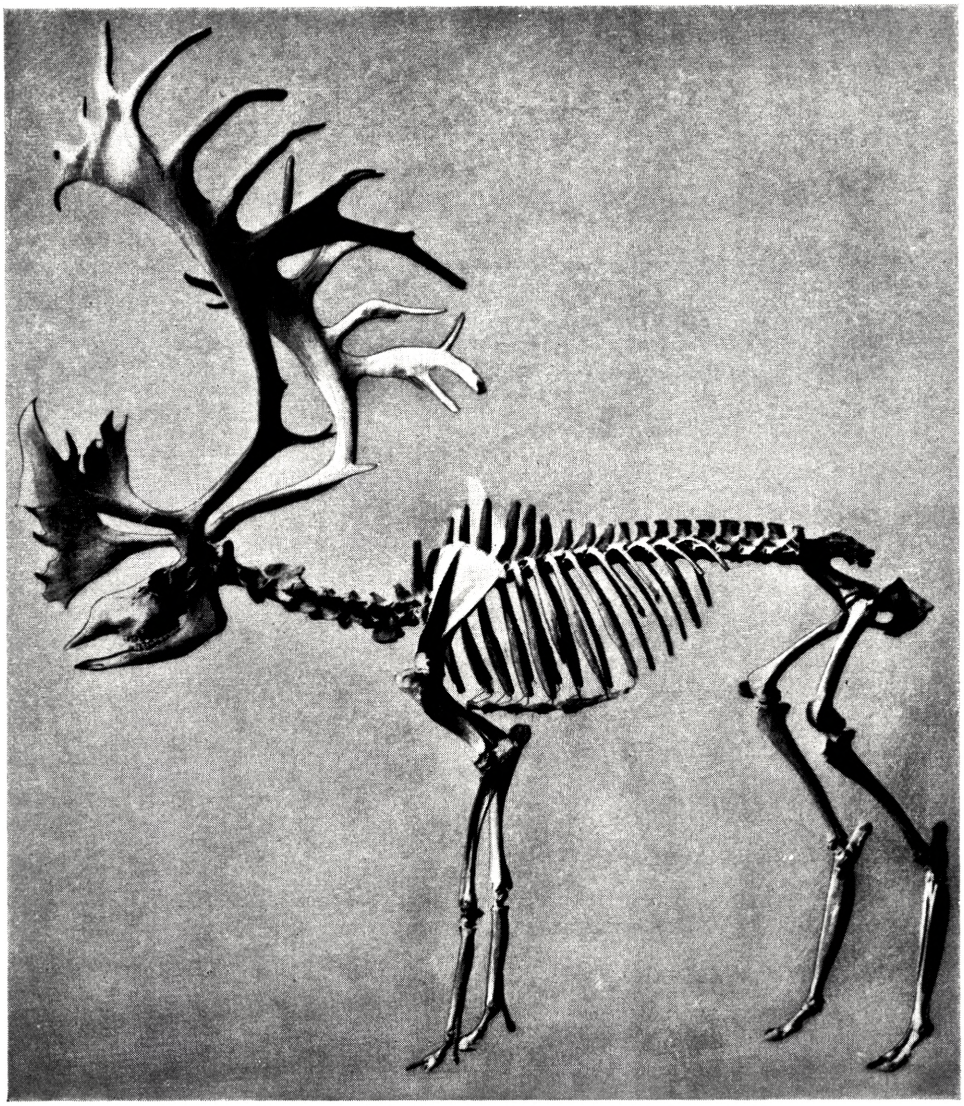


Fig. 20. Skeleton from VILLESTOFTE, Funen.

must be the wild reindeer of the alps of Swedish Lappland. This animal is now extinct in Sweden and scientific material of it is very scarce. But *Rangifer t. tarandus* in addition includes the still existing wild Norwegian reindeer — in former days the area of distribution of this wild reindeer in Sweden was completely continuous with that of southern Norway — and the tame mountain reindeer of northern Scandinavia. According to NILSSON (1847) the height at the withers of a wild reindeer stag from Norway is 113 cm, and at the loins 115 (converted from Swedish feet and inches, and here cited from Lönnberg). Collett gives the height of Norwegian males at the shoulder at about 110 cm.

Of greater size is the woodland reindeer (*R. t. fennicus* Lönnberg). Its area of distribution formerly extended over the greater part of the forest-clad Finland—Karelia, the Kola Peninsula, the adjoining parts of Russia, and the forests of northern Sweden (Lönnberg *loc. cit.* p. 12). Lönnberg, after Pleske 1884, records that a not yet full-grown stag ("probably three years old") had a vertical height of 121 cm at the withers and 131 cm at the loins. The same author informs us that a mounted animal in the Zoological Museum of Helsingfors, from the Kola Peninsula, has a shoulder height of 120 cm and a height at the loins of 128 cm, thus agreeing with Pleske's measurements—but he does not tell us whether this animal is quite correctly stuffed, i.e. whether it has the measurements of the live animal.

It is not possible directly to compare the measurements of the skeleton from Villestofte with measurements taken of the animal itself with skin, muscles and hoofs. I suppose that the living animal must be 5 to 10 cm higher at the shoulders than the skeleton. The Villestofte animal thus being just as large as Lönnberg's large woodland reindeer from Fennia.

Skulls. More exact measurements may be taken of the *skull* (Table 1). This table shows that several measurements in the Villestofte specimen prove to be just as large or larger than in *R. t. fennicus:* the basal length (the basicranial length of Lönnberg) is 356 and 357 mm, respectively, distance from *crista occipitalis* to posterior end of nasals 174 and 176 mm, distance between tip of nasals and tip of premaxillaries 114 and 104 mm, vertical height at anterior end of nasals 69 and 69 mm, width of skull behind the canines 69 and 69 mm, and zygomatic breadth 155 and 149 mm, respectively. The facial part from the orbit to the tip of the premaxillaries is, however, shorter in the Villestofte specimen than in *R. t. fennicus* (230—243 mm, respectively). In *R. t. fennicus* the orbits are strongly protruding, so the width of the skull is remarkable. — Besides size, however, Lönnberg mentions several other differences in the features of the skull in the two subspecies, features which he considers characteristic of the two types, the barren-ground or tundra reindeer and the woodland reindeer, but later authors have not, as we shall see, been able to agree with this.—In *R. t. fennicus* the nasals should be strongly elevated above the maxillary bones, but in *R. t. tarandus* they should rise very little above the maxillary suture. Consequently the height of the facial portion of the skull is considerably greater in the former than in the latter. On this point the Villestofte reindeer also agrees with the woodland reindeer of Lönnberg. Curiously enough, the measurements of the vertical height of the skull at the *os supramixillare accessorium* and of the distance from m2 to the nasal suture are exactly the same in the holotype of *R. t. fennicus* and in the Villestofte specimen, 115—115 and 69—69 mm, respectively.

In *R. t. fennicus* the nasals anteriorly are broader than in *R. t. tarandus* and the anterior nasal opening has its greatest width at the sutures between the *ossa supramaxillare accessoria* and the premaxillaries; in *R. t. tarandus* the greatest width of the nasal opening, still according to LÖNNBERG, is situated nearly in its middle. However, this shape of the nasal aperture is not characteristic of the woodland type, but is a very rare case. WOLLEBÆK (1926) has only twice in a number of 200 skulls found it in a Spitzbergen reindeer and in a specimen from Karelia (Finland). The width of a single nasal at the *os supramaxillare accessorium* is in the holotype of *R. t. fennicus* 21 mm, in the Villestofte reindeer 20 mm, but in two Swedish reindeer measured by LÖNNBERG 14 and 15 mm, respectively. Here again it should be emphasized, however, that these characters are not so constant as believed by LÖNNBERG, who had only two skulls of the woodland reindeer at his disposal, and who compared them with only two Swedish skulls of the mountain reindeer.

COLLETT, WOLLEBÆK, and GRIEG record that these *fennicus* features may be found in the Norwegian reindeer, too, and SCHARFF states that even on a Swedish reindeer skull from Skansen, preserved in the Dublin Museum, the nasals are arched, and he continues: "altogether I doubt that this particular structural character of the nasal bones is of such importance as we are led to believe." I may add, in contrast to what is claimed by LÖNNBERG, that in most reindeer from Greenland and in a specimen of the Norwegian wild reindeer, CN 1624 in the Zoological Museum of Copenhagen, the nasals are just as elevated above the maxillaries as in the *R. t. fennicus*, and in CN 1624 the nasal opening is of nearly the same shape as in this subspecies. Even the great length of the skull may be found in Swedish reindeer (cf. Table I). This means that an exact verification of these two subspecies, *R. t. tarandus* versus *R. t. fennicus* cannot be based on the said characters.—FLEROV (1933, p. 331), and ELLERMAN & MORRISON-SCOTT (1951) take *R. t. fennicus* as synonym of *R. t. tarandus*. In any case, however, these comparisons indicate that the Villestofte specimen was just as large as these large Scandinavien "forest reindeer". (cf. p. 100).

Comparison with other Subspecies

It should be pointed out, as already mentioned, that several authors, e.g. SCHARFF (1899), SCHLOSSER (1909), KORMOS (1916), and especially JACOBI in his great monograph of 1931, emphasize the view that the prehistoric reindeer in Europe was identical with the American barren-ground reindeer, *R. t. arcticus*, or at any rate closely related to this form, and not, as it would seem easy to suggest, with the recent European reindeer.

In order to explain the occurrence of the American reindeer in Europe in the Quaternary, JACOBI calls attention to WEGENER's theory about the continental movement. According to this theory North America in this period was still connected with Europe and these two areas were quite naturally inhabited by the same species of reindeer. This reindeer followed the receding inland ice to the north, but was at the beginning of the Forest period stopped at Närke Sound across Central Sweden. The climate was then so mild that the advancing forest grew right to the border of the ice sheet and *R. t. arcticus* died out in Europe. Simultaneously the extensive barriers in the form of a belt of lakes going from the Caspian Sea to the White Sea disappeared and the Asiatic reindeer *R. t. tarandus* was then able to immigrate into Europe. After that *R. t. tarandus* spread throughout Northern Europe towards Spitsbergen, and according to JACOBI even as far as Greenland, to which the distance, according to WEGENER's theory, still was not greater than it could be covered by the reindeer.

This interesting theory has already been much discussed by several authors and much has been written pro and con. Today, however, not many scientists believe in WEGENER's theory. A priori it seems curious that the lakes east of Ural could stop the reindeer, whereas these animals should have been able to cross the sea ice and emigrate to Greenland.

What is the difference between the European *R. t. tarandus* and the American *R. t. arcticus?* There is no agreement on this point; but three characters have been stressed as of special importance: (1) the length and shape of the facial part of the skull, (2) the shape of the antlers, and (3) the roots of the lower p. 4. We shall look more closely at these characters, starting with the skull.

In order to determine the relations of animals, the *skull* characters are always of special interest. As regards the prehistoric reindeer, however, we have never known very much about these features. However, we have now the Villestofte skull and as a great supplement to this a nearly complete skull from Bornholm (Strangegaard), of which only the *premaxilla* is missing, a brain-case, broken in front of the *orbitae* (Skinderbygaard) and a considerable part of a skull with the left side broken through the *foramen infraorbitale* (Almindingen). Even if one must be cautious to draw extreme conclusions from such a small material—vestigia terrent—it is the first time that measurements of a complete skeleton and a rather complete skull can be included in the investigations of fossil reindeer. The importance of this would be highly increased if it was possible to compare them with adequate recent material, in which the ranges of variation were well-known. At any rate it could then be seen whether the Danish specimens were within or outside this variation, but unfortunately we have only fairly few measurements of reindeer from today. Until more material is at hand we are unable to draw very definite conclusions as to the relationship of the different forms of reindeer.

Even if the *premaxilla* is missing in the Strangegaard specimen, the other measurements of length (distance from *crista occipitalis* to tip of nasal (288 mm), distance from *condylus occipitalis* to anterior border of canine tooth (320 mm), etc.), show that this specimen has a condylobasal length of about the same size, or rather a little greater (about 385 mm) than the Villestofte reindeer. About the same condylobasal length may be established in the Almindingen reindeer, about 370 mm (cf. p. 37). Also this shows that these specimens must be stated as very powerful animals and the same holds good of the Skinderbygaard reindeer. According to JACOBI the condylobasal length in *R. t. tarandus,* males, varies between 320 and 384 mm, in *R. t. arcticus,* males, too, between 345 and 397 mm. FLEROV (1933) regards the tundra reindeer in Eastern Europe and Siberia as a special subspecies, *R. t. sibiricus* Murray, the skull of which is like that of *R. t. tarandus*, but larger (total length: min. 346 mm; mean 373 mm; max. 420 mm). According to FLEROV the Eurasian reindeer decrease in size as we pass from east to west. The total length of 9 males of *R. t.*

Fig. 21. Skull from VILLESTOFTE. Lateral view.

tarandus ranges from 348 mm to 387 mm. In 6 males of *R. t. valentinae* FLEROV, from the woodland zone, it is true, of South Siberia, the range is from 356 mm to 404 mm, and still larger is *R. t. phylarchus* Hollister, from Kamchatka, the coast of the Okhotsk Sea and Amurland; in 7 males the total length there ranges from 392 mm to 438 mm (cited from HERRE 1955). These last-mentioned animals are thus nearly just as large as the great American caribou; in *R. t. montanus* from British Columbia the condylobasal length varies from 418 mm to 443 mm and in *R. t. caboti*, from northeastern Labrador, from 357 mm to 426 mm.

FLEROV also has established a new species *R. angustirostris* from the Bargusin Mountains, the northeastern coast of Lake Baikal, characterized by a large skull, elongated, narrow, and high rostrum, and strongly arched nasals. The position of this subspecies, however, seems to be uncertain and SOKOLOV takes *angustirostris* as a synonym of *phylarchus*. I should also like here to call attention to a subfossil skull of reindeer from the White River, 80 km. northwest of Irkutsk, Siberia, also described by FLEROV (1934) as a new species, *R. constantini*. This fairly incomplete skull (premaxillaries and part of the brain-case are missing) was found in paleolithic deposits

Fig. 22. Skull from STRANGEGAARD. Lateral view.

of the Solutrean age. The skull is very narrow and elongated, nasal bones very much arched, rostrum high and narrow as in *R. angustirostris*, and "molar teeth larger than in any other known recent reindeer" (101 mm).—The greatest interest of this specimen, however, in this connection is that it is subfossil and demonstrates that a differentiation of reindeer in Siberia already had taken place at the Solutrean age.

Hence, it may be emphasized that the lengths of the three subfossil Danish reindeer skulls fall within the range of variations of *R. t. tarandus* and *R. t. arcticus*, they do not reach the maximum length of *R. t. sibiricus*, let alone the skull length of the large woodland animals. It may be added that in 11 adult males from Greenland, collected during the years 1910—1917, the condylobasal length is between 356 and 386 mm (Degerbøl 1957). However, the condylobasal length cannot be used for determination of the relationship of the Danish reindeer, *tarandus* contra *arcticus*.

According to JACOBI there is, however, a character with which to separate the European-West Asiatic tundra reindeer from all the American forms; the latter should have longer nasal bones and longer rostral parts. JACOBI writes about this on p. 80: "Wie besonders aus den (noch unveröffentlichten) Kurventafeln hervorgeht, weicht die *arcticus*-Gruppe, überhaupt die amerikanischen Arten, von der *tarandus*-Gruppe in der *besonderen Länge der Nasenbeine* ab, womit eine Verlängerung des Rostralabschnittes parallel geht, der Schädel *erscheint* dadurch mehr in die Länge, was sich aber aus dem Indexverhältnis zwischen der Länge des Schädels und des Rostrums nicht zuverlässig belegen lässt."—With this extremely important information JACOBI, unfortunately, gives no measurements or ratio which could be used as a base of comparison.

I have, however, earlier (1957) discussed the length of the nasal bones in different subspecies of reindeer. Short nasal bones are not only found in such small arctic reindeer as the Spitsbergen and the Peary-reindeer, but also in the large West Greenland reindeer (*loc. cit.* fig. 3).

As mentioned above, the nasal bones are comparatively short in the Villestofte skull (ratio 29.9 in relation to condylobasal length) and this holds good also of the Strangegaard specimen (ratio 30.4). In 20 reindeer from Scandinavia this ratio ranges from 28.4 to 36.3.—In relation to *basal* length, a measurement which is stated by LÖNNBERG, the ratio in 16 Scandinavian reindeer ranges between 30.6 and 38.9. In the Villestofte and Strangegaard specimens this ratio is 31.5 and 32.5, respectively. According to LÖNNBERG the nasal bones are very long in *R. t. fennicus*, the ratio, however, in relation to basal length is 35.0 in the type specimen, and in a tame "woodland reindeer" from Rödingsträsk, Lappland, 36.1, thus within the range of variation of mountain reindeer.—That a small ratio, however, also may be found in an American reindeer is demonstrated by a reindeer from Alaska in which the ratio is only 31.7 (cf. Table 1). The short nasal bones in the two subfossil Danish reindeer so far indicate an accession to the European reindeer; at least it does not support the view that these prehistoric reindeer are of American origin.

Several authors have tried to ascribe a diagnostic value to the form of the nasal bones, but the variation is fairly considerable, as also discussed by DEGERBØL 1957. In skulls from Greenland and Ellesmere Island the nasal bones posteriorly towards the frontals, with a few exceptions (cf. *loc. cit.* p. 21), are separated in the mid-line by a considerable tip pointing forward from the frontal bones. In skulls from Scandinavia, however, this character is fairly variable, the naso-frontal suture, however, generally forming a common curve.

Also the fact that LÖNNBERG says nothing about the variation of the posterior border of the nasal bones, no doubt indicates that in all the Scandinavian reindeer examined by this author the nasals posteriorly were of a uniform shape, ending in a common curve, as seen in his figures (LÖNNBERG *loc. cit.* figs. 2 and 4).

This shape of the naso-frontal suture is also found in the three subfossil Danish

Fig. 23. Frontal part and nasal bones of VILLESTOFTE reindeer.

skulls (fig. 23). It should be added, however, that this form of the nasals may also be found in *R. t. arcticus,* i.a. in the skull from Baffin Land kept in the Zoological Museum of Copenhagen.

The shape of the naso-frontal suture in the three Danish subfossil skulls thus is most frequent in Scandinavian reindeer, but is extremely rare in Greenland reindeer. Conditions, though, are so varying that they indicate nothing definitely about the relationship: Europe-America.

In skulls with short nasal bones the nasal aperture is relatively large and vice

TABL

Cranial measurement	Denmark, subfossil					Sweden, recent			
	Villestofte ♂	Strangegaard ♂	Skinderbygaard ♂	Almindingen ♂ 1861	Østerbygaard ♂	R. t. fennicus ♂ (Lönnberg)	R. t. fennicus Sortevala ♂ (Lönnberg)	Dalecarlia ♂ (Lönnberg)	Dalecarlia ♂ (Lönnberg)
Condylobasal length	375	(385)	—	(370)	—	—	—	—	—
Basal length	356	(360)	—	—	—	357	379	334	319
Total length	388	—	—	—	—	397	—	374	361
Crista occipitalis – nasal tip	286	288	—	—	—	302	—	291	283
„ „ – „ base	174	175	—	170	—	176	—	171	175
„ „ – ant. border of orbita	185	178	—	170	—	—	—	—	—
„ „ – foram. supraorb.	137	129	138	122	132	—	—	—	—
Condyl. occipital. – foram. infraorb.	246	250	—	243	—	—	—	—	—
„ „ – ant. border of c.	311	318	—	—	—	—	—	—	—
For. magnum, sup. bord. – nasal base	172	178	—	174	—	—	—	—	—
„ „ „ „ – „ tip	282	288	—	—	—	—	—	—	—
Length of nasals, middle (connect.)	112	117	—	—	—	125	—	116	109
„ „ „ lateral	115	125	—	—	—	—	—	—	—
Tip of nasal – tip of premaxilla	114	—	—	—	—	104	—	95	91
Base „ „ – „ „ „	218	—	—	—	—	—	—	—	—
For. infraorb. – „ „ „	134	—	—	—	—	—	—	—	—
Orbita – „ „ „	230	—	—	—	—	243	261	219	213
„ – foram. infraorbitale	100	106	—	106	—	—	—	—	—
Palatal length	235	—	—	—	—	—	—	—	—
Mastoid breadth	137	137	146	135	128	143	—	122	120
Meatus acusticus breadth, incisura	124	123	127	120	112	—	—	—	—
Greatest zygomatic breadth	155	(150)	—	(144)	—	149	—	133	134
Frontal breadth	127	115	125	125	—	—	—	—	—
Least interorbital breadth	121	134	134	(130)	—	—	—	—	—
Interorbital breadth, middle	134	—	—	—	—	149	155	130	129
„ „ at sut. zyg.-lacrym	139	148	(142)	(144)	—	—	—	—	—
Greatest orbital breadth	(182)	—	—	(174)	—	—	—	—	—
For. infraorbital breadth (outer border)	77	85	—	—	—	—	—	—	—
c–c breadth	70	(78)	—	—	—	(72)	(76)	(64)	(59)
Greatest breadth of both nasals	(62)	60	—	—	—	54	—	65	66
„ „ „ one nasal	42	36	—	—	—	36	36	41.5	—
Least breadth of nasals	(33)	33	—	—	—	33	—	24	28.5
„ „ „ one nasal	20	16.5	—	—	—	23.5	—	13	19
Anterior breadth of nasals	(37)	38	—	—	—	36	—	27.5	28.5
Greatest maxill. breadth (at sut. zyg.-maxill.)	116	128	—	—	—	—	—	—	—
Breadth of condyli occipitales	72	72	72	74	72	82	80	68	66
p 2–p 2 breadth, inner side	40	51	—	—	—	—	—	41	38
m 1–m 1 breadth, inner side	58	65	—	—	—	—	—	57	56
m 3–m 3 breadth, inner side	58	68	—	—	—	—	—	63	63
m 2–m 2 breadth, outer alveoles	97	107	—	—	—	—	—	—	—
Vertical height at ant. end of nasals	69	70	—	—	—	69	—	59	61
Height from m 2 to sut. internasal.	115	113	—	—	—	115	—	97	109
„ „ „ „ sut. nas.-maxil.	80	86	—	—	—	—	—	—	—
p 2–m 3 length, upper	97	102	—	—	—	85	98	99	96

Norway, recent							West-Greenland, recent								
Norway ♂ (Lönnberg)	Norway Taumevand ♂ CN. 1623	Norway Taumevand ♂ CN. 1622	Norway Taumevand ♂ CN. 1624	Norway Taumevand ♂ CN. 1626	Norway Taumevand ♂ CN. 1625	Norway Heimdalen ♂ (Miller)	West Greenland (11 specimens) ♂♂ (Degerbøl)	West Greenland Holsteinsborg ♂ CN. 1082	West Greenland Holsteinsborg ♂ CN. 1048	Exeter Sound Baffin Island ♂ CN. 1406	Alaska ♂	Sweden CN. 342	Lappland CN. 158	Sweden Rödingsträsk ♂ dom. (Lönnberg)	Chuckchee reindeer (Lönnberg) ♂ dom.
—	321	329	325	325	325	365	356–386	375	375	(385)	384	378	374	—	—
332	302	306	302	305	306	—	333–361	353	355	(365)	363	359	353	355	329
359	339	346	335	335	342	—	377–407	400	405	—	400	402	390	391	362
271	256	270	265	262	263	280	276–308	298	288	305	299	306	(290)	305	276
—	165	170	152	159	164	—	175–192	188	192	180	179	184	180	—	—
—	163	168	155	166	166	—	172–195	187	195	190	188	190	183	—	—
—	124	134	115	123	118	—	135–151	145	151	138	140	140	135	—	—
—	211	217	220	223	214	—	238–257	249	255	246	252	247	251	—	—
—	277	280	278	—	277	—	307–334	322	—	320	330	322	317	—	—
—	160	165	158	160	155	—	170–185	180	185	175	175	177	181	—	—
—	250	261	261	257	246	—	270–292	280	272	293	290	294	(287)	—	—
116	93	102	115	103	98	108	90–116	112	90	119	115	124	111	(128)	129
—	94	100	111	103	96	—	100–115	114	100	125	126	130	121	—	—
98	90	(87)	(85)	(88)	(94)	—	105–130	115	130	—	124	110	110	100	95
—	180	(184)	(190)	(180)	(185)	—	205–228	222	—	—	232	227	215	—	—
—	116	(116)	(110)	(108)	(115)	—	123–140	134	128	—	140	137	130	—	—
220	202	(205)	(200)	(197)	(202)	—	225–247	239	235	—	247	241	233	236	223
—	89	91	94	93	88	—	96–110	109	—	107	110	109	107	—	—
—	200	(205)	(205)	—	(204)	—	222–250	235	231	—	238	240	228	—	—
—	116	122	111	128	119	—	125–147	146	135	145	136	140	144	—	122
—	112	113	107	114	111	—	111–130	130	126	123	123	120	124	—	—
133	134	130	126	132	131	138	135–151	151	145	140	148	145	144	149	—
—	98	100	93	101	107	—	95–117	108	117	128	121	121	121	—	—
—	120	121	114	114	110	—	115–132	125	126	137	130	147	142	—	—
129	130	132	122	126	115	—	—	—	—	—	—	158	152	139	126
—	131	129	118	129	125	—	132–149	143	146	142	151	153	150	—	—
—	167	160	155	158	154	160	160–177	74	175	(182)	(171)	188	187	—	—
—	73	65	65	72	68	—	71–90	88	84	84	87	86	85	—	—
—	60	63	56	—	62	—	64–76	73	73	76	72	73	75	70	(72)
64	59	66	60	62	53	53	51–67	67	51	(54)	59	59	86	62	(62)
37	32	38	38	38	32	—	31–42	42	35	(29)	40	35	48	—	—
23	23	30	27	32	26	—	24–34	28	30	39	32	33	32	28	29
12	11	15	16	18	13	—	14–20	17	17	25	21	17	165	—	18
25.5	24	28	27	32	27	—	23–34	30	32	37	32	41	41	37	32
—	110	104	97	103	93	—	113–129	129	118	113	123	117	120	—	—
—	63	67	64	69	60	—	72–80	76	72	74	75	71	76	—	—
43	44	45	37	54	46	—	50–63	59	57	51	62	56	60	56	—
—	55	56	52	63	56	—	61–72	72	68	63	67	65	71	66	—
59	60	56	51	62	56	—	61–72	72	66	60	67	66	71	71	—
—	88	88	83	94	85	—	100–108	108	102	101	104	100	105	—	—
—	56	55	51	(58)	58	—	64–80	72	—	67	76	67	60	—	57
—	98	103	92	96	96	—	110–126	122	—	114	124	112	118	—	103
—	76	74	69	68	81	—	81–98	89	98	86	87	84	87		
98	88	85	93	85	78	94	85–101	95	92	97	88	91	90	87	93

versa. In *R. t. fennicus*, which has the long nasal bones, 125 mm, the nasal opening (distance from tip of nasal to tip of premaxilla) is 104 mm; in a tame Chuckchee reindeer (Table 1) the measurements are even 129 and 95 mm, respectively, while the specimen from Holsteinsborg (West Greenland), CN 1048, with its short nasal bones of 90 mm, has a nasal opening of 130 mm. You may say that this correlation is so far a matter of course, as both these measurements are included in the total length of the skull, but it must be emphasized, that the position of the posterior border of the nasal bones also varies with the length of the skull. In skulls with long nasal bones, the posterior border is situated fairly far back on the skull, as i.a. can be seen from the table, the distance from the *condylus occipitalis*, or from the posterior border of the *crista occipitalis*, to the posterior edge of the nasal bones then being shorter.—The length of the nasal bones can hardly be of any importance to the animal, but the size of the nasal opening might perhaps be correlated to the conditions of the climate. It seems as if animals in arctic regions get shorter nasal bones, i.e. larger nasal openings, which again means a relatively large muzzle part in the live animals. Presumably this means a better heating of the air of respiration and perhaps also a better protection against dust in the respiration air; cf. the large muzzle in such a steppe animal as the saiga antilope *(Saiga tatarica)*. Short nasals in the reindeer from the high North thus may be an adaptation to arctic climate and grazing in an open country or mountainous region.

In this connection it may be noticed that in a subfossil skull from Ireland, viz. the Ashbourne skull (cf. p. 82), the maxillary bones are strongly outward bulging with the result that the width of the nasal cavity, as stressed by Scharff (1918), is very great.

In the short nasal bones the Danish subfossil specimens differ from the said Ashbourne skull, in which the nasal length is 131 mm. It was on the basis of this skull that Scharff (1918) described a new subspecies, *R. t. hibernicus* "differing in the width of the nasal cavity and in the length of the nasal bones from recent Greenland, Scandinavian, and Siberian animals". In the length of the nasal bones (131 mm) the Ashbourne skull surpasses even the Siberian Reindeer (cf. Lönnberg, p. 17), in which the nasals measured 129 mm. In the Greenland skull the nasals are quite short (100 mm in length).—In the width of the nasal bones, however, the Irish Reindeer resembles the Greenland form and differs from the Scandinavian one—thus a new subspecies.—I may add that Scharff was only able to compare the Irish skull with a single skull of a "Siberian" reindeer, published by Lönnberg; Jacobi, however, (p. 100) points out that this skull really belonged to a tame Chuckchee reindeer.

To this subspecies (*R. t. hibernicus*) Jacobi (1931, p. 100) aptly remarks: "Die hierbei ermittelten Gleichungen und Unterschiede finden jedoch an meinen Kontrollmessungen keine Stütze, auch lässt das einzige Belegstück bei dem weiten Abänderungsspielraum dem Zufall so viel Einfluss, dass es bedenklich wäre, auf das schwankende Ergebnis hin eine besondere Subspecies des Diluvianrens anzuerkennen." I may add that a nasal length of 131 mm is of course a large measurement, but in relation to the length of the skull it no doubt falls inside the range of variation in *R. t. tarandus*. If we e.g. put the condylobasal length at 385 mm as in the large Strangegaard specimen, the ratio is 34.0.

The width of the nasal bones depends upon the elevation of the nasal roof. Flat nasal bones give a great combined breadth; as especially seen in the Swedish skull CN. 158 with quite flat nasal roof and in which this measurement is exceptionally large, 86 mm. The elevation of the nasal bones, however, varies within the individual populations. A high nasal roof occurs in the two Danish skulls and, as already mentioned, in the majority of the Greenland ones, cf. the vertical height in Table 1. Greatest similarity shows the Villestofte specimen with CN 1082 from West Greenland, which has the same condylobasal length, the same nasal length, the same length of nasal opening and practically the same distance from the *condylus occipitalis* to the *foramen infraorbitale*.

We have a measure of the *rostral length* in the distance from the orbita to the tip of the premaxilla; here the Villestofte specimen measures 230 mm (basal length 356 mm), while the holotype of *R. t. fennicus*, which has the same basal length (357 mm), measures 243 mm, and the Swedish skull, CN 342, 241 mm (basal l. 359 mm). Especially great is this measurement in another individual of *R. t. fennicus*, 261 mm (but the basal length is 379 mm). Out of the Greenland skulls the attention may be drawn upon Holsteinsborg CN 1048, which has a rostral length of 235 mm (and the same basal length as the Villestofte specimen).

If the rostral length is correlated to the basal length (= 100) we shall get a number of indices (cf. fig. 24). From this it will be seen that the Villestofte specimen has a lower index than the Swedish and with one exception (from Inglefield Land) even than the West Greenland reindeer, i.e. that the Villestofte reindeer has a short rostral length (ratio 64.6). On this point the Villestofte reindeer differs highly from *R. t. fennicus* with the very great rostral length (ratio 68.1 and 68.9 in type and cotype, respectively).

I have only two measurements of rostral length in the American reindeer, and they are fairly large (ratio 67.4 and 68.0 in specimens from Cockburn Land and Alaska, respectively). If Jacobi is right, also the short rostral length of the Villestofte reindeer thus indicates an accession to the European-Asiatic reindeer.

In spite of the fact that the facial part in the Villestofte reindeer is fairly short, the *processus horisontalis* of the premaxilla is very long, 64 mm (measured on outer edge), longer than in most other specimens. Consequently the *proc. verticalis praemaxillaris* is fairly concave (fig. 34).

In reindeer from high arctic regions the skull is relatively broad with strongly protruding almost tubular orbits, cf. the ratios in fig. 4, Degerbøl 1957. *The greatest orbital breadth* (measured over the posterior border of the orbit) is surprisingly great in the Villestofte specimen, 182 mm. Strangely enough, Jacobi states that this measurement in *R. t. tarandus* varies between 156—170 mm, in *R. t. arcticus* between 154—178 mm (in the males). A figuer by Jacobi furthermore shows that he has taken the measurements in the same way as I have. But in the Baffin Island specimen and in the Swedish skull CN 342 we find measurements as great as in the Villestofte skull, 182 and 188 mm, respectively. None of the Greenland skulls reaches these *absolute* measurements. It is remarkable that also regarding orbital breadth (ratio fig. 25) the Villestofte specimen shows closer agreement with the European *R. t. tarandus* than with the American *R. t. arcticus*, but perhaps this is only a convergent evolution. The Villestofte reindeer, the oldest of the Danish finds, bears the stamp of a rough climate. Short nasal bones, small rostral length, and large orbital breadth just characterize reindeer from arctic regions. The large size of the Villestofte reindeer indicates, however, that the conditions of life, i. a. nutrition, even in the Early Dryas period; have been just as favourable as in West Greenland today.

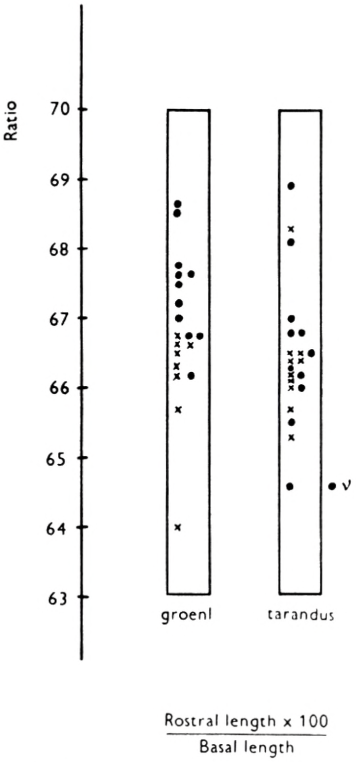


Fig. 24. Rostral length ratio. *Groenl.:* • From West Greenland proper × from Inglefield Land.

Information about other characteristics of the Danish subfossil skulls can be obtained from Table 1. I have there given some measurements of a pair of skulls from the American side, from Baffin Island (Exeter Sound, Cumberland Pen.) and from Alaska (White river), kept in the Zoological Museum, Copenhagen, and which are of somewhat the same size as the subfossil Danish ones. The specimen from Baffin Island is a "pick-up", the premaxillary part is missing, just as in the Strangegaard specimen. The distance from *condylus* to *sutura intermaxillaris* is the same in the last-mentioned two specimens (320 mm).—For further comparison are stated in Table 1 after LÖNNBERG some measurements of the paratype of *R. t. fennicus* and of a pair of Swedish skulls with which this author has compared this *fennicus* specimen. A complete skeleton of a Swedish reindeer (CN 342) has been transferred to the Zoological Museum after the death of King Frederik VII (1863); but unfortunately there is no further information about the specimen. The same holds good of another complete skeleton, CN. 158, from the year 1858, but only labelled "Laplands Ren, *Rangifer tarandus* Linné *lapponic*". These two skulls have a very broad frontal part; thus the smallest interorbital breadth is 147 and 142 mm respectively, whereas the Strangegaard and Skinderbygaard skulls at this point only measure 134 mm. In *R. t. fennicus* the interorbital breadth is large, too, 149 and 155 mm, respectively in holotype and paratype, "at the *middle* of the orbits". This measurement can not be taken with certainty, but it shall be stressed that the two large Swedish skulls, CN. 342 and 158, also are very broad "at the middle" of the orbits: 158 and 152 mm respectively. LÖNNBERG takes the broad orbital part as characteristic of the woodland type; however, the nasal bones in CN 342 and 158 are flat and not elevated as indicated for the woodland reindeer and the tooth-rows are fairly large. The skull CN 342 is very light and the

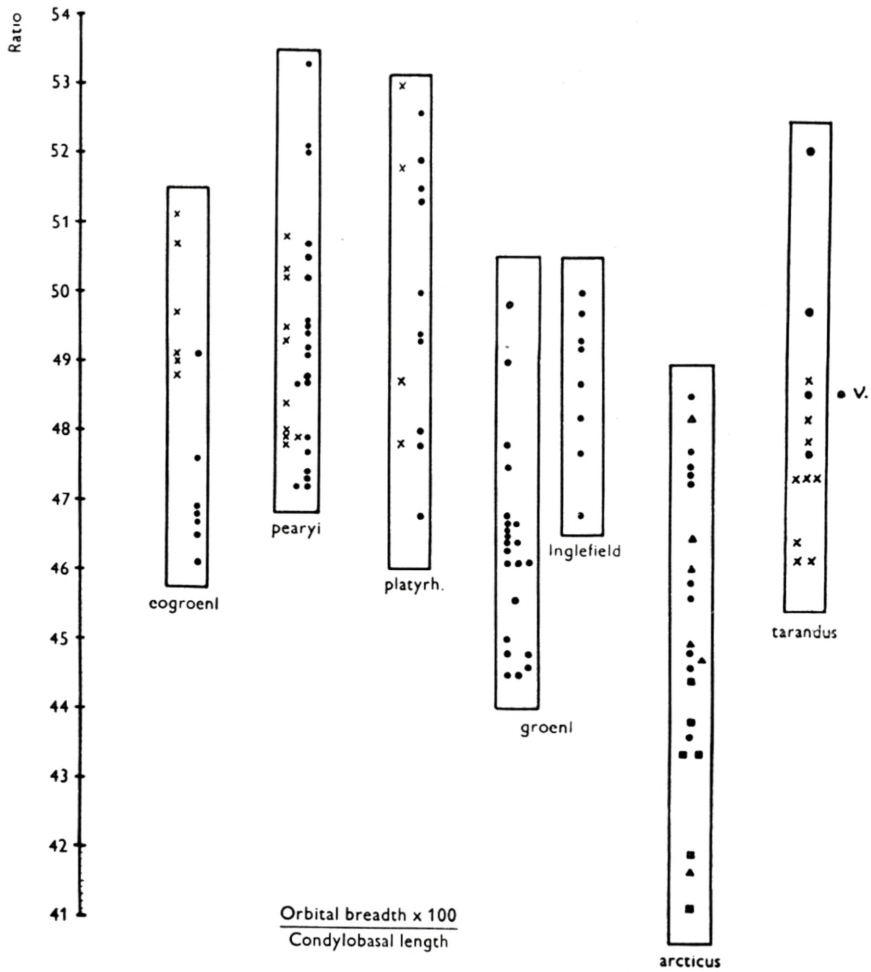


Fig. 25. Greatest orbital breadth ratio. *Arcticus:* ▲ granti, ■ osborni and montanus. (Cf. DEGERBØL, fig. 4, 1957).

brow tine is missing from both antlers. I suppose the skull has belonged to a tame but large reindeer.

To this I have added the measurement of some of the largest skulls from West Greenland (cf. DEGERBØL 1957, Table 10).

From the characteristics mentioned about the skulls it appears that several characters, i.a. the short nasal bones, small rostral length and great orbital breadth, might indicate an affinity to the European reindeer, but because of insufficient material, especially of recent animals, the relationship of the Danish reindeer to the

European-American animals cannot be stated definitely. I hope, however, that the measurements of the skeletal parts of prehistoric Danish reindeer published here may be of some value as a basis of comparison of future finds.

Mandibles. In the Villestofte reindeer the mandible is exceptionally heavy. The depth of the *ramus horisontalis* is larger than in recent reindeer from Greenland, and the same holds good of the greatest thickness of the horizontal part, cf. Table 2,

TABLE 2.

Mandible	Subfossil					West Greenland. Recent										
	Villestofte	Almindingen Bornholm	Køge Bay 1954	East Prussia	East Prussia	Holsteinsborg ♂ CN. 1245	Holsteinsborg ♂ CN. 1022	Nordre Strøm-fjord ♂ CN. 1041	Holsteinsborg ♂ CN. 1082	Holsteinsborg ♂ CN. 1048	Holsteinsborg ♂ CN. 1023	Holsteinsborg ♂ CN. 886	Sukkertoppen ♂ CN. 1047	Sukkertoppen ♂ CN. 1046	Sweden CN. 342	Lappland CN. 158
Condylobasal length	375	—	—	—	—	386	385	384	375	375	366	364	362	359	378	374
i 1. — proc. condyloideus	320	—	—	327	—	325	319	320	320	315	308	310	308	305	316	322
i 1. — proc. angularis	302	—	—	302	—	294	284	293	290	287	286	283	280	278	298	297
Diastema (i 1 — p 2)	110	—	—	—	—	112	109	103	103	101	97	97	102	105	117	118
Depth of diastema, behind for. dentale	22.2	20.5	18.4	20.0	20.2	21.2	20.8	20.2	19.5	20.2	16.5	18	20	19.0	17.8	20.0
Depth at m 1, ant. root, outer side	36	—	33	—	—	34	32	34	33	33	32.5	32	32	31	34	36
Depth at m 1, ant. root, inner side	36	—	34	—	—	34	33	35	33	34	32	34	33	32	33	36
Depth between m 1–m 2 outer side	38	—	—	34.6	37.5	34	33	35	33	33	32	34	34	32	34	38
Depth between m 1–m 2 inner side	40	—	—	—	—	34	35	36	33	34	33	35	35	33	34	37
Depth at m 2 (below ant. root) outer side	40	—	—	—	—	34	34	37	35	35	33	34	35	32	35	40
inner side	41	—	—	—	—	34	34	37	34	35	33	34	36	33	35	39
Depth between m 2–m 3, outer side	42	—	—	39.2	39.2	34	34	37	36	34	35	35	36	33	36	40
inner side	43	—	—	—	—	35	34	37	36	35	35	36	38	34	37	40
Depth behind m 3	47	—	—	—	—	34	37	39	37	38	37	39	38	37	39	44
Greatest thickness	19.8	—	18.5	18.2	17.5	16.5	17.7	17.0	16.5	16.5	16.0	15.5	16.0	15	16.8	18.0
Proc. angularis – proc. coronoideus	147	—	—	—	—	148	142	148	146	146	147	147	154	145	143	154
Proc. angularis – proc. coronoideus (vertical)	137	—	—	—	—	141	132	130	129	130	135	139	148	—	120	—
Vertical height of ramus verticalis (to proc. articularis)	113	—	—	—	—	111	98	103	103	106	100	102	110	120	196	115
p 2–p 4 length (crown)	46.5	42	46	—	—	40	42	45.5	45	41	44.5	42	45	45	39	37
m 1–m 3 length (crown)	59.5	62	—	—	—	54	59	64	60	55	61	59	58	56	58	56
p 2–m 3 length (crown)	105	103	—	—	—	93	99	108	103	95	104	99.5	102	99	96	93
p 2–m 3 length, alveoles	107	108	—	—	—	99	102	110	104	98	107	102	105	104	99	96

where I have given some measurements of Greenland reindeer which have the same, or still larger, condylobasal length as the Villestofte specimen, particularly large is the depth behind m 3. Of the American reindeer, the measurements of which are given by ALLEN, only a few can in this respect compare with the Villestofte specimen. Of 7 males of *R. t. arcticus* the two largest have a "depth at m^1" of 36 mm (condylobasal length 397 and 355 mm, respectively) just as in the Villestofte reindeer, whereas the other 5 animals measure 31, 31, 32, 33, and 33 mm. (ALLEN 1908, p. 493). Of course these measurements depend on age, but the reindeer from Villestofte is not an old specimen and the measurements here cited from ALLEN are from adults, too.

In the large *R. t. montanus* ALLEN (1902 p. 153) gives "the depth of mandible at m^2" in two males as 40 mm and 39 mm, respectively, but the condylobasal lengths in these two specimens are 430 mm and 420 mm, respectively, and the same applies to a specimen of *R. t. osborni* with a depth at m^2 of 38 mm, and a condylobasal length of 420 mm. In the Villestofte specimen this measurement is 40—41 mm.

According to the same author (1902) the depth at m^2 in mandibles of 5 males of *R. t. granti* are: 38, 37, 35, 33 and 33 mm (with the condylobasal length: 375, 350, 370, 370, and 364 mm, respectively).

Fairly heavy mandibles may appear in *R. t. pearyi*.

ALLEN (1908) also has published the m^1-depth of 21 specimens of this subspecies; the largest measurement, 34 mm, is found in two males with much worn teeth, but the condylobasal lengths in these two specimens are only 334 mm and 320 mm, respectively.

ALLEN has not given any definition of his measurements "depth at m^1 and m^2"; but it appears from Table 2, that the depth measurements of the middle of *ramus horisontalis* of the mandible change very little from p 3 to m 2, so ALLEN's measurements give a fairly good idea of the depth of the mandible.

A heavy mandible is also found in two subfossil specimens from East Prussia (H. GROSS, 1943). Thus a fairly heavy mandible seems to be characteristic of the subfossil reindeer; just as heavy mandibles, even if the teeth are not particularly large, are found in many subfossil mammals, i.a. in dogs (DAHR 1937, DEGERBØL 1943).

Teeth. Since the subfossil reindeer is comparatively well represented by single teeth or by complete rows of teeth we have fairly good material for comparison with the recent reindeer. The view has been set forth that the subfossil animal has relatively powerful teeth, larger than in the recent European reindeer and especially larger than in the domesticated form. This is one of the difficulties in the investigations, viz. the lack of material of wild Eurasian reindeer. As a substitute the tame reindeer has been used for the sake of comparison, but generally these animals are smaller and less powerful.

For elucidation I have listed a number of tooth measurements in Table 3. It will be seen from this table that the Funen reindeer in comparison with other subfossil European reindeer has fairly short rows of teeth. As regards the length of the maxillary tooth row a measurement of 97 mm is a little below the range of variation stated by JACOBI, according to NEHRING, HAGMANN, STUDER, etc., for the European subfossil reindeer (100—105 mm). This is, however, a surprisingly small range of variation, which is due to the small material. In the Strangegaard specimen the maxillary tooth row is 102 mm long. For the length of lower cheek teeth JACOBI states that it ranges from 105 to 115 mm. The Funen reindeer here measures 105 mm and in a mandible from Bornholm the length of the tooth row is 103 mm.—On basis of the many bones of reindeer from Stellmoor, Early and Late Dryas, KOLLAU (1943) has stated a larger range of variation of the cheek teeth. In 23 specimens the length of the upper tooth row varies between 94 and 103 mm; the lower row between 97 and 115 mm (59 specimens).

For the sake of comparison I have in Table 3 also stated tooth measurements for some recent Norwegian and Swedish wild and tame reindeer, partly my own measurements and partly from the literature, and besides for Greenland and Ellesmere Island wild reindeer, kept in the Zoological Museum of Copenhagen.—In southern Norway there are still reindeer which are considered wild, though there may have been some hybridization with straggling tame reindeer (COLLETT 1911). The measurements published here of Norwegian reindeer are from animals which were shot in 1936 at Taumevandet, Setesdalen, and presented to the Zoological Museum by Dr. B. BENZON. They are comparatively weak animals with slender skulls and antlers, but they are no doubt a fairly good representation of the population.

The length of the cheek teeth in these Norwegian animals is not, however, so very small. 93 mm being the greatest measurement of the maxillary tooth row, these animals approach the Funen reindeer. The literature even contains still greater measurements in Norwegian reindeer. GRIEG (1911) gives for three excavated reindeer from Hardangervidden—animals whose geological age, however, is not very high—95 mm as the greatest length of the maxillary row of teeth, and LÖNNBERG (1909) even states 96 mm and 98,5 mm in the two Swedish reindeer which he used for comparison with *R. t. fennicus*. According to MILLER (1912) the length of the maxillary tooth row in the European reindeer varies between 94 mm and 98 mm. And even the European tame reindeer may attain the same cheek teeth length as the Villestofte animal. GRIEG gives the following measurements for Norwegian tame reindeer: Maxillary tooth row: 81, 83, 84, 85, 87, 88, 88, 90, 92, 92, and 98 mm; lower cheek teeth: 87, 88, 90, 93, 94, 97, 98, 100, 102, and 105 mm.

Also among Greenland reindeer there may be individuals with as large teeth as the subfossil Danish animal. In 27 reindeer from West Greenland the length of the upper tooth row ranges from 84 to 101 mm, and in 26 specimens the length of the mandibular tooth row ranges from 89 to 108 mm.

On the other hand it may be mentioned that according to LÖNNBERG the woodland reindeer *(R. t. fennicus)* is characterized by relatively small cheek teeth. The length of the maxillary and mandibular tooth row in the holotype of *R. t. fennicus* is only 85 and 90 mm, respectively. The length of the upper molar series is thus in the Finland reindeer (*R. t. fennicus*) only 23.8 $^0/_0$ of the "basicranial length" (= basal length) but

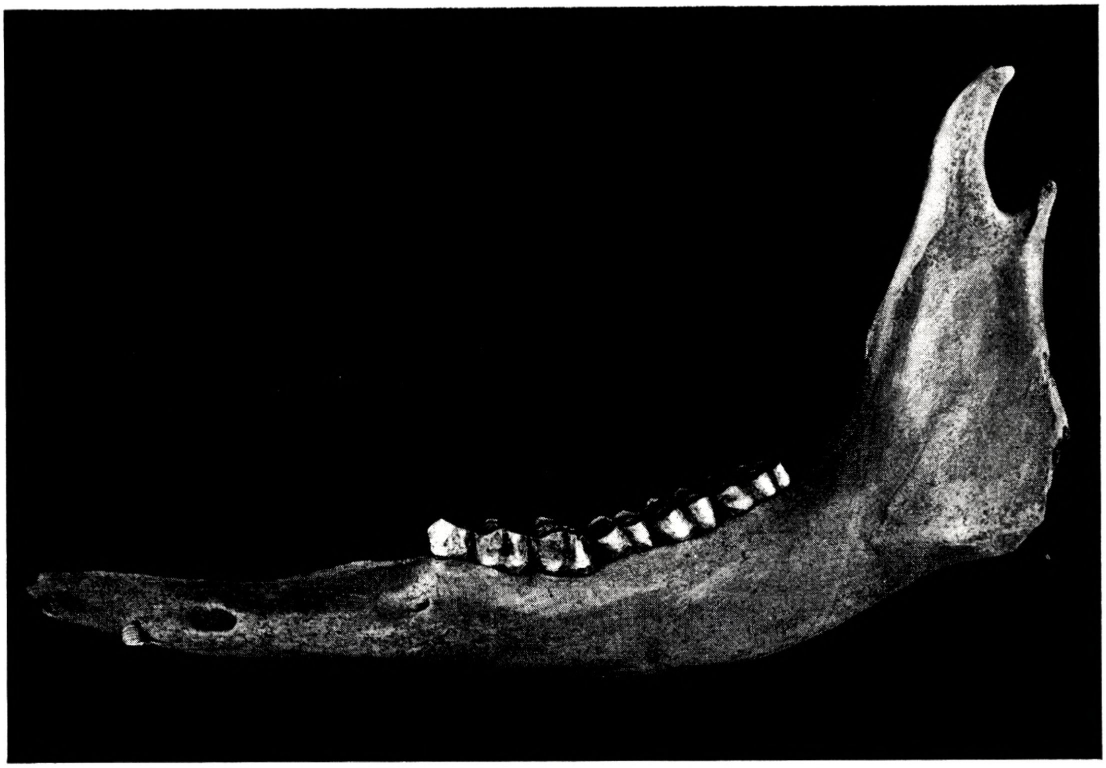


Fig. 26. Left mandible of Villestofte reindeer. Lateral view.

Fig. 27. Left mandible of reindeer from Holsteinsborg (CN. 1048), West Greenland.

TABLE

Tooth rows. Length	Subfossil										Recent		
	Villestofte	Strangegaard	Almindingen	Europe (Jacobi)	Stellmoor (Kollau)	Norway (Grieg) Protohistoric	Brunniquel France	Grotte de Keilhac France	East Prussia (Gross)	Hungary	Norway (Zool. Mus. Copenhagen)	Norway (Grieg) Tame reindeer	Norway (Lönnberg)
1. Maxillary tooth row	97	102	—	100–105	94–103 (23 spec.)	90, 91, 95	—	—			77–93 (6 spec.)	81–98 (12 spec.)	98
2. Mandibular tooth row	105	—	103	105–115	97–115 (59 spec.)	96, 99 101, 107	107	109	106 111	103 104 106	90–100 (4 spec.)	87–105 (10 spec.)	104
Condylobasal length	375	(385)		300–384	—	—	—	—	—	—	321–329	—	—

in the Swedish reindeer the same percentage is 29.4 to 30.0 (LÖNNBERG p. 8). Table 3 shows, however, that LÖNNBERG had the bad luck that the only two Swedish reindeer with which he made his comparisons, had extremely large teeth, and moreover, small "basicranial length", 334 and 319 mm, respectively.—In a second specimen of *R. t. fennicus* LÖNNBERG surely found the said percentage to be 25.8. However, he does not give the absolute measurement, but as the "basicranial length" is indicated to be 379 mm, this means that the maxillary tooth row has been no less than 98 mm long. The relative shortness of the tooth row in that specimen thus is caused by the remarkable length of the skull. Large animals normally have relatively small teeth. In the Villestofte reindeer the maxillary tooth row is 26.7 $^0/_0$ of the basal length. I suppose that the "basicranial length" of LÖNNBERG means the basal length (should it mean the condylobasal length the said percentage is only 25.4).

Table 3 thus shows that the subfossil Funen reindeer and a specimen from Almindingen, Bornholm, do not have greater measurements of the cheek teeth than falling within the range of variation of recent Scandinavian wild reindeer. Somewhat larger teeth are found in the Strangegaard specimen. It is true that the subfossil European reindeer generally speaking have powerful teeth, but it may be pointed out that subfossil animals usually have larger teeth than the corresponding recent forms, as will be known from a number of species of prehistoric mammals from Denmark (bears, pine martens, wild cats, etc. DEGERBØL 1933.

3.

	Recent												
	R. t. fennicus (Lönnberg)	Sweden (Lönnberg)	Europe (Miller)	West Greenland (Zool. Mus. Copenhagen)	Baffin Land (Zool. Mus. Copenhagen)	R. t. arcticus (Jacobi)	R. t. arcticus (Allen)	R. t. pearyi (Allen and Zool. Mus. Copenhagen)	R. t. stonei (Murie) Interior Alaska	R. t. osborni (Murie)	R. t. caboti (Jacobi)	R. t. montanus (Allen)	"Woodland" (Lönnberg) ♂♂ dom. 5 spec.
	85, 98	96 98.5	94– 98	84–101 (27 spec.)	99	90–94	82–94 (10 spec.)	83–97 (35 spec.)	85–107 (44 spec.) Average 94)	83–106 (21 spec.) Average 100.5)	99–102	93–101 (4 spec.)	84–93
	90	105 104	101– 104	89–108 (26 spec.)	—	92–102	87–102 (10 spec.)	90–109 (35 spec.)		95–113 (21 spec.) Average 106.8	105– 112	99–110 (4 spec.)	
	—	—	—	286–386	(385)	—	303–397 (10 spec.)	273–335 (35 spec.)	344–403 (35 spec.)	(360, 420)	357– 426	355– 430 (4 spec.)	

Table 3 also shows that according to tooth measurements it is not possible to distinguish between European and American reindeer. On an average, however, some American subspecies have larger teeth than the European individuals, but it should be borne in mind that the American material is comparatively large and represents animals which even in our time live under good conditions.

In order to elucidate more exactly the range of variation of the teeth of the prehistoric European reindeer, I shall give some measurements of the posterior, lower molar, m 3 (Table 4) which is very well represented.

In the Zoological Museum of Paris, Palaeontological Laboratory, is preserved a considerable osseous material of reindeer from the palaeolithic settlements of Southern France. Unfortunately these bones are so greatly fragmented—as is generally the case with bones from settlements—that complete rows of teeth or complete limb bones are missing, but a number of single teeth are present.

It will be seen from Table 4 that after all the lower m 3 of the Villestofte and Bornholm reindeer is not so small. Furthermore, this table and fig. 28 emphasize the considerable size of the teeth of the prehistoric reindeer in comparison with recent animals. In the prehistoric animals this tooth is not only on an average longer, but also broader than is the case in reindeer from Greenland and Ellesmere Island. In four recent Norwegian stags the hindmost lower molars are so small that they are outside the range of variation of the subfossil reindeer. The small

TABLE 4.

Posterior lower molar (m 3) (in millimeters) Subfossil	Villestofte	Almindingen	Køge Bay 1941	East Prussia (Gross)	East Prussia (Gross)	France																	
						Brunniquel	Montgaudier	Laugerie (Dordogne)	Laugerie (Dordogne)	Grotte de Bize (Bude)	Montgaudier	Montgaudier	Montgaudier	Grotte de Bize	Grotte de Bize	Montgaudier	Brunniquel	Montgaudier	Montgaudier	Montgaudier	Montgaudier	Laugerie	Montgaudier
Greatest length..	24	25.0	24.5	24.6	23.5	22.5	22.5	22.8	23	23	23.5	23.5	24	24	24	24.5	24.7	25	25	25	25	25	25
Greatest breadth.	11	11.0	10.9	11.1	11.3	11	10	9.6	10	11	10.5	10	10	11	11	10	11	10.5	10.5	11	12	11	11

Posterior lower molar (m 3) (in millimeters) Subfossil	France			Hungary (Kormos)											Württemberg							
	Montgaudier	Grotte de Bize	Grotte de Bize												Vogelherd (Lehmann)	"	"	"	"	"	"	
Greatest length..	26	26	27	22.1	23.5	23.7	23.9	24.3	24.9	25.0	25.4	25.5	26.5	28.4	22	23.7	24.1	24.2	24.3	25.0	25.3	25.3
Greatest breadth.	11.5	—	—	10.5	10.2	10	10.8	10.4	10.5	10.5	11.1	11.2	11.2	11.3	9.7	10.8	11.1	10.2	9.6	10.1	10.5	11.3

Posterior lower molar (m 3) Recent	Norway						NW Greenland						West Greenland									
	CN. 1621 ♂	CN. 1622 ♂	CN. 1624 ♂	CN. 1623 ♂	Heimdalen (Miller)	Sweden CN. 342	Inglefield Ld ♂ 2717	Inglefield Ld ♂ 2714	Inglefield Ld ♀ 2715	Inglefield Ld ♂ 2713	Inglefield Ld ♀ 2712	Olriks Fjord ♀ 2709	Holsteinsborg ♂ 1048	Holsteinsborg ♂ 886	Holsteinsborg ♂ 1047	Holsteinsborg ♂ 1050	Holsteinsborg ♂ 1022	Holsteinsborg ♂ 1245	Holsteinsborg ♂ 1082	Holsteinsborg ♂ 1041	Sukkertoppen ♂ 1046	Sukkertoppen ♂ 1047
Greatest length..	17.5	20.3	21	21.2	22.6	24	19.5	20.0	20.8	21.0	22.0	22.0	22.2	22.6	22.8	23.0	23.0	23.0	24.0	25.2	20.0	21.0
Greatest breadth.	9.0	9.8	9.8	9.5	10.4	10.5	9.3	10.0	9.5	9.8	10.0	10.0	10.7	10.4	11.0	10.0	10.5	11.0	—	10.8	10.5	10.7

Posterior lower molar (m 3) Recent	West-Greenland									Ellesmere Island						Axel Heiberg Ld.					
	Godthaab ♀ 2718	Godthaab ♂ 2728	Godthaab ♂ 2729	Godthaab ♀ 2731	Godthaab ♂ 2735	Godthaab ♀ 2720	Godthaab ♀ 2719	Godthaab ♂ 2726	Godthåb ♂ 2727	♂ 2684	♂ 2685	♀ 2701	♂ 2702	♂ 2703	♀ 2695	♂ 2673	♂ 2671	♀ 2683	♂ 2672	♀ 2682	♂ 2675
Greatest length..	20.0	20.0	20.0	20.5	20.5	20.5	21.5	22.0	22.4	20.4	22.3	23.5	23.5	24.0	24.5	20.0	20.5	22.0	22.5	22.5	23.0
Greatest breadth.	9.8	10.0	11.0	10.0	10.8	11.0	10.5	10.5	10.5	—	10.5	10.5	10.5	10.2	10.5	10.0	9.8	10.0	10.5	10.7	10.6

TABLE 4 (continued).

Posterior lower molar (m 3) Subfossil	Itivnera, Godthaabsfjord West Greenland										
Greatest length . .	17.0	17.4	18.0	18.0	18.5	18.5	18.7	18.7	19.0	19.2	19.5
Greatest breadth.	9.0	9.0	9.5	9.7	9.5	9.5	9.0	10.0	9.0	9.4	9.5

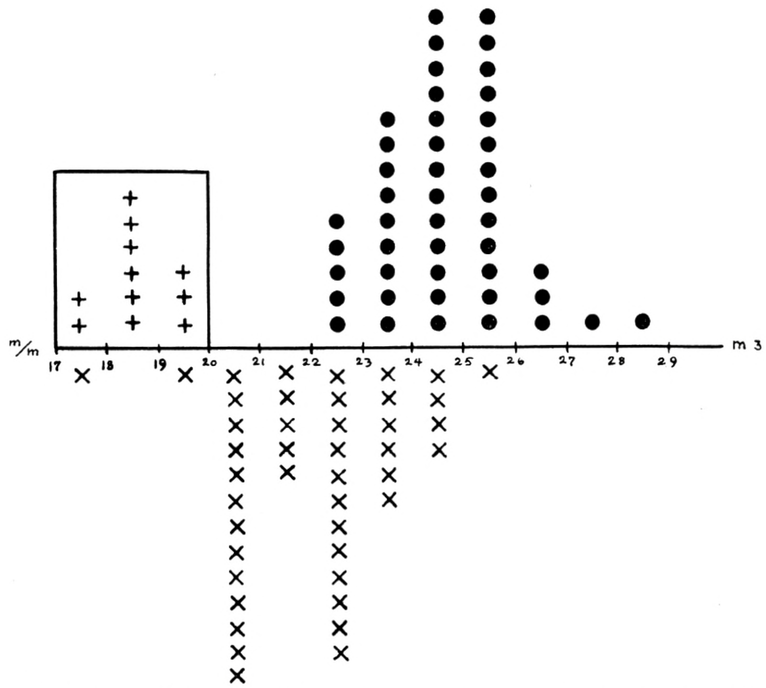


Fig. 28. Length of lower posterior molar. • subfossil, + from Itivnera, × recent.

reindeer from Ellesmere Island, *R. t. pearyi*, has relatively large, lower posterior molars.

Exceptionally small are the posterior, lower molars in a prehistoric osseous material from Itivnera in the Godthaabsfjord, West Greenland. In the summer of 1958 the archæologist, Dr. HELGE LARSEN, the National Museum in Copenhagen, made excavations in the said prehistoric site, which represents the recently discovered Sarqaq culture from about 800 B.C. The length of 11 lower m 3 ranges from 17.0 mm to 19.5 mm (cf. fig. 28). This is even more astonishing as this material comes from a region which today is one of the best reindeer-areas in Greenland, inhabited by large reindeer, and which also in Norsemen times, about 1000—1360 A.C. was occupied by large reindeer (DEGERBØL 1936 and 1957).

The length of the lower m 3 particularly depends on the development of the

TABLE

Mandible Teeth	Subfossil																
	Denmark				East Prussia		France					Hungary					
	Villestofte	Køge Bay 1954	1941 "	Almindingen			Brunniquel	Brunniquel	Grotte de Keilhac	Grotte de Bize	Montgaudier				Pilisszántó (Kormos)		
p 2—m 3 length ...	105	—	—	—	—	—	107	—	109	—	—	106	104 103	—	—	—	—
p 2—p 4 " ...	47	46	—		47.6	46.0	44	—	46	44	—	44	—	—	—	—	—
m 1—m 3 " ...	59.5	—	—		63.5	61.0	65	66	60	63 64	59.5 60	61	—	60 66			
p 2 length	12.8	13.8	—	10.5	13.8	14.2	—	—	—	—	—	—	—	—	—	—	—
p 2 width	8.4	8.7	—	7.5	8.8	8.8	—	—	—	—	—	—	—	—	—	—	—
p 3 length.........	16.3	15.4	—	16.5	17.2	16.2	—	—	—	—	—	—	—	—	16.5	—	—
p 3 width	11.4	11.4	—	11.8	11.5	11.5	—	—	—	—	—	—	—	—	10.4	—	—
p 4 length	17.0	17.0	—	17.4	18.0	17.0	—	—	—	—	—	—	—	—	18.3	19.7	20.3
p 4 width	12.4	12.0	—	12.5	12.0	12.0	—	—	—	—	—	—	—	—	11.4	13.0	12.2
m 1 length	16.0	17.5	—	17.5	19.1	18.3	—	—	—	—	—	—	—	—	18.7	19.0	19.2
m 1 width	10.7	10.5	—	10.9	12.0	10.8	—	—	—	—	—	—	—	—	10.0	11.4	10.2
m 2 length	19.4	21.0	21.8	21.5	20.0	20.8	—	—	—	—	—	—	—	—	21.3	22.2	—
m 2 width	12.5	11.8	12.1	12.0	12.2	12.0	—	—	—	—	—	—	—	—	10.2	12.0	—
m 3 length	24.0	—	24.5	25.0	24.6	23.5	24.7	25	23	—	—	—	—	—	24.9	—	—
m 3 width	11.0	—	10.9	11.0	11.1	11.3	11.0	11	—	—	—	—	—	—	10.5	—	—

posterior lobe or column. In the Itivnera material this column is much reduced or completely absent.

An explanation of this remarkable fact is difficult to give. It may be noted, however, that m 3 with strongly reduced posterior column may occur in very weak recent reindeer, cf. the smallest of the Norwegian reindeer, CN. 1621, in which this column is missing (Table 4), but a reduction is not particularly found in the small reindeer from Ellesmere Island, East Greenland, and Spitzbergen, on the contrary, these small high arctic reindeer have relatively large, lower m 3.—Curiously enough examples of m 3 with the posterior column missing is also found in another prehistoric material, from K'aersut, Igloolik, Melville peninsula, Canada, from about the same period, 500 B.C. In 2 mandibles out of 7 from this place, the lengths of the lower, posterior molars are only 17,4 and 18.0 mm, respectively (the other measurements are: 20.0—20.5—21.0—21.5 mm). This settlement was excavated by Mr. MELDGAARD, M. A. and has not yet been published. During the Sarqaq-period the climate was fairly warm and dry (LARSEN and MELDGAARD 1958), as also was the case at

5.

Subfossil								Recent								
Switzerland								Norway				Sweden				
Kesslerloch (Hescheler)	Kesslerloch (Hescheler)	Kesslerloch (Hescheler)	Kesslerloch (Hescheler)	Kesslerloch (Hescheler)	Kesslerloch (Hescheler)	Kesslerloch (Hescheler)	Kesslerloch (Hescheler)	Taumevand ♂ CN. 1624	Taumevand ♂ 1623	Taumevand ♂ 1622	Taumevand ♂ 1621	Sweden CN. 342	Mountain reindeer (Lönnberg) ♂ dom.	Woodland (Lönnberg) ♂ dom.	Sukkertoppen ♂ CN. 1046	Holsteinsborg (Left side) ♂ CN. 1023
—	—	—	—	—	—	—	—	100	96	91	90	96	—	—	98	102
45	45	45	45	44	44	42	45 41	42.5	39	36.7	39	39	—	—	45	45
63	64	59	61	67	61	61	63 66	58.5	57	54	51	58	—	—	55	59
—	—	—	—	—	—	—	—	10.5	11.7	9.7	10.8	9.5	11	9.7	13.3	12.8
—	—	—	—	—	—	—	—	7.3	7.7	7.4	7	7.0	7.7	6	7.6	8.4
—	—	—	—	—	—	—	—	14.7	13.8	13.0	14.0	14.0	17	13	15.0	16.3
—	—	—	—	—	—	—	—	9.4	9.4	9.6	9	10.0	11	9	9.3	10.5
—	—	—	—	—	—	—	—	16.5	15	14	14.6	16.5	17	14	16.0	17.7
—	—	—	—	—	—	—	—	10.7	10.7	10.5	9.4	11.0	11.5	10.5	10.5	12.2
—	—	—	—	—	—	—	—	18.8	17.6	16.2	16.2	16.0	19	17	18.0	18.2
—	—	—	—	—	—	—	—	9.7	9.5	9.5	8.6	9.6	10	9	10.5	10.0
—	—	—	—	—	—	—	—	19.2	19.3	17.5	17.4	18.5	20	19	18.2	19.0
—	—	—	—	—	—	—	—	10.5	10	10.5	9.3	10.5	11	10	11.1	11.4
—	—	—	—	—	—	—	—	21.0	21.2	20.3	17.5	24.0	22	21	20.2	22.3
—	—	—	—	—	—	—	—	9.8	9.5	9.8	9.0	10.5	9.5	10	10.7	11

Igloolik in the said period—perhaps too dry for the welfare of the reindeer. It is to be hoped that new and more extensive excavations may settle this question.

Curiously enough the lower m 1 in the Villestofte specimen is very small, 16 mm, even smaller than in the Norwegian reindeer (Table 5). This is presumably an individual deviation; in two mandibles from East Prussia belonging to the late-glacial period m 1 is well developed: 19.1 and 18.3 mm in length, respectively.

A comparison with these two East Prussian mandibles—which I have had the opportunity to investigate—(Gross 1942, p. 74) indicates that the premolars in the subfossil reindeer are especially powerful. The great breadth of the premolars in the two East Prussian mandibles is due to the fact that the posterior column, which forms the posterior edge of the tooth, is so particularly broad, that the greatest width of the teeth occurs posteriorly, whereas the lower premolars in the Greenland animals generally are broadest in the middle.—Measurements of maxillary teeth are given in Table 6. Here, too, it may be noted that the upper m 1 in the Villestofte reindeer is fairly small (cf. fig. 29).

TABLE 6.

Maxillary teeth	Subfossil					Recent											
	Denmark		France		Hungary	Norway					Sweden						
	Villestofte ♂	Strangegaard ♂	Grotte de Bize	Grotte de Keilhac	Pilisszanto (Kormos)	Taumevand ♂ CN. 1624	Taumevand ♂ CN. 1623	Taumevand ♂ CN. 1622	Taumevand ♂ CN. 1621	Taumevand ♂ CN. 1625	Mountain reindeer (Lönnberg) ♂ dom.	Woodland (Lönnberg) ♂ dom.	Sweden CN. 342	Sukkertoppen ♂ CN. 1046	Holsteinsborg ♂ CN. 1023	Exeter Sound ♂	Alaska ♂
p 2—m 3 length	97	102	—	—	—	93	88	85	83	77	—	87	91	94	97	99	88
p 2—p 4 „	47.3	50	48 / 47	—	—	42.3	41.5	40.4	40.5	36	—	—	43	42	45	47.5	43
m 1—m 3 „	53.7	56	56	57	—	52.2	49.7	47.3	46	42	—	—	50	53	55	54.5	48
p 4—m 3 „	67	—	—	—	—	66.5	61.8	59.5	58.5	54	—	—	63	67	69	—	61
p 2 length	16.3	17.2	—		(length of 24 premolars) 14.5–18.5	13.5	12.5	13.2	13.3	11.2	16	12.5	15.0	14.0	15	—	15
p 2 width	16.1	—	—	—		12.9	12.5	13.8	13.1	13.3	14.5	12	15.0	13.5	14.5	—	12.8
p 3 length	15.6	15.5	—	—		14.0	13.8	13	13.3	—	16.3	13.5	13.5	14.0	15.5	16.5	14
p 3 width	16.5	—				13.8	13.2	14.5	13.1	—	16.5	12	15.0	14.0	15.0	17	14.2
p 4 length	14.7	15.3	—	—		14.5	13.5	13	13.3	13	15.5	13.5	15.0	14.5	15.0	—	14.7
p 4 width	17.5	—	—	—		14.2	13	14.5	13.1	13	15.5	12.5	15.6	14.5	15.8	—	15.2
m 1 length	16.8	17.6	—	—		17.6	16.5	15.5	15.2	12.6	18	16.5	16.0	16.5	17.5	—	14.5
m 1 width	14.6	—	—	—	(41 molars) 18.7–22.8	13.5	14.0	13.2	12.7	13.1	15	13	15.2	14.5	15.2	—	15.7
m 2 length	19.5	20.0	—	—		18.4	18.0	17	16.5	14.3	18.5	17.5	16.7	18.5	18.7	19	16.4
m 2 width.......	16.8	—	—	—		14.2	14.0	15	14.4	13.3	16	15	16.0	16.0	16.2	17.3	16.0
m 3 length	19.5	18.5	—			17.2	16.0	15.2	14.8	14.6	17.5	16	17.0	18.2	19.0	19.5	16.4
m 3 width	16.0	—	—			13.5	13.2	14.1	13	12.7	15.5	12.5	15.6	15.2	16.0	15.5	16.0

As an important indication of the affinity of the prehistoric European reindeer to the American barren-ground reindeer several authors (i.a. KORMOS 1916, and JACOBI) have emphasized the occurrence of an extra root in the lower p 4. In the subfossil reindeer as well as in the American *R. t. arcticus* an adventitious root is found fairly often between the ordinary anterior and posterior root of this premolar. As demonstrated by FRIIS (1941), however, an extra root in this tooth may also be found in *R. t. tarandus*, and I may add, in *R. t. groenlandicus*, too.—In the Villestofte reindeer a longitudinal, low ridge exists between the anterior and posterior root, but no extra root is found. Neither is an additional root seen in a right mandible from Køge Bay. In the left mandible from Almindingen, Bornholm, however, a large additional double root, on the medial as well on the lateral side, is found, about 1 cm long and 2—3 mm in diameter at base.

I agree with the opinion of GRIPP and other authors that it is difficult to understand that this character should be of any importance whatsoever with regard to the existence of relationships or not.

Antlers. The Villestofte reindeer has powerful antlers. The length along the outer curvature is 1350 mm and the widest spread is 1150 mm. In Norwegian wild reindeer a length of beam of 1200 mm represents powerful animals, but COLLETT states for two Norwegian wild reindeer (two record specimens) a length of 1510 mm and 1511 mm, respectively. The greatest spread was 849 and 1040 mm, respectively, and total number of points 43 and 25, respectively. The length and width of antlers, however, may vary very much within the same population. In 12 large reindeer from West Greenland, *R. t. groenlandicus,* the average length of the beam is 1210 mm, ranging from 1080 to 1300 mm., and the average spread is 1073 mm (880—1260 mm).

In the Villestofte animal the beam must be characterized as round or oval. The diameters of the beam are in the left antler: (1) 56×46 mm, (2) 42×39 mm, and (3) 46×36 mm; in the right antler: (1) 58×41 mm, (2) 40×37 mm, and (3) 45×39 mm. Halfway between the back tine and the lower tine of the palm the measurements are 55 mm and 40 mm, which shows that the beam above the back tine broadens fairly rapidly. The breadth of the palm or shovel between 1st and 2nd tine is 111 mm, between 2nd and 3rd tine 105 mm, and between 3rd and 4th tine 126 mm on the right side, 107, 87, and 105 mm, respectively, on the left palm.

It also appears from the many tines or points that the Villestofte reindeer has very powerful antlers. On the left antler the brow tine is simple, ending without any forking, the length of the complete tine is 23 cm, diameters in the middle 18 and 21 mm, but the second tine, the bez, is broad, palmated, with 9 points or tines; moreover, the lower of these tines is faintly bifurcated; the height of the palmation is 23.5 cm, the length of the tine is 35 cm in a straight line, along the median curvature 41 cm, diameters 35×28 mm. On the right side the brow tine as well as the bez are strongly palmated, with 11 and 10 points, respectively. The height of palmation is 37.5 cm and 24 cm, respectively. The length of the brow tine is 32 cm, diameters 29×24 mm. Length of bez tine 28 cm in a straight line, at the median curvature 37 cm, diameters 40×26 mm.—On both sides the back tine is well developed, distinctly bifurcated, about 10 cm long on the left antler and 7 cm on the right side. The diameters of the left back tine are 32×15 mm, of the right 25×9 mm. About 10 cm above the back tine there is on the left antler a small additional point about 10 mm high and 20 mm long. Also the shovel or palm is on both antlers strongly developed with large tines. The left palm has 6 main tines, of which 3 are divided, altogether this palm has 12 tines; the right antler has 7 main tines with 13 points. The left antler has 25 points in all, the right antler 36, on both antlers 61 points altogether.—In the aforementioned record specimen with 43 points, kept in the Zoological Museum of Oslo (COLLETT p. 524), the brow and bez tines are both palmated in the right antler just as in the Villestofte reindeer; the number of points are in the right antler: brow tine 11, bez tine 6, back tine 1, and palm 9; altogether 27 points; in the left antler the brow tine is wanting, the bez tine is palmated with 8 points, the back tine is only indicated, and the palm has 8 points, in all 16 points.

The antlers of reindeer are extremely variable, but usually two principal types are recognized: a tundra or barren-ground type with a long, slender, and rounded

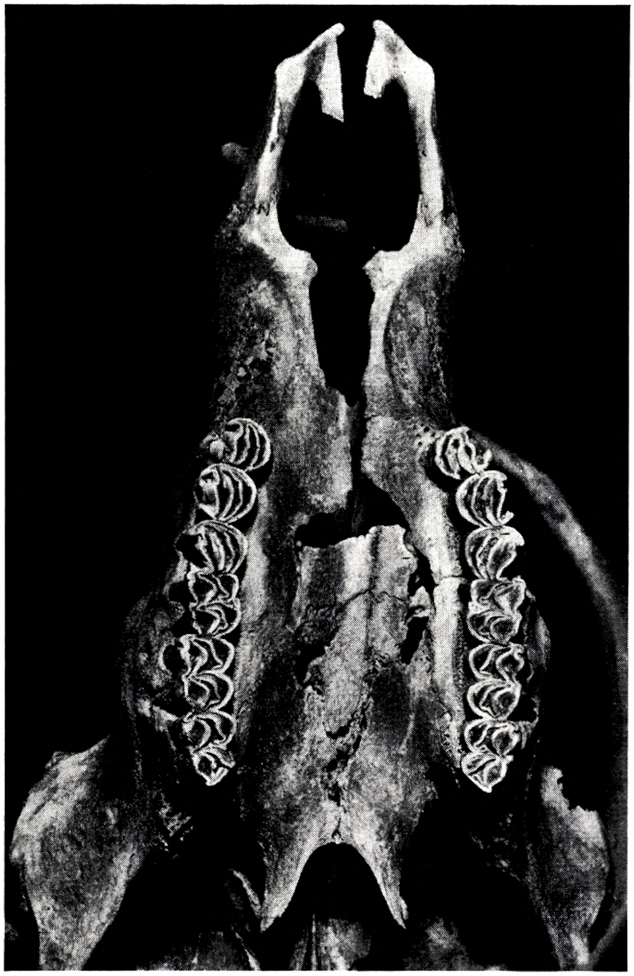


Fig. 29. Palatal part with upper teeth. Villestofte reindeer.

beam, and only slightly developed palmation (the cylindricorne type of Cameranos) and a larger woodland type characterized by a shorter, stouter, more compact, and flattened beam and greatly developed palmation of brow and bez tine (the compressicorne type); but there is no sharp distinction between the two types. As the antlers of the Villestofte reindeer are long, relatively slender, and in the lower part rounded, this animal must belong to the tundra type—this is also in agreement with its geological age, the Early Dryas period (cf. p. 49). On the other hand it may be emphasized that the beam above the back tine is rather flattened as is the case in the woodland reindeer. The greatly developed palmation of the brow tine and bez tine normally characterizes this type, too. Reynolds (1933, p. 22) writes about this: "In the Woodland variety one brow tine is commonly much palmated, and considerably

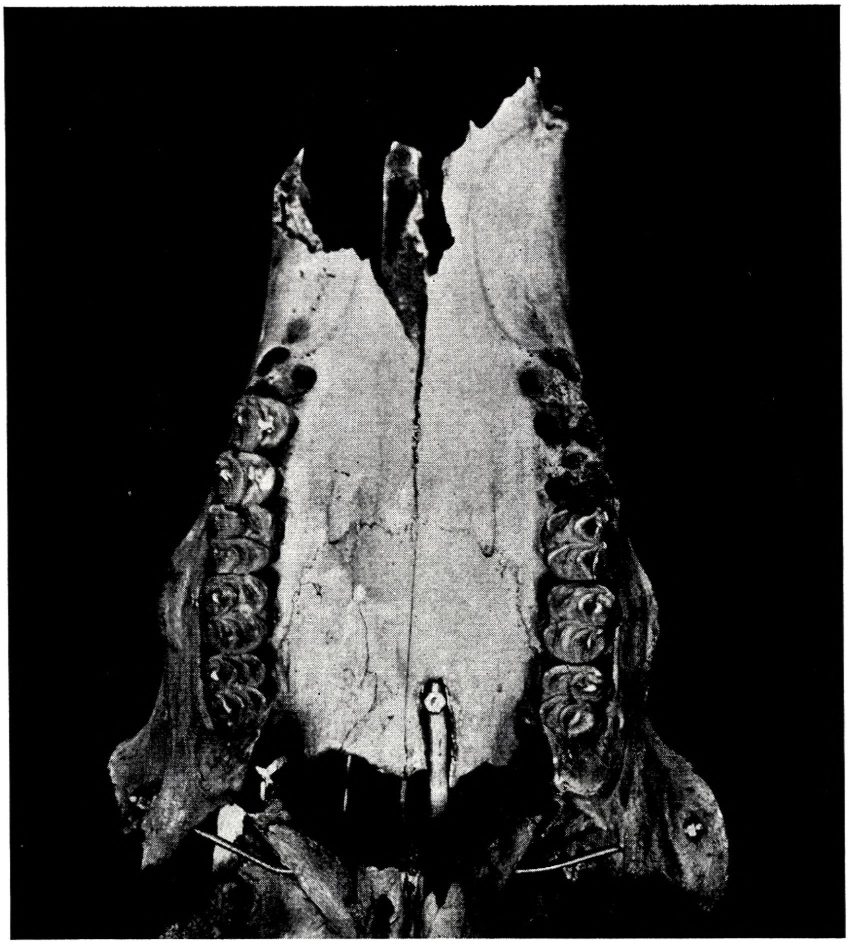


Fig. 30. Palatal part with upper teeth. STRANGEGAARD reindeer.

larger than the other, while the succeeding bez tines are also large and palmated, a rare feature in the Barren Ground variety." However, in the Norwegian specimen just mentioned the brow tine as well as the bez tine is palmated. Accordingly the Villestofte reindeer is not—as many other recent and subfossil reindeer—a typical barren-ground reindeer, but it does not belong to the woodland type. Several writers are of opinion that there is a third "race" or type, intermediate in character between the two main types mentioned. RITCHIE (1920) maintained this opinion with regard to several subfossil reindeer, and even to the Scottish reindeer and the recent Scandinavian animals, and SANDFORD holds the same view regarding the reindeer of Spitzbergen.

I cannot agree with this opinion. As a typical barren-ground form I shall mention the West Greenland reindeer. From a biological point of view they are mountain

Fig. 31. Skull from VILLESTOFTE. From the right.

Fig. 32. Skull from VILLESTOFTE. From the left.

or barren-ground animals; forests do not exist in their biotopes. But from a morphological point of view these reindeer just represent the above-mentioned "intermediate" form.

A specimen from Holsteinborg, CN. 1022, and other Greenland reindeer are very like the Villestofte reindeer. We thus have a type of reindeer living in an open scenery (tundra, barren-ground, mountains, alps) which is characterized by long beams, which at least in their lower part are rounded, but above the back tine may be more or less flattened; the brow tine or (and) the bez tine may be heavily palmated. Of course such antlers may easily be confounded with the woodland type, especially if only fragments are present; cf. fig. 34 but they will always have longer beams, and the palmation does not—apart from rare exceptions—attain the luxuriance which may be found in the woodland type. On the basis of a fairly ample material an exact determination is always possible. The more or less pronounced palmation is partly a phenotypical phenomenon, i. a. a question about a greater or smaller surplus of food and thus of strength of the animals. This is in good agreement with the modern view of the good conditions of life for reindeer, and many other ungulates in the late-glacial tundras in Denmark. It should be borne in mind that even if glacial conditions prevailed in Denmark in the late-glacial period, these conditions are not comparable to arctic conditions in more northerly regions in recent time, since the altitude of the sun, the length of summer and winter, and many other factors have been different in the two localities, so that the ecological climates have been widely different. From Dr. IVERSEN's investigations (1945) we know that in late-glacial times the soil of Denmark was nutritious and covered with a rich vegetation, i. a. of *Gramineae* and *Cyperaceae*, "In Early Dryas time the warmer slopes with a southern exposure had a very interesting plant community, with *Hippophaë*, *Artemisia* and *Helianthemum* as character plants. This community is quite unknown in present-day Arctic and sub-Arctic regions and gives the late-glacial vegetation its character. — — — It may therefore be questioned whether one is justified in using the appellation Arctic or sub-Arctic of late-glacial vegetation. The points of similarity with the Central-European alpine vegetation are in reality more prominent."—The late-glacial Danish mammalian fauna is not at all arctic either (cf. p. 101).

A presumed occurrence of subfossil remains of these two types of reindeer, the barren-ground type and the woodland type, has played an important rôle in the discussion of the history and migration routes of the prehistoric reindeer. LARTET and R. DE SAINT-PERIER (1936) were of opinion that the Pyrenean reindeer was of barren-ground type, and the same view was held by BEYER (1894) regarding the reindeer of Rixdorf, near Berlin; while according to GERVAIS the woodland type prevailed in northern France. SCHARFF (1897) has suggested a double migration of reindeer from North America into Europe, an earlier one of the barren-ground reindeer followed by a later migration of the woodland type. He gives a map showing a land bridge from Greenland to Spitzbergen, Norway, and the British Isles in interglacial times.

Fig. 33. Skull from Villestofte. Anterior view.

As we now know that reindeer which lived (Villestofte specimen) or live (Greenland specimens) in a distinctly open landscape, have powerful antlers and a relatively great palmation in appearance leading to the woodland type, it is doubtful whether the old verification of woodland reindeer in prehistoric Europe is correct. No doubt they have been confounded with what I have here called the open-land type and thus do not indicate a forest-clad scenery.

Jacobi (1931) believes in the *shape of the antlers* to have found a clear distinguishing mark between the American tundra reindeer *R. t. arcticus* and the European reindeer *R. t. tarandus*. In *R. t. arcticus* the beam above the back tine should form an even curvation or arch, while this part in *R. t. tarandus* is straight or only slightly curved, forming a well-defined angle or bend with the beam below the back tine. When the back tine is absent, the beam, however, shows a tendency to be curved as in *R. t. arcticus*.

This very interesting theory has already been much discussed by several authors and much has been written pro and con. In their great work: *La grotte de Cotencher*, DUBOIS and STEHLIN (1933) touch upon this problem when discussing the prehistoric reindeer. They are of the opinion that there is no special reason for accepting JACOBI's theory. FLEROV (1933) holds the same view. GRIPP (1937), who has treated the large material of reindeer from Meiendorf, Early Dryas period, on the other hand writes (p. 62): "Auch die Meiendorfer Funde geben Jacobi recht." At the same time it is pointed out, however, that also the *tarandus* type, judging from the shape of the antlers, is clearly represented, though there are only two specimens out of 105 present.

GRIPP also draws attention to the fact that EDINGER (1931) from the Ruhr area has pictured an antler of the *tarandus*-type.

Six years later GRIPP (1943) examined the still greater material, 1300 antlers or fragments of antlers, of reindeer from Stellmoor, Late Dryas period. This time, however, there were so many antlers of intermediate shape, that GRIPP did not find it possible to distinguish sharply between the *arcticus* and *tarandus* type and he figured all transitional stages. Nevertheless, GRIPP is of the opinion that it is unquestionable that the antlers of Pleistocene and late-glacial reindeer in Europe in general have another shape than those of recent European wild reindeer. The prehistoric reindeer are more in accordance with the American *Rangifer t. arcticus* than with the Eurasian *R. t. tarandus*.

In other known stock of prehistoric reindeer a similar intermixture of "arcticus" and "rangifer" features are known. In 77 antlers of reindeer described by GROSS (1939) from East Prussia beams with "arcticus" curve as well as beams with "tarandus" bend are pointed out, but the *arcticus* type is predominant. A paper by the same author (1942) records the occurrence of an antler of the *tarandus* type from the late-glacial period.

A general account of the reindeer in the British Isles is given by REYNOLDS (1933). Figures in this paper show antlers of both types, too, i.a. fig. 9. The famous skull with antlers from Ashbourne, co. Meath, Ireland, which for the first time was figured by CARTE (1864) is here reproduced anew; it has typical curved antlers. The same holds good of the subfossil antlers from Sweden published by ISBERG (1930). SOERGEL (1941) has re-examined the oldest finds of reindeer from the early and middle Pleistocene (Süszenborn, Steinheim, Frankenhausen) and he arrived at the result that these antlers, 7 in all, belong to the tundra reindeer, in contrast to several previous writers, who were of the opinion that also the woodland reindeer had inhabited Central Europe during the Pleistocene.—SOERGEL furthermore demonstrated that the

Fig. 34. Skull from VILLESTOFTE with brow and bez tines. Lateral view, right.

tarandus type as well as the *arcticus* type is represented.—It is remarkable that in the three known antlers from Frankenhausen the bez tine is missing, whereas the brow tine in two of the three specimens from Süszenborn is bifurcated.

The problem now arises: Does JACOBI's distinguishing mark, viz. the shape of the antlers, hold, or have we merely two extremes with intermediate forms before us? In "Danmarks Pattedyr" 1935, p. 26, I drew attention to the great variation of antlers of recent animals and to the fact that it is often extremely difficult to decide to which type many of these antlers should be referred, but was nevertheless of the opinion that the majority of the Danish subfossil reindeer showed the curved shape of the antlers. As also pointed out by M. E. FRIES (1941) both these antler "types" are found in Scandinavian reindeer, but this author claims that they are really only extreme forms of an intermediate common type with rather a sharp curve above the back tine; the part of the beam above this curve, however, is not straight, but clearly slightly curved.—It is remarkable, too, that in rare cases the "*tarandus*" type may be found in the American reindeer (cf. MURIE 1935, p. 113). Also a collection of skulls of Greenland reindeer kept in the Zoological Museum in Copenhagen, shows how difficult it is to distinguish between the two types set up by JACOBI. A single skull CN. 1022 even has one antler shaped as the *arcticus* type, the other as the *tarandus* type. Most of the Greenland antlers, however, belong to the *tarandus* type; several of them have on the beam above the back tine a distinctly *forward* directed curve, i. e. the anterior border of the beam is here more or less convex, in my opinion the most characteristic and decisive feature of the most pronounced *tarandus* type.

It is thus obvious that both forms of antlers may occur in the same population of reindeer. This means that there is no distinct distinguishing mark in this feature, but one type or the other may be more or less dominating within a certain population.

After these remarks we shall consider the *antlers of the Danish animals*. In the Villestofte specimen the beam above the back tine is evenly, although faintly, curved, and this holds good, too, of the Strangegaard animal, while the antlers in the Skinderbygaard reindeer are atypical.

On Plates I—IV some of the best preserved Danish antlers are figured, starting with antlers which have distinctly curved beams ("arcticus type") and ending with antlers showing "tarandus" features. It will be seen that the majority of the beams belongs to the former type.

In order to demonstrate the variation of antlers from a rather limited area, the isle of Bornholm in the Baltic Sea, I have put figures of these antlers together on Plates III and IV. It appears that here, too, the variation is just as great as in the rest of Denmark. It should be remembered, however, that Bornholm in late-glacial times was part of the European continent and not an isolated island.

As a deviation it may be noted that the beam in some specimens from Bornholm (Nos. 166 (92) Pl. IV R 2, No. 6; 169 (178) Pl. III, R. 1, No. 4; 172 (3) Pl. IV, R. 3, No. 8; 186 (15) Pl. IV, R. 3, No. 7 and 187 (17) Pl. IV, R. 3, No. 9) above the back tine is considerably narrower than below this tine.

For the sake of description GRIPP (1943) has distinguished between 5 different types of beams.

(1) The typical *arcticus* sickle with the front side of the beam, above the bez tine, formed as a semicircle, and the posterior margin of the beam, below the bez tine, forming a smaller segment of a circle.—As the anterior arc grows smaller and the posterior one larger the shape of the beam is changed into (2), where the anterior and posterior arc are of about the same size ("Gleichkreiser-Stange"), or (3), where the lower arc is the largest ("Untere Gross-Kreiser-Stange"). (4) the middle part of the beam, between bez tine and back tine, is nearly straight, and (5) the anterior border of the beam forms one single large arc.—1, 2, and 5 are characteristic of the *arcticus* antler-type, 3 and particularly 4 pass into the *tarandus*-antler-type; but of course these types are not sharply defined.—Characteristic of the *arcticus*-antler is, in other words, the evenly curved beam, particularly a larger, upper, anterior concavity and a smaller, lower, posterior arc.

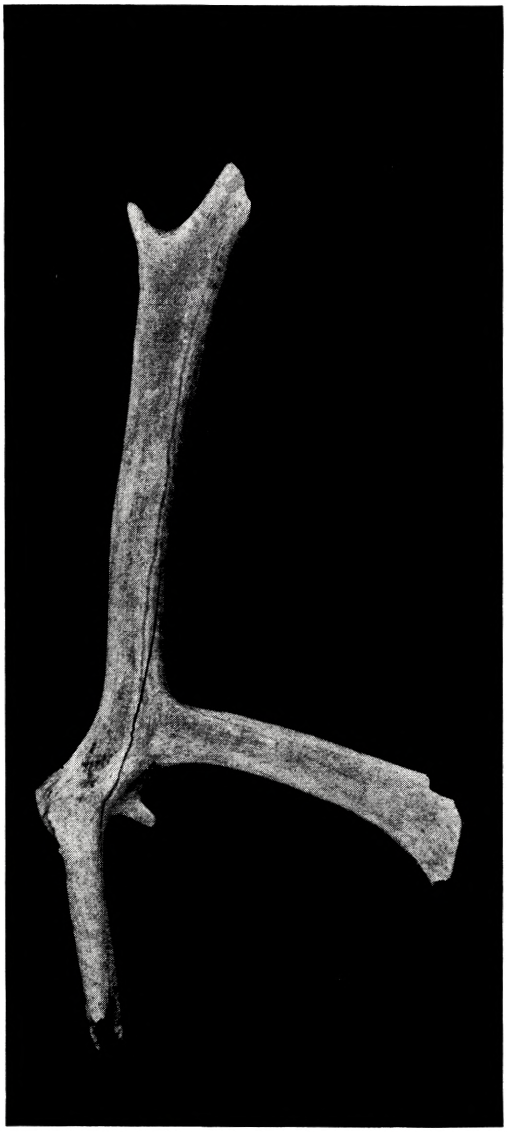


Fig. 35. Antler from BORNHOLM (No. 191), fairly broad and with a supernumerary tine.

Also in the Danish material these types are represented. Beams with an anterior and a posterior curve (Type 2) are of most frequent occurrence; particularly demonstrated in the upper rows of all plates (I—IV). Beautiful examples are e.g. seen in Plate I, upper row, Nos. 2, 3, 4, and 5. The lower posterior arc may be so small that we find transition to an "arcticus sickle" or even to a single curve, as seen in Plate II, Row 1, Nos. 1, 2, and 6. Especially when the back tine is absent or very small, the beam has a tendency to form one single curve, cf. Nos. 5 and 6 (from Risbanke and Vollerslev) in Plate II, upper row. Vollerslev represents a form often seen in the antlers from Meiendorf, characterized by a typical "arcticus curve" of the beam, and the tip of the beam round or slightly flattened with few simple and small tines; no real palm. Beams of this type are figured by GRIPP (1937) in Pl. 9 figs. 15 and 18, and in Pl. 10, figs. 14, 15, 16, 17, 19, 22, 23, and 25. All the antlers figured by Rust (1937) on Pls. 24, 25, 26, 27, 28, and 29 also belong to this type. In recent reindeer, too, i. a. Alaska-Yukon caribou, this shape of antlers exists (Murie 1935, figs. 5).

In several antlers the lower part of the beam, below the back tine, may be fairly straight, as seen especially in the lower rows in the plates; when also the upper part of the beam is nearly straight, we pass over to the "tarandus" type.

Quite aberrant is the nearly straight beam in the Skinderbygaard reindeer (cf. p. 38). A beam of about the same shape is described and figured by Schweder (1906) from Olai, Riga Bay, Latvia; found at a depth of 3 m below peat and river deposits with *Betula nana* and *Dryas octopetala*. The brow tine in this Olai reindeer is small, 13.5 cm long. The bez tine, which is broken 41 cm from the base, is broad as in the Skinderbygaard specimen, diameters are 50—70×25 mm.

It is a remarkable feature in the subfossil Danish reindeer that the back tine very often is missing. In 53 antlers from Bornholm 18 have no back tine, and in reindeer from the rest of Denmark this tine is missing in 21 antlers out of 48. It seems that the same holds good of the antlers from Meiendorf and Ahrensburg; of 10 antlers worked up by the prehistoric people and figured by Rust 4 have no back tine, and in the plates given by Gripp this tine is absent in 8 out of 30. On the other hand, the back tine is often well-formed. In 4 specimens (Bornholm Nos. 152 (130), 167 (145), and 179 (157) and in the left antler of the Villestofte reindeer) an extra back tine is present.

Of other variations may be mentioned that the brow tine is absent in 6 specimens: Bornholm (203) (181), Karrebækstorp (57), Ringsted river (64), Risbanke (71 b), Vintappergaarden (84 b), and Strødam (92). The bez tine is absent in 2 antlers: Bornholm (197 (195)) and Silkeborg (130); in one antler, (207 (13)) from Bornholm, a supplementary tine issues from the base of the bez tine (fig. 36), and an extra tine below the bez tine is found in Bornholm No. 206 (184).

Rutten (1909) has established the late-glacial reindeer from the Netherlands and Northern Europe as a new subspecies, *R. t. diluvii*, characterized by a very small brow tine; only three antlers were, however, at his disposal. The brow tine may be very small in some Danish antlers, but this is not at all characteristic of the population; on the contrary, the brow tine is often very large and palmated: Villestofte, Skinderbygaard, Strangegaard, Trige bog, Isterød, etc. (Plates I—IV).

Generally the Danish late-glacial antlers of reindeer are of the round, cylindricorne type with only a small difference between the longest and the shortest diameter; but several are fairly heavy, broad and flattened with relatively sharp anterior and posterior edges: Bornholm (Nos. 169 (178), Pl. III, R. 1, No. 4; 191 (224) fig. 35, and 207 (13), fig. 36), Søborg bog (No. 24), and the bez tine may be very broad (Kirke-Saaby No. 30). In the antler No. 169 (178) the brow tine as well as the bez tine is furthermore strongly palmated, a character normally distinguishing the woodland type (cf. p. 77). However, a broad bez tine is also found in the Skinderbygaard reindeer, which is otherwise a typical tundra specimen. Unfortunately these flattened antlers are not dated within the late-glacial periods, but no doubt they all belong to the tundra reindeer and thus furthermore indicate the variation in these animals.

Altogether it must be admitted that the shape of the antlers of the late-glacial reindeer is fairly different from the majority of antlers of recent Scandinavian reindeer; however, the difference is not greater than to be explained by an evolution during about 12,000 years, which have passed since the Younger Dryas period.

Also in the famous cave paintings and engravings on bones and ivory made by late paleolithic men several authors have tried to find racial features characteristic of the late-glacial reindeer. Unfortunately, however, they have arrived at quite different results. Ritchie, for instance, (1920 p. 344) is of the opinion that the drawings of reindeer "clearly indicate a woodland variety. In the Aurignacian painting of two Reindeer fronting each other, on the walls of the French cave at Font-de-Gaume, in Dordogne, the brow tines of one of the Deer are strongly palmated and unequally developed. In the late Magdalenian picture of a Reindeer grazing by a pool, found engraved on a piece of bone at Kesslerloch, near Thayngen, Switzerland, the brow and bez tines are both heavily palmated."

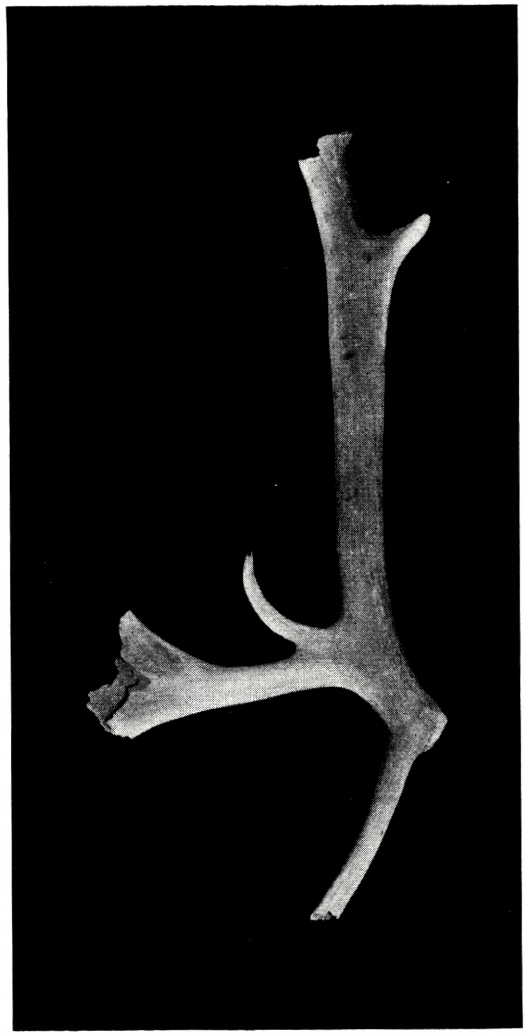


Fig. 36. Antler from Bornholm (No. 207) with an extra tine at base of bez tine.

Jacobi (1931 p. 15), however, holds the view that the said pictures indicate the tundra reindeer and even the American barren-ground caribou characterized by the strongly curved beams.

As we now know from the Danish material that strongly palmated brow and bez tines may occur in tundra reindeer, this character in the Kesslerloch specimen does not prove the existence of the woodland reindeer in late-glacial times. On the other hand, it should be noted that the antler in this grazing reindeer from Kesslerloch is not at all typical of *R. t. arcticus*. It is true that the beam above the back tine is strongly curved, but the beam below the back tine is quite straight, not curved as ordinarily in *R. t. arcticus*, here again, however, we must admit, that this shape of antlers also occurs in Danish reindeer.

The antlers of the two reindeer from Font-de-Gaume form one great curve, but as the back tine is missing (not drawn) this does not, from a critical point of view, mean anything definite with regard to the problem of subspecies.

In my opinion this also holds good of the antlers of reindeer in palaeolithic art in general, they are made with marvellous artistic skill, but not so minutely that they may form the basis of a final decision of the rather subtle question *arcticus* versus *tarandus*. However, considering the fairly large variation of the antlers in prehistoric reindeer, as demonstrated in the osseous material, we cannot expect to find a single strict type represented in palaeolitic art, on the contrary we just find a variation also now known from the many excavated antlers.

Unfortunately little is known with regard to the Pleistocene osseous material of the American reindeer, *R. t. arcticus* (Frick 1937, Hibbard 1952 and 1958). Hibbard (1952) has described and figured two antlers of the barren-ground caribou from near Fowearville and Minden City, Michigan, from deposits laid down after the retreat of the Wisconsin ice-sheet. They are both broken between the tip and the back tine, and also the brow tine and bez tine are partly broken. The shape of the beam is of the *arcticus* type, i.a. with the part above the back tine evenly curved, the part below the back tine, however, is fairly straight. These two antlers thus indicate that the barren-ground reindeer, *R. t. arcticus*, once, in prehistoric times, was distributed farther south than today. In historic times Michigan was once inhabited by the woodland reindeer (*R. caribou*). This reindeer, however, has left this state long ago. The last recorded ones were on the Isle Royale about forty years ago (Burt 1946, p. 262).

It thus appears that in the late-glacial Danish population of reindeer the curved shape of the antlers (*arcticus*-type) is dominating, just as in the reindeer from Meiendorf, Stellmoor, and Ahrensburg. This may indicate, as also suggested by Soergel, that the *tarandus*-type or -stage has evolved from a common circumpolar species in which the *arcticus*-form was dominant. On the basis of the antlers it is not necessary to assume a direct American migration of reindeer to Europe.

Limb Bones

From Denmark only few limb bones of reindeer are known. Most important is of course the complete skeleton of the Villestofte reindeer, but besides a few complete limb bones, i.a. from the submarine find in Køge Bay, are at hand. Of course only limb bones of animals of the same age and sex may be directly compared. Limb bones of adult animals have completely closed sutures between diaphysis and epiphyses, and the surface of the bone is hard and bright. In females the limb bones are characterized by their smaller width, especially of the diaphysis. For the sake of

TABLE 7.

Metacarpus	Subfossil: Denmark: Villestofte ♂	Andst (♂)	Køge Bay (♂) (1954)	Køge Bay (♀) (1935)	Køge Bay (♀) (4.10.1944)	Køge Bay (♀) (20.10.1947)	Køge Bay (9.8.1948)	Køge Bay (21.10.1947)	Køge Bay (2 specimens)	Strangegaard	France: Montgaudier (♂) Charente	Montgaudier (♀) Charente	Germany: Stellmoor (Kollau)	Schussenquelle (♀)
1. Total length	208	206	210	200	199	(200)	—	—	—	209	195	183	174–216	—
2. Length, median . . .	200	199	203	195	193	—	—	—	—	—	—	—	(88 spec.)	173
3. Proximal width:														
a. Transvers.	41	38	36	36	35	38	35	39	32	—	37	32	—	—
b. Ant.-post .	30	28	(26)	26	27	28	28	30	24	—	—	—	—	—
4. Width, middle	27.2	25.5	26	19.3	21.5	22.5	—	—	—	—	27	19	—	—
5. Least width:														
a. Transvers.	26.5	24.5	25	19.3	21.5	—	—	—	—	—	—	—	—	—
b. Ant.-post.	17.4	18.2	17	16.0	16.5	—	—	—	—	—	—	—	—	—
6. Distal width:														
a. Transvers.	47	46.5	43	43	43	—	—	—	43	—	45	41	—	—
b. Ant.-post.	24	22.3	—	22.0	21.0	—	—	—	22	—	—	—	—	—

Metacarpus	Recent: Lappland ♂ CN. 158	Holsteinsborg ♂ 886	West Greenland ♂♂ (4 spec.)	West Greenland ♀♀ (4 spec.)	Rödingsträsk (Woodland, Lönnberg) ♂ dom.	Kvikkjokk (Mountain) (Lönnberg) ♂ dom.	Recent ♂,♀ dom. (Kollau)	R. t. osborni (Kollau)	Trail creek Alaska	Sachalin (Tscherski)	Lappland (Tscherski) ♀ ad. jun.	Lower Tunguska (Tscherski)	Sweden CN. 342
1. Total length	202	206	184–194	173–190	208	194	{186 185	228	216	—	—	—	194
2. Length, median . . .	195	197	179–187	166–184	—	—	—	—	209	213*	212*	230	187
3. Proximal width:													
a. Transvers.	35	38	35–39	33–36.5	—	—	—	—	41	39	—	39	37
b. Ant.-post.	24	28	26–28	23–26	—	—	—	—	31	—	—	—	28
4. Width at middle	25.4	29.4	25–28	18.8–20	—	—	—	—	28	26	—	21	27.8
5. Least width:													
a. Transvers.	25.4	28.2	—	—	—	—	—	—	26.5	—	—	—	27
b. Ant.-post.	17.3	18.8	15.5–17.5	14–15.5	—	—	—	—	18.7	—	—	—	16.6
6. Distal width:													
a. Transvers.	48	50	45–48	41–45	—	—	—	—	48	49	—	48	45
b. Ant.-post.	23.5	24.5	23–24.5	21.3–24	—	—	—	—	25.5	—	—	—	23.5

* Outer side.

TABLE 8.

Metatarsus	Subfossil: Denmark: Villestofte ♂ (Left)	Villestofte (Right)	Køge Bay (♀) (30.8.1948)	Køge Bay (♀)	Køge Bay (♀) (20.10.1947)	Køge Bay (30.4.1936)	Køge Bay (1954)	Hvam	Aaremyre Bornholm	Germany: Stellmoor (Kollau)	Schussenquelle (♀)	Ljachow Siberia (Tscherski)
1. Total length	289	287	261	260	255	—	—	282	—	251–288 (21 spec.)	— 258*	276 270*
2. Proximal width:												
a. Transversal	36	36	28	28	26	32	—	31	—	—	28	30
b. Ant.-post	37	37	32	31	32	35	—	34	—	—	—	—
3. Width at middle.. (transversal)	29	29	18	19	—	27	—	22	—	—	17.2	22
4. Least width, transversal	26	25	16	16	17.5	21.5	23	21	24	—	16.2	18
5. Distal width:												
a. Transversal	46	46	40	40	40	—	(43)	43	46	—	38	41
b. Ant.-post	25.6	25.6	22.2	22.2	24	—	(23)	25	25	—	—	24

Metatarsus	Recent: Lappland ♂ CN. 158	Holsteinsborg West Greenland ♂ CN. 886	West Greenland (4. specimens) ♂♂	West Greenland ♀♀ (4 spec.)	Rödingsträsk (Woodland, tame) ♂ (Lönnberg)	Kvikkjokk (Mountain, tame) (Lönnberg)	Tame ♂, ♀ (Kollau)	R. t. osborni (Kollau)	Sachalin (Tscherski)	Sweden CN. 342
1. Total length	278	288	263–278	240–266	285	270	{ 257 251	307	— 288*	272 263*
2. Proximal width:										
a. Transversal	32	32	30–34	28–30	—	—	—	—	33	33
b. Ant.-post	33	37	32–37	30–32	—	—	—	—	—	36
3. Width, middle.... (transversal)	25	27	24–32	18–20	—	—	—	—	25	25
4. Least width, transversal	22	24	24–26	16–18	—	—	—	—	—	23
5. Distal width:										
a. Transversal	44	46	43–46	40–45	—	—	—	—	48	43
b. Ant.-post.	24.5	24	25–26	23–25	—	—	—	—	—	24

* Outer side.

TABLE 9.

Antebrachium (Ulna and radius)	Subfossil: Denmark: Villestofte ♂	Subfossil: Denmark: Nørre Lyngby (♀)	Subfossil: Denmark: Køge Bay (♂)	Subfossil: Denmark: Hylke (♂)	Subfossil: Germany: Schussenquelle (♀)	Subfossil: Germany: Stellmoor (Kollau)	Subfossil: Siberia: Lena (Tscherski)	Subfossil: Siberia: Jana (Tscherski)	Recent: West Greenland (Degerbøl) ♂♂ (3 spec.)	Recent: West Greenland (CN. 709) ♀	Recent: Rödingsträsk (Woodland, tame) ♂ (Lönnberg)	Recent: Kvikkjokk (Mountain, tame) ♂ (Lönnberg)	Recent: Lower Tunguska (Tscherski)	Recent: Trail Creek Alaska	Recent: Sweden CN. 342
Radius															
1. Total length	282	255	—	—	—	247–288 (13 sp.)	—	—	271–289	255	278	248	—	294	276
2. Length, inner side	274	252	—	—	259	—	263	259	263–280	248	—	—	311	290	268
3. Proximal width ..	51	45	51	49	44	—	51	50	51–55	46	—	—	—	—	50
4. Proximal width of articulating surface	47	42	46	46	—	—	46	46	46–49	—	—	—	—	49	47
5. Width in middle of diaphysis	37	25	35	35	—	—	32	33	32–37	25	—	—	—	32	32
6. Least width of diaphysis	35	25	30	—	—	—	—	—	32–36	—	—	—	—	28.5	31
Antebrachium															
7. Distal width	50	42	47	—	44	—	48	49	48–50	43	—	—	—	49	48
8. Total length	349	—	—	—	327	296–367 (29 sp.)	—	—	345–364	319	—	—	—	—	345

comparison measurements of the subfossil Danish animals are given together with the corresponding measurements of a number of limb bones of reindeer from the late-glacial settlement at Stellmoor (KOLLAU 1943), Schussenquelle (FRAAS 1863), and of recent animals from Scandinavia and West Greenland (Tables 7—16).

From the tables it will be seen that the Danish subfossil reindeer were large animals. The measurements of the skeletal parts of the Villestofte reindeer belong to the largest recorded among the many late-glacial reindeer from Stellmoor, and among recent reindeer from Scandinavia and Greenland as well.

Of special interest are the measurements given by LÖNNBERG (1909, b, p. 179) of a "woodland" reindeer shot out of a herd of domesticated but very shy reindeer at Rödingsträsk, the Lule-river district. The height of the shoulders of this 5 year old male is 120 cm. and at the loins 124 cm. In contrast to what is the case in the mountain reindeer the shoulder height in the woodland reindeer is generally smaller than the height at the loins; also a feature characteristic of animals which live in forest-clad environments (cf. *Capreolus*). The measurements of this woodland reindeer thus correspond very well with the measurements of the wild *R. t. fennicus* (cf. p. 51).

TABLE 10.

Scapula	Subfossil													Recent								
	Denmark					Norway			Germany													
	Villestofte ♂	Køge Bay (30.4.1936)	Køge Bay (21.10.1947)	Køge Bay (4.10.1947)	Køge Bay (1954)	Hardangervidden (Grieg)	Hardangervidden (Grieg)	Hardangervidden (Grieg)	Schussenquelle	Schussenquelle	Schussenquelle	Schussenquelle	Stellmoor (Kollau)	Norway (Grieg)	Norway (Grieg)	Rödingsträsk (Woodland, tame) ♂ (Lönnberg)	Kvikkjokk (Mountain, tame) ♂ (Lönnberg)	Tame ♂, ♀ (Kollau)	Holsteinsborg ♂ CN. 1048	West Greenland ♀ CN. 709	Sweden CN. 342
1. Greatest length ..	271	—	—	—	—	230	209	176	260	252	252	—	—	220	161	265	237	229 217	294	230	271
2. Physiological length	—	—	—	—	—	—	—	—	248	238	—	—	139–269 (468 spec.)	—	—	—	—	—	279	—	252
3. Least width of collum																					
a. Ant.-post......	42	42	39	36	33	38	35	30	38	38	36	39	—	41	36	—	—	—	45	35	40
b. Transversal ...	22	21	20	18	17	—	—	—	19	18	19	18	—	—	—	—	—	—	22	17	19
4. Proximal width :																					
a. Ant.-post	53	55	52	50	44	—	—	—	47	49	47	47	—	—	—	—	—	—	56	47	53
b. Transversal ...	36	36	33	33	30	—	—	—	34	33	32	33	—	—	—	—	—	—	39	36	36
5. Greatest diameter of *cavitas glenoidalis*	43	42	39	36	35	38	32	33	—	38	—	38	—	40	32	—	—	—	43	39	42

HERRE (1955, p. 6) states that the shoulder height in 64 tame adult, castrated reindeer from Lappland ranges between 92 and 115 cm, on an average 104.8 cm.

The *metacarpus* of the Danish subfossil reindeer is represented by 10 specimens of which 5 are complete (Table 7). Whereas the length of the complete metacarpals are fairly uniform, the measurements of the width in the middle of the diaphysis fall into two groups: larger measurements no doubt characterizing males (25.5—27.2 mm) and smaller measurements characterizing females (19.3—22.5 mm). The same holds good in recent reindeer from West Greenland: in 5 males the measurement of width ranges from 25 to 29.4 mm, in 4 females from 18.8—20 mm. In the aforementioned specimen from Rödingsträsk (woodland reindeer, according to LÖNNBERG) the length of the *metacarpus* is just as large, 208 mm, as in the reindeer from Villestofte. Also the two Swedish reindeer, CN. 342 and 158, have large limb bones.

According to TSCHERSKI (1892, p. 200) still larger measurements may be found in Scandinavian reindeer. In a metacarpal bone of a wild reindeer from the Lappmark, presented to the Irkutsker Museum by PLESKE, the length on the outer side is stated to be 212 mm, which means a total length of 218—220 mm. Surprisingly enough this is the same length as TSCHERSKI (*loc. cit.* p. 209) states in a recent *metacarpus* from Sachalin, the *terra typica* of the large *R. t. setoni* of FLEROV.

In a recent reindeer from the Lower Tunguska river TSCHERSKI, in addition,

TABLE 11.

Humerus	Denmark						Germany								
	Villestofte ♂	Køge Bay (1936)	Køge Bay (4.10.1947)	Køge Bay (20.10.1947)	Køge Bay (20.10.1947)	Køge Bay (21.10.1947)	Stellmoor (Kollau)	Schussenquelle	Lappland ♂ CN. 158	Rödingsträsk (Woodland, tame) (Lönnberg)	Kvikkjokk (Mountain, tame) (Lönnberg)	Sweden CN. 342	West Greenland (3 specimens) ♂♂ (Degerbøl 1957)	Ljachow (Tscherski)	Lower Tunguska (Tscherski)
1. Total length	256	261	—	—	—	—	222–268 (51 sp.)	225	253	256	215	260	261–271	267	293
2. Length, median: (caput–trochlea) ...	232	237	—	—	—	—			233	—	—	237	239–250	—	—
3. Proximal width:															
a. Greatest transv.	71	67	—	—	—	—	—	—	66	—	—	62	70–76	—	—
b. Greatest ant.-p.	84	74	—	—	—	—	—	—	70	—	—	67	70–76	—	—
4. Width in middle:															
a. Transversal	32	30	24	26	—	—	—	24	29	—	—	29	27–31	—	—
b. Ant.-post	37	35	27	28	—	—	—	26	33	—	—	34	—	—	—
5. Least width of diaphysis, transvers.	28	27	23	25	—	—	—	21.8	29	—	—	27	26–28	—	—
6. Distal width:															
a. Transversal	53	50	46	49	48	45	—	47	51	—	—	50	52–56	—	—
b. Greatest ant.-p.	55	54	53	53	51	—	—	—	51	—	—	51	—	—	—

states the *metacarpus*-length at outer side to be no less than 230 mm, corresponding to about 237 mm in total length. It may be noted, however, that the last-mentioned animals are woodland reindeer, as also PLESKE's reindeer from Lappland no doubt corresponds to LÖNNBERG's *fennicus* type.

Of smaller size than these limb bones are the skeletal parts of reindeer excavated by TSCHERSKI in the Ljachow Island and on the Jana river, northern Siberia, representing the tundra reindeer. The total length of 10 metacarpals ranges from 184 to 211 mm (184, 187, 193, 197, 198, 199, 201, 201, 209, and 211 mm).

Considerably larger limb bones are found in the caribou in western North America, as indicated by KOLLAU (Tables 7—8). The length of a *metacarpus* in *R.t. osborni* is indicated to be no less than 228 mm, i. e. about the same size as the measurements in the woodland reindeer just cited from TSCHERSKI. Very long, 216 mm, is also a *metacarpus* from an excavation at Trail Creek, Alaska, made by Dr. HELGE LARSEN. This specimen, kept in the Zoological Museum of Copenhagen, is from the upper layer and thus probably fairly recent. The width in the middle of the diaphysis of this specimen, however, can hardly compare with the corresponding measurements in the Villestofte reindeer and in the largest Greenland specimen.

In reindeer from West Greenland the limb bones are particularly powerful, as will be seen from the many measurements of large widths in these bones. Powerful

TABLE 12.

Tibia	Subfossil									Recent						
	Denmark				Germany		France									
	Villestofte ♂	Køge Bay (30.4.1936)	Køge Bay (♀) (30.8.1948)	Køge Bay (11.1.1949)	Schussenquelle	Stellmoor (Kollau)	Vezère	Laugerie (Dordogne)	La Madelaine (Dordogne)	Holsteinsborg ♂ CN. 1048	Holsteinsborg ♂ CN. 886	West Greenland ♀ CN. 709	Rödingsträsk (Woodland, tame) ♂ (Lönnberg)	Kvikkjokk (Mountain, tame) ♂ (Lönnberg)	Tame ♂, ♀ (Kollau)	Sweden CN. 342
1. Total length	331	328	302	—	295	292–327 (22 sp.)	—	—	—	334	346	312	345	298	285, 297	337
2. Prox. width, trans. .	69	68	60	—	58	—	—	—	—	71	68	64	—	—	—	69
3. Width of diaphysis																
a. Width at middle, transversal	33	30	22	26	23	—	—	—	—	33	33	24	—	—	—	30
b. Least width, transversal											30					27
4. Distal width:																
a. Transversal	45	44	40	39	36		34–43* (24 sp.)	37, 41	36, 38, 39, 40 (4 sp.)	44	43	40	—	—	—	45
b. Ant.-post	36	35	33	21	—					36	34	33	—	—	—	34

* 34, 35, 35, 36, 36, 36, 37, 37, 37, 37, 37, 37, 38, 38, 39, 39, 39, 39, 39, 40, 41, 41, 42, 43

TABLE 13.

Femur	Subfossil		Recent	
	Villestofte ♂	Stellmoor (Kollau)	West Greenland (3 specimens) Degerbøl 1957 ♂♂	Sweden CN. 342
1. Total length	298	263–297 (27 spec.)	300–316	305
2. Length, median, from caput.	290		284–307	298
3. Prox. width:				
a. Transversal	82	—	78–83	74
b. Ant.-post., of caput...	32.5	—	30–32.5	31
4. Width in middle........	26	—	26–27	26
5. Distal width	63	—	53–67	64

TABLE 14.

Calcaneus	Subfossil					Recent				
	Denmark					Sweden			W. Greenland	
	Villestofte ♂	Køge Bay 1936	Køge Bay 1941	Nørre Lyngby ad. jun.	Stellmoor (Kollau)	Lappland ♂ CN. 158	Sweden CN. 342	Holsteinsborg ♂ CN. 1048	Holsteinsborg ♂ CN. 886	Umanak ♂ CN. 1611
1. Greatest length	104	102	98	97	89–107	100	103	107	107	102
2. Greatest breadth	31	27	27	26	(134 sp.)	29	27	32	31	29
3. Least breadth of corpus	14	13	13	13	—	14	14	16	16	14
4. Least height of corpus ..	27.3	26	25	23	—	—	24	27	26	26

TABLE 15.

Astragalus	Subfossil					Recent	
	Denmark			Germany			
	Villestofte ♂	Nørre Lyngby	Nørre Lyngby	Vogelherd (Lehmann) (19 specimens)	Stellmoor (Kollau)	Sweden CN. 342	Holsteinsborg ♂ CN. 1048
1. Length, lateral	50	46	44	43–49	45–56	47	47
2. „ , medial	—	45	43	41–45	—	45	45
3. Height, lateral	—	21	26	24–28	—	26	25
4. „ , medial	28	—	26	25–28	—	26	27

limb bones are often met with in animals living on mountains, even in domesticated animals, e.g. in sheep and goats from Norsemen times in Greenland (DEGERBØL 1936) and from Iceland (DEGERBØL 1943).

What is said about the *metacarpus* also holds good of other limb bones, and the many large measurements of these bones furthermore stress the general aspect of the subfossil Danish reindeer as powerful barren-ground animals. In contrast, however, to the large limb bones in the subfossil reindeer the toe joints are relatively short (Table 16). KORMOS (1916) proved that 40 phalanges, I and II, of subfossil reindeer from Hungary were shorter, but broader than was the case with the corresponding bones in a recent Norwegian reindeer. From this he drew the conclusion that the subfossil reindeer were smaller, but of stronger build than the modern Scan-

TABLE 16.

Toe joints	Subfossil								Recent						
	Denmark					Germany		Hung.							
	Villestofte ♂	Køge Bay (1941)	Køge Bay (1943)	Køge Bay (20.10.1947)	Køge Bay (18.10.1949)	Stellmoor (Kollau)	Vogelherd (Lehmann)	Pilisszántó (Kormos) (40 specimens)	Holsteinsborg ♂ CN. 1028	Holsteinsborg ♂ CN. 1048	Holsteinsborg ♂ CN. 886	Umanak ♂ CN. 1611	Norway dom. (Kormos)	Dom. (Lehmann) 2 specimens	Sweden CN. 342
Phalanx 1															
1. Greatest length:															
a. Fore limb....	52	52	48	46	54	47–63 (676 sp.)	48–53 (17 sp.)	45–55 (49.7)*	56	59	59	53	54.8	54.2–55.1	53
b. Hind limb ...	54								59	55	56	50	56.4	56.0–56.5	59
2. Proximal width:															
a. Fore limb....	25	22	19.5	20	21	—	—	19–25 (21.1)	24	24	23	—	22.1	—	23
b. Hind limb ...	23								23		26	—	21.0	—	22
3. Distal width:															
a. Fore limb....	20	21	16.5	16.5	18	—	—	16–20 (17.5)	29	19	19	—	18.9	—	20
b. Hind limb ...	20								19	20	20	—	19.1	—	20
Phalanx 2															
1. Greatest length:															
a. Fore limb....	37	—	—	—	—	35–46 (401 sp.)	31–38 (9 sp.)	33–40 (36.2)	43	43	43		41.0	—	42
b. Hind limb ...	40									41	42		42.6	—	46
2. Proximal width:															
a. Fore limb....	20	—	—	—	—	—	—	17–21 (18.0)	19.5	19	20		19.7	—	20
b. Hind limb ...	20									20	21		19.5	—	20
3. Distal width:															
a. Fore limb....	19	—	—	—	—	—	—	14–19 (16.4)	17	17	17		17.3	—	18.5
b. Hind limb ...	17									18	19		16.1	—	17

* Average.

dinavian reindeer. This, however, is a mistake. It is a general rule that the toe joints, which carry the whole body weight, are shorter and broader in tall and heavy animals than in corresponding smaller and more slightly built specimens. This also clearly appears in the Villestofte reindeer and this feature also stresses the fact that this specimen was heavily built.

The Occurrence in Time in Denmark and Ecological Conditions.

It is a remarkable fact, as already mentioned, that all Danish discoveries of reindeer belong to the late-glacial period. The reindeer in Denmark thus undoubtedly had disappeared at the beginning of the forest period. Neither from the great settlements from Boreal time (Maglemose near Mullerup, Sværdborg, Holmegaard, Lundby, and Aamosen on the Halleby river) nor from the many kitchen middens from Atlantic and Subboreal periods a single bone of reindeer is known. This occurrence in time together with ecological and anatomical evidence clearly shows that the prehistoric Danish reindeer must have been typical animals from the open country. Even in the Allerød period the reindeer seem to have been decreasing in number. In the Allerød settlement of Bromme, Zealand, bones of elk (*Alces*) were, as already mentioned, predominating, whereas only a few fragments of reindeer were found. This is in agreement with the pollen investigations made by H. Krog (cf. p. 138) according to which most discoveries of reindeer from the Allerød period either belong to the beginning or to the end of the period. Fairly early in the Allerød period southern Denmark was occupied by large-leaved birches, and in parts of the period the climate was temperate (Iversen 1954, p. 95).

The many shed antlers furthermore prove that reindeer stayed in Denmark even in the winter months. There is a considerable variation in the dates of shedding the antlers according to sex, age, and physiological conditions of the individual animal. It is generally stated, however, that the mature reindeer stags usually shed their antlers in November—December, the females and young deer some months later, in April, May, and June (Jacobi, p. 237; Murie, p. 26; R. Möller, p. 379; Banfield, 10 B, p. 6; Collett p. 525).

This agrees well with the fact that the late-glacial winters in Denmark were not at all rich in snow, as perhaps might be expected. The pollen analysts have in the late-glacial flora of Denmark demonstrated a number of chianophobous plants which do not tolerate more than a thin and transient snow cover, and they are of the opinion that though the winter cannot have been dry, the precipitation during the winter months may have been only moderately high (Iversen, *loc. cit.* p. 103).

Shed antlers also are frequent in the remains of reindeer in Sweden, East Prussia, and the British Isles. It is true that the rarity of shed antlers in the settlements at Meiendorf and Stellmoor has been advanced as indicating that the reindeer in the said localities lived elsewhere during the winter months, but it only demonstrates that the reindeer hunters did not stay at these places in winter time, as also appears from other facts (Krause 1937). Naturally enough the prehistoric people of Meiendorf and Stellmoor preferred to make implements of the antlers of the many reindeer killed for the meat. It must be borne in mind that reindeer antler, as animal matter in general, can be worked with advantage particularly when fresh. Furthermore it should be emphasized that it is generally maintained that shed antlers are chewed or partly eaten by the reindeer themselves, by rodents and carnivores during the winter months. In spring most antlers found on the ground have their tines and beams severely gnawed, which in this case means unfit for the making of implements. I must add, however, that i. a. in Greenland shed antlers of reindeer, even lying on the ground for years, generally are not chewed (Degerbøl 1957). As these worked antlers from Meiendorf and Stellmoor are full-grown, with hard surface and compact, it means that the said animals were killed after the velvet of the antlers had been shed which may take place in (mid-)September (Rust 1937 p. 116; Jacobi p. 237; Murie p. 26, and Banfield p. 5 (10 B)). By October the antlers are polished clean and smooth.—Hence, the Villestofte-, Strangegaard-, and Skinderbygaard-reindeer have succumbed about the month of October, the reindeer from Almindingen (No. 147), with shed antlers, had perished a month or two later, in December—January.

Considering the large seasonal movements of many reindeer in recent times it is probable that the prehistoric reindeer migrated, too. But why and where to? A common explanation of the migration of the reindeer is that the animals move south in winter for the shelter in the forest, returning northwards in spring to spend the summer on the open plains or tundra. However, this "need-for-shelter theory" (Murie) cannot apply to the reindeer in general, e.g. reindeer in Greenland, on the Canadian arctic islands, and many other localities (Jacobi, *loc. cit.* p. 186) remain there summer and winter, and even the Alaska-Yukon caribou do not move to the forest. Murie (1935, p. 45) writes about these last-mentioned animals: "The great herds of the region perform extended and striking migrations each year, yet it can hardly be said that they travel all these hundreds of miles for shelter, since the summer and winter ranges are substantially alike." The animals were repeatedly found on exposed ridges above the timber line during severe winter weather; Murie is convinced that the prime cause of migration is the search for suitable food.

"The shifting herds have left some areas vacant for years, they returned to them for another period, leaving other sections, in turn, unoccupied. It would be detrimental to the welfare of the herds were the entire available range utilized continuously" (p. 56).

The comprehensive and complicated migrations of the barren-ground caribou, *R. t. arcticus*, in the territories between Hudson Bay and the Mackenzie river have in recent years particularly been investigated by A.W.F. Banfield (1954 A). The animals are there moving between the forest belt in winter, and the tundra in summer, but small herds remain on the tundra all winter. In April and May with lengthening daylight and fine weather the caribou move towards the tundra, which they inhabit from June to September.

Banfield gives a description of the physical environment, and particularly of the extremes of the climate since "these extremes and not the average conditions determine the distribution of organisms." The climate is characterized by long, rigorous winters with extremely low temperatures. The average annual extreme low temperature over the caribou winter range is found to vary from $-60°$ F to $-45°$ F ($-51°$ to $-43°$ C) and there is a tendency for the caribou to desert during the winter the central tundra around which the $-60°$ F isotherm is drawn (*loc. cit.* p. 8). If we through this area, however, draw the January isotherms we shall find that the isotherm of $-30°$ C passes the area about Fort Churchill a little south of 60° N.l. To the southeast the winter range of the barren-ground caribou is situated between the said isotherm and about the $-25°$ C January isotherm, but to the northwest the animals are distributed north of Great Bear Lake and the Arctic Circle, just to the Polar Sea, i.e. north of the $-30°$ C isotherm.

During the winter months the snowfall is heavier on the central tundra, 60 inches (1524 mm) or more, than on the coast or in the forested belt. At this period most of the reindeer are to be found in the forested regions, where the average snowfall is 45 to 55 inches (1143 to 1397 mm). BANFIELD also gives the isotherms for the average annual extreme high temperature and demonstrates that most of the reindeer are north of the isotherm of 80° F (27° C), in early summer when this temperature may be reached.

From BANFIELD's map of the summer distribution of the *R. t. arcticus* we may find that in the southeast the southern limit of the summer range borders on the July isotherm of 15° C, and that the majority of the animals is north of the isotherms of 12—13° C. Roughly speaking the July isotherm of 10° C runs through the area from about Eskimo Point across Baker Lake, at the bottom of Chesterfield Inlet, to the northern part of Great Bear Lake, where it crosses the southern limit of the summer range in the northwest. Thus a large number of the reindeer in their summer distribution are north of the July isotherm of 10° C.—BANFIELD adds that in general the soils are poor. Humus in connection with coniferous forests is generally shallow and acid in reaction.

In the late-glacial period the conditions of life for the reindeer in Denmark were quite different. The geographical position of Denmark is farther south, about 55°—57° N. latitude, and the importance of this has already been mentioned (p. 80). In addition Dr. J. IVERSEN (1954), on the basis of the flora composition in late-glacial time, has stated that even when it was coldest, at the end of the pleni-glacial, and in Zone I c (when the Villestofte reindeer existed) the January temperature was not below $-8°$ C. In Zone III, the Late Dryas period, the January temperature on Bornholm was probably somewhere between $-2°$ and $-6°$ C, while the July temperature may have been about 11° C (*loc. cit.* p. 102). "According to this rough estimate the temperature climate would be slightly oceanic."

As already mentioned, the snow cover was moderate, the light conditions exceptionally good, as shown by the many heliophytes, and the virgin soil was nutritious.

Altogether, the large amount of shed antlers, and that of young animals and females, too, in Denmark indicates that at least many reindeer lived in this area even in winter. It is not necessary to suppose that there was a special north-south migration—at the beginning of the Early Dryas period the border of the forest was so far south as Northern Spain (FRENZEL and TROLL 1952)—there might have been an east-west migration as well. The reindeer of the eastern and northern parts of Europe, where the snow cover was high, might in winter have made for the west, where the snow cover was thinner.

The reindeer herds may more or less have followed the border of the Baltic Ice-lake (cf. MUNTHE, Maps 2 and 3). The numerous remains of reindeer in East Prussia and particularly on Bornholm and in Køge Bay may be naturally explained when this view is accepted. Bornholm no doubt at a fairly early date was an isolated island. At least the prehistoric vertebrate fauna of Bornholm is characterized by the great amount of remains of such early immigrants o our country as *Rangifer tarandus* and *Alces alces*, whereas no bones of the urus, *Bos primigenius*, have been found, in spite of the fact that this species already is known from Denmark at the end of the Younger Dryas period (cf. p. 102).

It should also be emphasized that according to Sv. EKMAN (1948, p. 148) the Scandinavian wild mountain reindeer ("fjällren") in winter time did not move to the forest either. The tame reindeer of the Lapps only live in the mountains during summer time, but in winter they are *brought* down to the coniferous forests. For this reason it is a common opinion that the wild reindeer lived in the same manner. This is not, however, the case. The mountain reindeer lived in the mountains all the year round. Only occasionally they moved down to the birch forest in the higher valleys, but never to the pine forest, where the snow may lie deeper.—It is an interesting fact that the woodland reindeer, too, during summer as well as winter stayed in their special biotope, the forest, never ascending the mountains. These two forms of reindeer thus lived apart in different biotopes and normally they did not intermix. "Even regarding size and some other characters the woodland and the mountain reindeer differ, and they may be regarded as two different races," EKMAN adds (*loc. cit.* p. 113).

We must admit that if we acknowledge the existence of a wild woodland reindeer in Sweden in former times, as suggested by LÖNNBERG, we shall get an explanation of the old puzzle of the occurrence in Sweden of tame reindeer with quite different habits and greater size than the mountain reindeer, which otherwise inhabited this country.—LÖNNBERG assumed that the "domesticated Reindeer of the woodland have descended from the formerly existing wild Woodland Reindeer, or more probable still have originated as products from crossing the tame Reindeer (the typical *R. tarandus*) with wild stags of the Woodland race. The offspring has then inherited its liking for the forest from its Woodland-ancestors. Not only the habits but also the greater size of the tame "woodland" Reindeer ("skogsrenar") is thus easily accounted for" (1909 A, p. 14).

From a taxonomic point of view, however, as particularly discussed here, it is on account of insufficient material difficult to find distinct distinguishing characters, perhaps besides size, between the two forms (cf. p. 91). It is true that FLEROV takes *R. t. fennicus* as a synonym of *R. t. tarandus*, but FLEROV also has set up a new subspecies of the woodland reindeer from Siberia, *R. t. valentinae*, the range of which is the forest zone of Siberia. There is every probability then that previously the Siberian woodland reindeer had extended its area of distribution farther to the west than to-day, i.e. through Finland into Sweden.

From an ecological point of view, however, the mountain reindeer and the woodland reindeer are two distinct types. This may explain the disappearance of the Danish open-land reindeer at the beginning of the forest period. The late-glacial fauna in Denmark was a fairly rich one (Degerbøl 1957). From the Late Dryas period besides *Rangifer tarandus* such mammals as elk (*Alces alces*), bison (*Bison bonasus arbustotundrarum*), wild-horse (*Equus caballus ferus*), varying hare (*Lepus variabilis*), and ground squirrel (*Citellus rufescens*) have been identified. From the preceding period, the Allerød period, the giant deer (*Megaloceros giganteus*), wolverine (*Gulo gulo spelæus*), bear (*Ursus arctos*), and beaver (*Castor fiber*) are known, some of which no doubt still lived in the Late Dryas period. From late-glacial times furthermore the wolf, *Canis lupus*, has been identified. Just as the late-glacial flora in Denmark on several points showed similarity to the Central-European alpine vegetation (cf. p. 80), the wolverine and other late-glacial mammals are closely related to the late-glacial mammals from Central Europe. In other words, in the open late-glacial Danish landscape, which was of a certain steppe-like character, we find what is evidently part of the rich steppe fauna which from Central Europe made its way northwards, possibly driven on by advancing forest. It seems that the prehistoric Danish reindeer were still more adapted to the late-glacial barren ground, than the wild horse and the bison, which were still represented in the preboreal time. Like the giant deer, the reindeer were unable to acclimatize themselves to the ecological conditions in a forest-clad landscape; in order to survive they had to advance farther north to Scandinavia.

It is generally maintained that the migration or seasonal movements, and thus the area of distribution, of reindeer are particularly caused by three factors, weather, food, and plague of insects (especially blood-sucking mosquitoes (*Aëdes*) and black flies (*Simulium*)).

Regarding food the conditions of life for reindeer in late-glacial times in Denmark, and particularly in the peculiar park tundra of Younger Dryas or Zone III, have already been mentioned.

As it has now been proved that the Danish late-glacial reindeer were barren-ground or tundra reindeer, we shall briefly discuss the distribution in relation to the temperature climate. Only very low winter temperatures seem to be of importance in the distribution of the reindeer. The winter temperatures and snow cover appear to have been favourable for the existence of reindeer in Denmark during the late-glacial periods. The summer temperature, however, has an important effect on the activity and distribution of these animals, which particularly are adapted to a cold climate.

Unfortunately detailed information regarding the distribution of reindeer in relation to summer temperatures is rarely given, but as already mentioned, most of the American barren-ground reindeer, *R. t. arcticus,* are in the summer time distributed north of the July isotherm of 12°—13°C, and only in the southeast the southern limit of the summer range is situated at the 15° July isotherm. In East Asia the border line between the distribution areas of the tundra reindeer and the woodland reindeer seems to follow the 10°C July isotherm (cf. map fig. 9 in Herre 1955) i.e. the southern limit of the Arctic region, as formed by the polar tree line.

In the late-glacial times in Denmark a July temperature of about 13°C no doubt already existed in the Allerød period. From his studies on the freshwater mollusc-fauna from Allerød deposits A.C. Johansen already in 1904 came to the conclusion that the July temperature in this period was about 14°C. And on account of recent flora investigations Iversen (1954, p. 97) concludes that the July temperature in the late Allerød was about 13°C or 14°C. In this fairly high summer temperature we may perhaps look for an explanation of the relatively few finds of subfossil reindeer in the Allerød period proper. In the summer time the reindeer may have moved to more northerly regions; on the other hand, however, we must suppose that they returned during the winter months.

In the transition period between the Younger Dryas and the Preboreal (Zone III and IV) the temperature rose very quickly. According to Iversen this fact is i.a. demonstrated in a very quick immigration of thermophilous aquatic plants at the end of the Younger Dryas period, and the transition zone itself is usually characterized by a very pronounced maximum in the juniper curve. "At the end of the Younger Dryas period the temperature seems to have risen so quickly that the forest development could not keep step with the climate improvement. We, therefore, have a transitional zone where the forest is still very open, though the climate was already favourable," Iversen summarizes, *loc. cit.* p. 98.

This might indicate that the quickly rising temperature still more than the changing of the vegetation caused the early disappearance of the reindeer in Denmark. Very quickly acting climate-indicators, however, are also found in other mobile mammals from this period. Already at the end of the Younger Dryas period the urus, *Bos primigenius,* had immigrated to Denmark (cf. Krog, p. 147) and astonishingly enough, even the wild pig, *Sus scrofa ferus,* was represented at Stellmoor, also from the Younger Dryas period; however, in this case it must be borne in mind that this locality is situated further south, at the base of the Cimbrian Peninsula. The favourable climate at Stellmoor furthermore is stressed by the presence of bones of the beaver, *Castor fiber,* at this site. The beaver is a forest-living animal or at least an animal for which it is necessary that trees are found at its biotope, as is also proved by pollen analysis (Schütrumpf 1943).

From Stellmoor several other mammal species have been demonstrated, not yet found in Denmark: *Lynx lynx, Vulpes* sp., and *Lemmus* sp. No doubt, even if the aforementioned Danish late-glacial mammalian fauna is a rich one, we must expect that still further mammal species may sooner or later be unearthed.

In England the reindeer probably also disappeared fairly early. At least, no remains of reindeer were found in the preboreal site at Star Carr, and neither in Ireland is there any evidence of the survival of reindeer into the postglacial period (MITCHELL 1941).

This dating of the Danish finds seems to be in contradiction to investigations published about the reindeer finds from southern Sweden, which in late-glacial times was a peninsula of the European-Danish continent. ISBERG (1930, 1942) has pollen-analysed 34 antlers of reindeer from Scania, especially antlers which for many years have been kept in museums. 15 of these antlers were dated at late-glacial times, 14 at the Boreal period, 4 at the transitional period between Boreal and Atlantic time, and one at the Atlantic period proper. It should be remembered, however, that these investigations were made about thirty years ago, thus before the more modern analysis which takes care of secondary pollen, pollen of herbs, etc. Later a discovery of reindeer from Sweden from "Nebbe Mosse" west of Simrisham in Scania has been scientifically excavated and examined (ALTHIN *et. al.* 1949). Mr. BRORSON-CHRISTENSEN, the pollen analyst, arrived at the result that the reindeer remains from Nebbe Mosse, part of a brain-case with a broken antler, had to be dated at the Late Dryas period. This writer also expresses his doubt regarding the correctness of the datings made by ISBERG. According to BRORSON-CHRISTENSEN many of the pollen analyses published by ISBERG may just as well be interpreted as belonging to the late-glacial period (cf. KROG, p. 140).

On the basis of archaeological investigations ALTHIN, too, is of the opinion that two Lyngby axes dated by ISBERG at the Boreal period actually must belong to the late-glacial period.

The great majority of the Swedish discoveries, about 150, are from Scania, and especially from the southern and southwestern part, too; this need not mean that the reindeer were commoner in Scania than farther north, but may be due to the fact that north af Scania the bogs were so acid that animal bones were badly preserved.

For many years only a few discoveries were known north of Scania. In recent years, however, several new records have been published. NYBELIN (1943) gives a map showing the distribution of ten finds north of Scania. Apart from a single find from Öland they are situated on the west coast south of Gothenburg and on the southern border of the late-glacial Närke Sound. Recent investigations have furthermore made it probable that these reindeer lived on the open tundra in the late-glacial period. At that time the border of the ice sheet passed away from west to east through Närke Sound. According to several writers, i. a. JACOBI (cf. p. 52), this barrier stopped further emigration of the animals to the north. Along the west coast, however, there may have been a possibility for the reindeer in winter time, when the sounds between the islands were frozen, to immigrate to Norway. From the ice-free coastal boundary of this country the animals may later, as the inland ice melted away, have advanced to the mountains in Scandinavia.

Still the possibility is left that reindeer might have survived in suitable open localities in Central Sweden, south of Närke Sound, until the ice-sheet had receded further north and the country had risen so much that Närke Sound had disappeared.

The reindeer immigrating from the south into Norway may have found the country occupied by animals which already had come in from the northeast. When the border of the ice-sheet went through Närke Sound the northern coastal part of Scandinavia was free of ice. During the last glacial period, the Würm glaciation, the ice-sheet hardly reached beyond the Kola peninsula and the White Sea. West Siberia probably was almost unglaciated (Frenzel and Toll 1952). Of these eastern reindeer, however, we have no information unless we adopt the aforementioned suggestion as also advanced by Gross (1939) that many of these animals in the winter months had emigrated west or southwest to East Prussia and Denmark.

A find of reindeer bones at Blomvåg, N.W. of Bergen (O. Holtedahl 1953. Bd. II, p. 597) might indicate that the reindeer had lived in Norway during the last interglacial period (Riss-Würm interglacial), but even if this was the case, it is very unlikely that so large an animal had been able to survive the Würm glaciation on a refugium in West Norway.

From these investigations it will be seen that the Danish late-glacial reindeer have some characters of their own; they are not quite identical with recent Scandinavian reindeer, but the differences are not greater than may be explained by an evolution through the about 12,000 years which have passed since then. In the shape of the antlers the majority of the subfossil reindeer from Denmark and southern Sweden was of the "arcticus" type, but according to Friis this type may also be found in recent Scandinavian reindeer. The variation of the shape of the antlers in the subfossil reindeer was so great that it might have served as a basis of natural selection. In other morphological skull characters, length and shape of the nasal bones and facial part, the three Danish subfossil reindeer seem to agree more closely with the Scandinavian reindeer than with the barren-ground reindeer of North America. But the material is too small to say anything definitely about this question, we must look forward to future discoveries.

Summary

In Denmark well over 200 finds of prehistoric reindeer are known; particularly comprising shed antlers or parts of frontlets with antlers, but also skeleton parts, brain-cases, and fragmentary skulls are represented (p. 7—49). Of special interest is a complete skeleton from Villestofte, Funen, from the Early Dryas period, Zone I c (figs. 20, p. 50), the only extant subfossil skeleton.

It is a remarkable fact that—with the exception of a few glacial finds—all these discoveries belong to the late-glacial period, as demonstrated by pollen-analysis (cf. Krog, p. 124) and stratigraphy: excavated in marl below the peat proper; no

skeleton parts have got the dark brown colour characteristic of finds from the peat.

This occurrence in time together with ecological and anatomical evidence clearly shows that the prehistoric Danish reindeer were typical animals from the open country, characterized by long beams, which generally are of the cylindricorne type. There is, however, a considerable variation in the shape of the antlers. The beams may be fairly flattened, the brow tine, and sometimes also the bez tine, may be highly palmated (fig. 34), as also now and then seen in recent mountain reindeer. Such antlers may easily be confounded with antlers of the woodland type, but on the basis of a fairly ample material, an exact determination is possible. From Plates I—IV it appears that the "arcticus" type of antlers is dominant in the late-glacial Danish reindeer, just as in the reindeer from Meiendorf and other late-glacial sites in Holstein. The divergence from the recent Scandinavian reindeer, however, is not greater than may be explained by an evolution through the 12,000 years, which have passed since the Late Dryas period.

Even if the Danish reindeer *skulls* belong to very powerful animals—the condylobasal length in 4 specimens ranges from about 370 mm to 385 mm—they do not reach the maximum length (420 mm) of *R. t. sibiricus*, let alone the skull length of the large woodland reindeer.

In several skull characters, i.a. the shape of the nasal bones, short nasals, small rostral length, and great orbital breadth, the Villestofte reindeer might indicate affinity to the European reindeer, *R. t. tarandus*. For a decision on this point, however, we must look forward to future discoveries.

It seems that the subfossil reindeer generally have fairly heavy mandibles.

Just as is the case in a number of species of prehistoric mammals, the subfossil European reindeer have larger teeth than recent reindeer (fig. 28).

From Tables 7—16 it appears that the subfossil Danish reindeer were large animals. The measurements of the *limb bones* belong to the largest recorded among the many late-glacial reindeer from Stellmoor and in recent Greenland and Scandinavian reindeer as well, even comprising the large "woodland" reindeer of Lönnberg (*R. t. fennicus*). This is in accordance with the modern view of the good conditions of life for reindeer and several other ungulates (*Equus, Bison, Megaloceros, Alces*) in the late-glacial open country in Denmark.

The many shed antlers prove that the reindeer stayed in Denmark even during the winter months. This agrees with the fact that the snow cover was moderate, and even in the Early Dryas period, Zone I c, the January temperature was not below $-8°$C.

Most of the mammal species from the late-glacial times in Denmark were adapted to an open biotope and disappeared earlier or later as the forest advanced into Denmark. The summer temperature has an important effect on the distribution of the tundra reindeer, which particularly are adapted to a cold climate. The limit of the summer range of the recent tundra reindeer borders on the polar timber line or the July isotherm of 10° C., or runs a few degrees further south. At the end of the Younger Dryas period, the temperature seems to have risen so quickly that the immigration of the forest could not keep pace with the climatic improvements. Denmark thus was still an open country, but the summer temperature was fairly high, passing 13—14° C. This might indicate that the quickly rising temperature still more than the changing vegetation caused the early disappearance from Denmark of the reindeer.

Fig. 20. phot. by Mr. U. Møhl, all other photos taken by Mr. H. V. Christensen; the photographer at the Zoological Museum, Copenhagen.

PLATES

Plate I.

Left antlers. Median view.

Row 1: 1 Nellemose mark, Langesø (No. 110). 2 Isterød (No. 25). 3 Orenæs (No. 33). 4 Skovsborggaard, Højslev (No. 139). 5 Mullerup brick-works (No. 31).

Row 2: 1 Baarse (No. 61). 2Vollerslev (No. 56b). 3 Sattrup, Gjedved (No. 23). 4 Lolland (No. 99). 5 Gørlev (No. 28). 6 Egebjerg brickworks (No. 14).

Row 3: 1 Herlev (No. 8). 2 Rykkerup (No. 34). 3 Vredsløse (No. 69). 4 Bølling lake (No. 133). 5 Jordrup (No. 123).

Row 4: 1 Hove river (No. 80). 2 Gaabense (No. 100). 3 Odense (No. 35). 4 Felskov rev (No. 66). 5 Bremerlandsgaarden, Helsinge (No. 26). 6 Jordløse (No. 74).

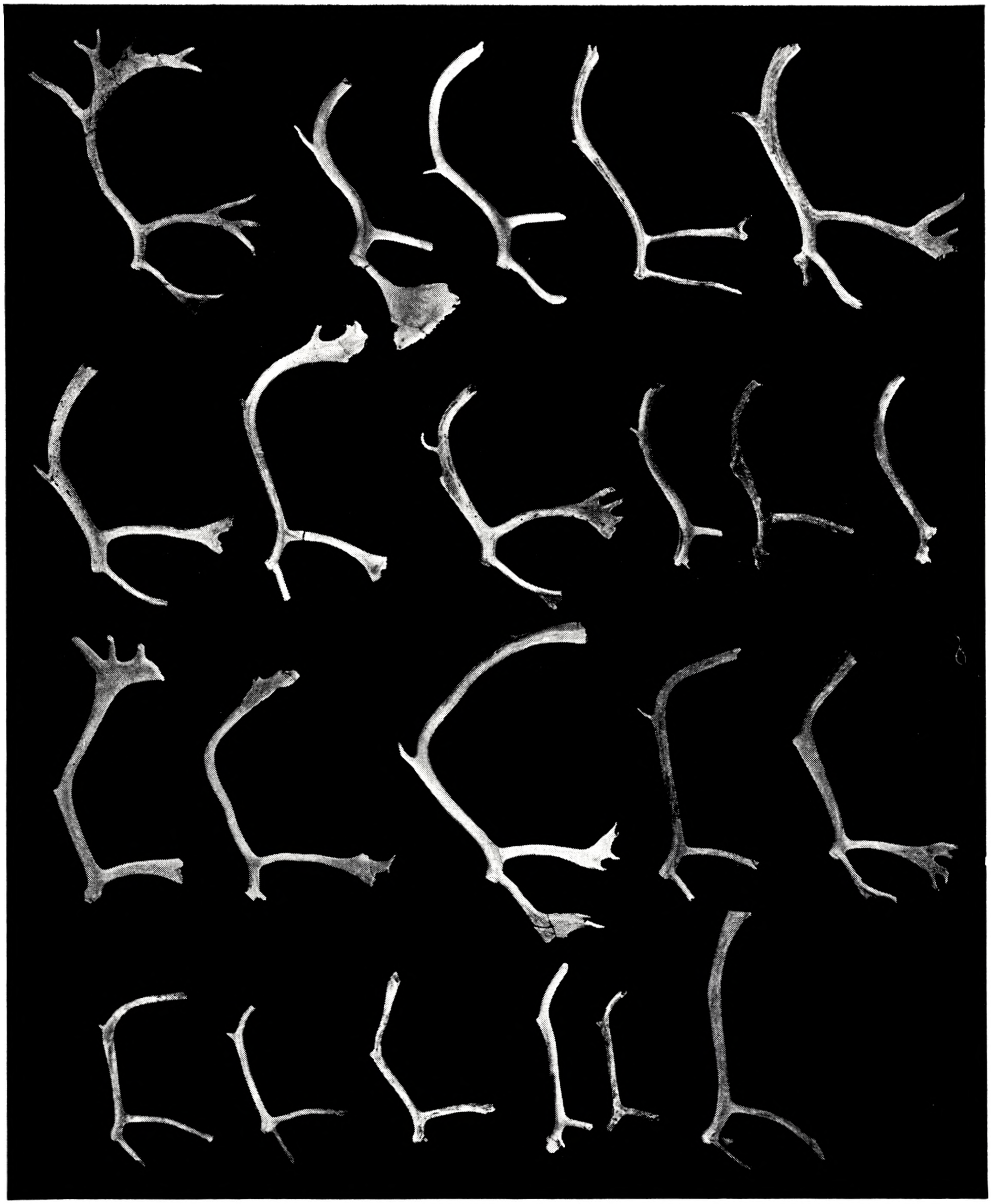


Plate II.

Right antlers. Median view.

Row 1: 1 Karrebækstorp (No. 57). 2 Østerbygaard, Vamdrup (No. 121). 3 Allerød (No. 17). 4 Bedstrup, Lynge (No. 86). 5 Risbanke, Gørslev (No. 71, b). 6 Vollerslev (No. 56, a).

Row 2: 1 Trige, Aarhus (No. 132). 2 Horsens (No. 128). 3 Vintappergaarden, Lyngby (No. 84, b). 4 Grejsdalen (No. 126, a). 5 Ringsted river (No. 64). 6 Silkeborg (No. 130). 7 Kirke Saaby (No. 30).

Row 3: 1 Kalø vig (No. 131). 2 Damhus river (No. 82). 3 Grønderup (No. 101). 4 Mulstrup (No. 19). 5 Askeby, Møn (No. 12). 6 Linnet, Vejle (No. 125). 7 Risbanke, Gørslev (No. 71, a).

Row 4: 1 Holbæk (No. 27). 2 Kjellerup (No. 22). 3 Lille Vejle river (No. 81). 4 Slædbæk (No. 103). 5 Hodde (No. 5).

Plate III.

(Bornholm)

Left antlers. Median view.

Row 1: 1 Klemensker (No. 167 (No. 1)). 2 Klemensker, Thor Westh's mose (No. 144, d). 3 Bornholm (No. 203 (187)). 4 Klemensker, Aarsballemosen (No. 169 (178)).

Row 2: 1 Klemensker, Præstegaardsmosen (No. 145). 2 Bornholm (No. 195 (2)). 3 Klemensker (No. 178 177). 4 Bornholm (No. 210 (179)). 5 Vallensgaards mose (No. 142).

Row 3: 1 Bornholm (No. 183 (184)). 2 Klemensker, Vognsø (No. 154 (50)). 3 Bornholm (No. 180 (14)). 4 Risegaard, Olsker (No. 143). 5 Bornholm (No. 189 (10)). 6 Olsker (No. 173 (152)). 7 Klemensker, Aarsballemosen (No. 159 (7)).

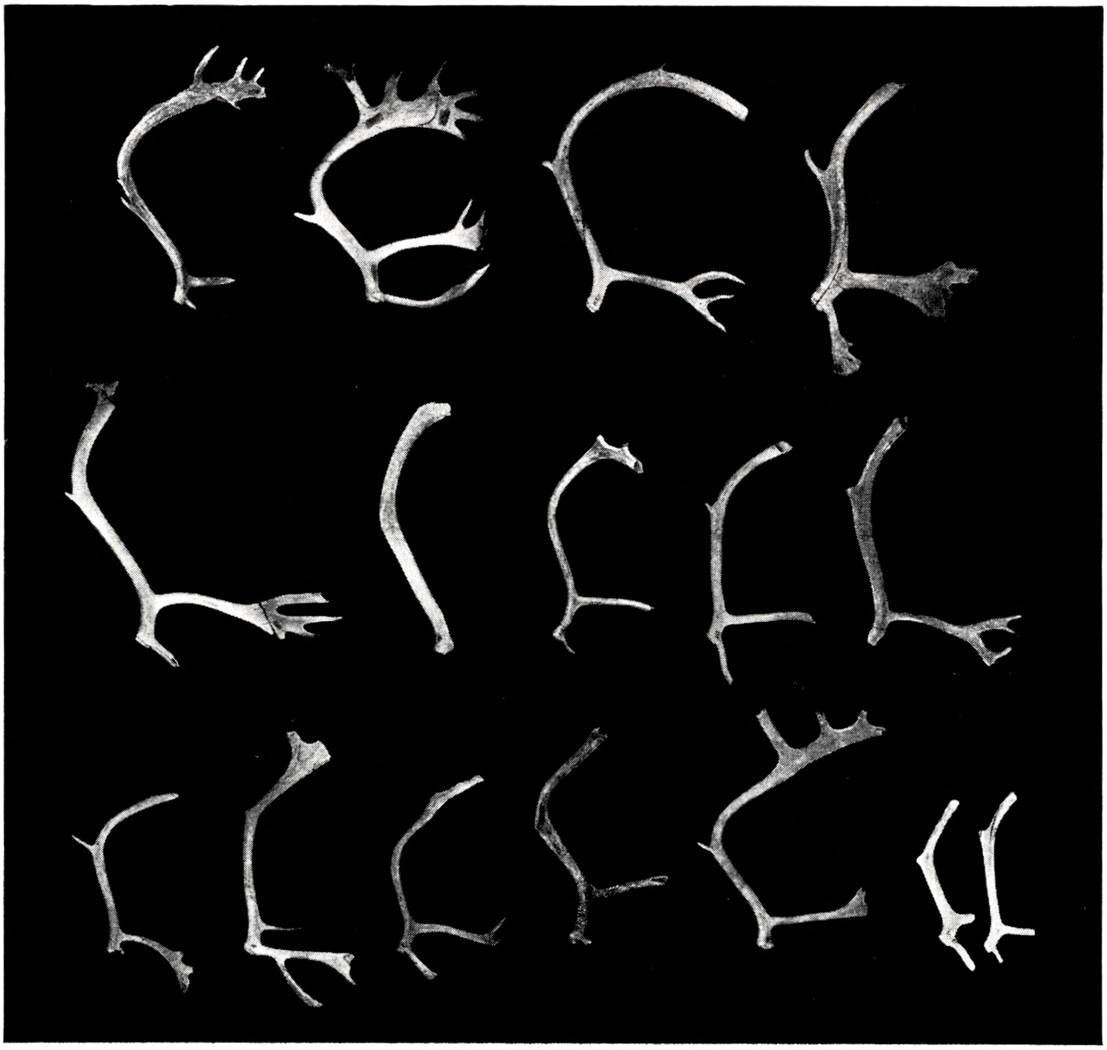


Plate IV.

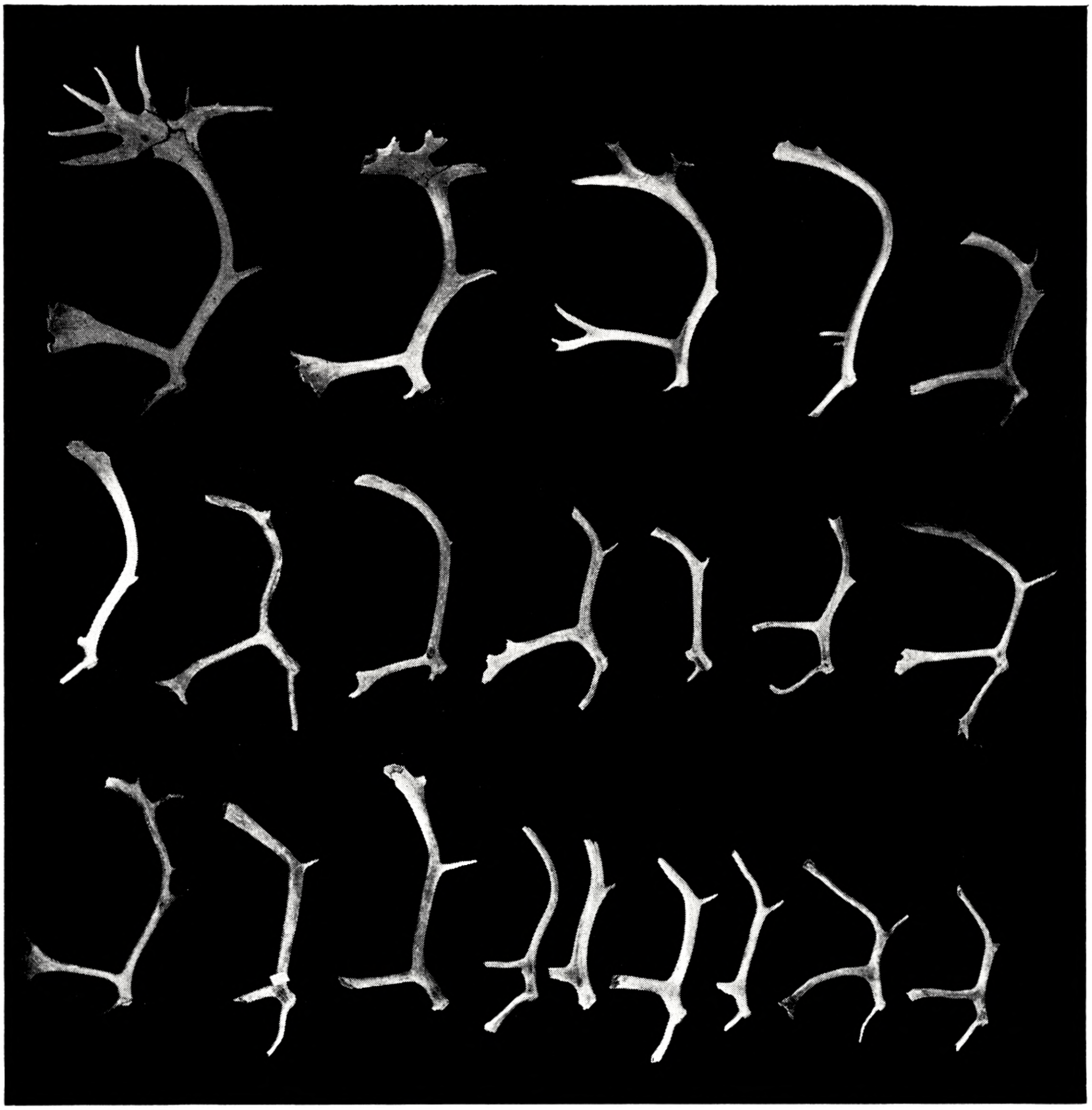
(Bornholm)

Right antlers. Median view.

Row 1: 1 Klemensker, Præstegaardsmosen (No. 151 (100)). 2 Klemensker, Aarsballemosen (No. 168 (146)). 3 Klemensker, Thor Westh's mose (No. 144). 4 Søhjem, Østermarie (No. 141). 5 Bornholm (No. 179 (181)).

Row 2: 1 Bornholm (No. 177 (12)). 2 Rutsker (No. 171 (167)). 3 Klemensker (No. 157 (95)). 4 Klemensker, Knudegaardsmose (No. 165 (93)). 5 Rø (No. 175 (166)). 6 Klemensker, Knudegaardsmose (No. 166 (92)). 7 Rutsker, Pellegaard (No. 170 (16)).

Row 3: 1 Klemensker, Nørregaard (No. 152 (171)). 2 Klemensker, Thor Westh's mose (No. 144, a). 3 Bornholm (No. 190 (183)). 4 Bornholm (No. 182 (188). 5 Klemensker, Aarsballe (No. 163 (163)). 6 Bornholm (No. 185 (190)). 7 Bornholm (No. 186 (15)). 8 Olsker, Vedbygaard (No. 172 (3)). 9 Bornholm (No. 187 (17)).



II. GEOLOGICAL PART

By Harald Krog

The Material

As already mentioned in M. Degerbøl's introduction, a great many finds of reindeer have been made over the years, hence ample material is now available. The finds have been made during various kinds of excavations, especially in connection with draining, but only rarely during peat-digging. Some were found deep below post-glacial layers of peat, others at a very shallow depth under the surface; one common feature, however, applies to most of them in that they were found in former freshwater basins, most frequently in layers whose content of clay or sand immediately reveals a late-glacial age.

Information concerning the finds, and hence the prospects of dating, vary widely. Our knowledge ranges from none at all concerning some old finds up to satisfactory geological investigations of the localities.

It has in each case been my task to date the finds as exactly as circumstances would permit, primarily by way of pollen analysis.

This I have endeavoured to achieve by procuring the largest possible range of samples for pollen analysis. In a great many instances, however, it has proved impossible to obtain any pollen samples, although in such cases it has occasionally been possible to make a closer estimation of the age by examining the available information concerning the find. There is thus a large number of finds that defy all attempts at any approximate dating. However, the majority of the latter group may be considered late-glacial, either because of information relevant to the finds, or because the latter have carried minute remains from the stratum in which they had originally been found—but too minute for any pollen sample. Some of these finds are old and have been published before together with data referring to the circumstances of the find, and it has thus been possible to place them in M. Degerbøl's list. Each of the finds that I have tried to date will be mentioned briefly in the section on dating.

Methodology

Finds which it has been possible to date on the basis of an investigation at the actual locality need no detailed mention here, whereas some explanation is required as regards the procedure in those cases in which it has been possible to obtain only one or very few pollen samples, most often from an antler. These samples varied much in size, in some cases there was insufficient material for a single pollen preparation. One cannot always be sure that the material in question represents the stratum of the find, in some cases it was evident from the outset that the material was contaminated, in others it proved to be so during the microscopic examination. It may be a matter of an admixture occurring during the excavation, or, especially in the case of old finds stored for a number of years, a matter of interpenetration of dust or other foreign substances. This I believe to have observed in two cases, nos. 145 and 186. I have invariably endeavoured to select the pollen samples with the greatest possible care and to avoid any pronounced surface material. It should be noted that samples of obviously doubtful quality have been eliminated in advance. I have admitted only samples which in my opinion could be expected to correspond to the stratum of the find. The reliability of the samples does, nevertheless, vary greatly. The comments on the dating of the individual finds will carry a brief reference to their place of origin.

In an earlier work on the dating of the European Pond Tortoise, *Emys orbicularis* (Degerbøl & Krog, 1951), I tried to estimate the reliability of the datings, based partly on the presumed dependability of the pollen sample, partly on the degree of certainty with which the pollen spectrum could be referred to a pollen zone. A similar critical division of the material may likewise be made here concerning the reindeer, but for various reasons I believe it to be of minor value and interest. In discussing the dating of the individual finds I have not, therefore, considered it necessary to give details concerning the origin or the quality of the samples. In but few instances have I found rather more ample information on these points desirable.

All pollen samples have been acetolysed according to the method described by Fægri & Iversen (1950). Most samples contained varying amounts of mineral material, which have been removed by means of hydrofluoric acid. However, for the purpose of comparison, all samples have been subjected to this treatment. Lime, if any, has been removed by means of hydrochloric acid. The pollen count has been effected on the principle of registering every known type of pollen and spore and, as far as possible, of determining unknown types. In this context it should be noted that *Populus* and *Juniperus* have been counted in all the pollen diagrams of this publication and in nearly all the other samples, the spectra of which are set out in tabular forms. Only in one of the first samples to be counted were *Populus* and *Juniperus* left out. In cases where the count has paid no regard to some type of pollen, the table of pollen spectra will carry a ? in the relevant column.

In the pollen diagrams some of the more rarely occurring types have been omitted as being of no dating-significance. A list of the more important ones will, however, appear in the closing chapter.

The sum on the basis of which the pollen percentages are computed, includes pollen and spores of all terrestrial plants, i.e. trees, shrubs, and herbs. Spores of *Lycopodium* constitute the only exception. The pollen sum is stated for each sample. In the case of the diagrams, a number of 500 is generally considered a minimum for curves of sufficient reliability from the statistical point of view, but in the case of individual samples the number varies considerably. However, some of these do not demand any great statistical reliability, and in other instances the sample size permitted counts of comparatively few pollen grains.

A large portion of the samples examined have been clayey and consequently carried an admixture of secondary (rebedded) pollen originating from the clay. As proved by IVERSEN (1936, 1942) it is possible to eliminate this source of error if we know the pollen content of the original clay from which the sediment's clay fraction was derived. In his above-mentioned works IVERSEN explains the method in detail, and in an earlier work I have demonstrated its practicability (KROG, 1954), so there is no need to expatiate on it here, although a brief account of how the method has been employed is, no doubt, called for.

Such secondary pollen types as have been brought in with the clay may in principle be divided into two groups. One comprises types immediately recognizable as secondary (predominantly Tertiary and Inter-Glacial), and these types have invariably been separated out and excluded from the count and from the pollen sum. The other group comprises types that may occur also as primary in the sediment in question; this group, however, can be computed and separated out only if there is previous knowledge of the pollen content of the clay contained in the sediment. Since, as already mentioned, the former of these two groups is excluded always, the latter group will not cause very great errors in the pollen spectra, provided that the amount of secondary pollen is comparatively small. I have, therefore, found it necessary to correct for the second group in only two of the accompanying diagrams (No. 8, Herlev, and No. 15, Copenhagen). In all instances of individual samples it has been possible to separate out those types only that are immediately recognizable as secondary. Hence, the indicated amount of secondary pollen embraces the immediately recognizable types only, except in the two cases mentioned.

Late-Glacial Stratigraphy, Pollen-analytically and Geologically

The pollen-analytical method has been the most important aid in the attempts to obtain datings of the reindeer-finds, whereas purely geologico-stratigraphical data have been decisive to but a less extent. As will appear from this treatise, it has become evident that nearly all our reindeer-finds originate from the late-glacial period. A brief survey, therefore, of the most characteristic features in the evolution of the late-glacial pollen flora and a few remarks on stratigraphy will be given here in order to furnish the necessary background. As regards the pollen flora, only such features as are of significance for the zone determinations of late-glacial pollen spectra will be indicated, whereas conditions pertaining to climate and vegetation will not be discussed in this section.

The following data are based on comparisons between late-glacial pollen diagrams which are becoming available in increasing numbers from Denmark and Scania. They are in part formerly published diagrams (particularly by JOHS. IVERSEN, but also by B. BRORSON-CHRISTENSEN and by H. KROG), in part those being published in this treatise, and, further, some unpublished ones. Although the data on the evolution of the pollen flora are thus pieced together from many localities, the diagram from Orenæs (p. 158), which is in most respects typical of the south of Denmark, will serve fairly well as an illustration of the essential features.

The zonation has, as is customary, followed KNUD JESSEN's system (1935): Late-glacial time embracing pollen zones I—III (I: Older Dryas period, II: Alleröd period, III: Younger Dryas period) and post-glacial time beginning with zone IV, pre-Boreal time. Concerning the shape and construction of the pollen diagrams the reader is referred to the diagram pages.

At Böllingsö in Central Jutland IVERSEN (1942, see also 1954) has been able to divide zone I into three sub-zones: a, b, and c, of which b, the so-called Bölling period, is somewhat milder. It is only in the westernmost part of the country, however, that the pollen diagrams have been successfully carried back to this sub-zone, and conditions attending the finds concerned have in no instance permitted a utilization of this division into sub-zones, for which reason no further mention of it will be made here.

The pollen diagrams accompanying this treatise all derive from the southeastern portion of the country, and zone I, where represented, appears only in its latest phase Ic. Zone I, when referred to below in connection with the pollen diagrams, generally stands for zone Ic.

A general rule applying to the late-glacial pollen diagrams is this: the quantity of herb pollen is largest in zones I and III, smallest in zone II. In the middle of zone II is often observed a section that is richer in herb pollen than any other part of the zone. The herbs varying in this way are primarily *Gramineae* and *Cyperaceae* which normally account for the bulk of the herb pollen, plus *Artemisia*, which often likewise accounts for an essential portion of the pollen. Among the arborescent plants it is primarily *Betula*, which varies in the opposite direction to that of the herbs, its curve generally running more or less parallel with the curve of the total amount of tree pollen. Normally, *Populus* occurs in quantities so small that it is difficult to plot a continuous curve for it, but in general it follows the fluctuations of the *Betula* curve. In most cases it is sparsely represented in zone II, occasionally as a continuous curve, and entirely missing in zones I and III, though perhaps sporadically present in zone III. In the transition between zones III and IV, sometimes just before and sometimes just after the zonal border, it reappears more strongly, and, as a rule, passes through zone IV, often in considerable quantities.

The curve of secondary pollen generally fluctuates concurrently with the herb pollen curve, i.e. small values in zone II, large ones in zones I and III. This fact simply indicates that the sediments in zones I and III are more clayey than those in zone II.

A number of pollen types, of which the majority occur normally in but minute quantities, play a certain role as indicators.

Hippophaë generally forms a continuous curve at the beginning of zone I and occasionally persists, perhaps less constantly, for a short time in zone II. A few pollen grains may occur in all three zones. *Helianthemum* (i.e. *H. oelandicum*-typ.; *H. nummularium* has been found only sporadically and unassociated with any definite pollen zone) behaves in much the same way. In most cases, however, *Helianthemum* appears slightly later than *Hippophaë*, but, then, frequently persists somewhat longer in zone II. *Helianthemum* may likewise occur sporadically in all zones. *Plantago maritima* is less common than the two just mentioned, but like these found preponderantly in zone I, occasionally a short time in zone II and, also, sporadically in all zones. Broadly speaking, the same applies to *Saxifraga oppositifolia*-typ. in the diagram from Vallensgaard, Bornholm (Iversen, 1954). Pollen grains from *Dryas* are but rarely of sufficient frequency to permit the plotting of a continuous curve. They have been found almost exclusively in zones I and III, mostly in zone I.

As already mentioned, herb pollen percentages decline in zone II. There are, however, some that react in the directly opposite way, and of these the most conspicuous are *Filipendula* and *Urtica*. They generally present a continuous curve in zone II and can attain a value of one, two, or three per cent., whereas they are normally found only sporadically in zones I and III, though occasionally in an almost continuous curve.

Dryopteris Linnaeana appears to be of great value as an indicator. It is found only occasionally in zone I and normally does not appear continuously for some time in zone II. From this point it continues through the entire zone III, at the beginning of which it often reaches its maximum, which may be very pronounced. The values for *Dryopteris Linnaeana* can show extreme variations from one locality to the next. *Sphagnum* spores will sometimes occur on a pattern similar to *Dryopteris Linnaeana*, but in contrast to the latter, *Sphagnum* is commonly found among the secondary types and consequently appears frequently in zone I.

Pollen of *Empetrum* generally occurs in a fairly consistent pattern, but may vary greatly in quantity from place to place. *Empetrum* is often found sporadically in zone I, perhaps a little more frequently in zone II, then forms a continuous curve through the larger part of zone III, and, again, attains its maximum at the transition from zone III to IV. Considerable deviations may, however, be observed.

A certain regularity can be traced in respect to the *Juniperus* curve. Generally it is continuous through the entire late-glacial time with very low values in zone I and sometimes for a short distance into zone II, but is considerably more frequent through the whole of zone III. A maximum is often found within zone II and, finally, a maximum, which can be extraordinarily clear-cut, invariably appears on the very border between zones III and IV. The values for *Juniperus* may vary very greatly from one diagram to the next, and at certain places it is even impossible to plot a continuous curve through zone III.

Two of the above-mentioned pollen types, *Filipendula* and *Urtica*, appear at the transition from zone III to zone IV in a manner similar to that of *Juniperus*. *Filipendula* in particular often has a distinct maximum, although on a smaller scale than *Juniperus*.

This transition from zone III to zone IV has gradually come to be the most sharply marked level in the late-glacial pollen diagrams. If one has a pollen spectrum with some *Populus*, much *Juniperus*, a liberal amount of *Empetrum*, *Filipendula*, *Urtica*, and, perhaps, a little *Dryopteris Linnaeana*, and if the spectrum is not otherwise post-glacially influenced, then the sample can safely be placed at this transition between zones III and IV.

With the beginning of zone IV the pollen diagrams as a rule undergo a profound change of character. There is normally a very pronounced decrease of herb pollen, and a number of pollen and spore types like *Empetrum*, *Artemisia*, *Chenopodiaceae*, *Galium*, *Thalictrum*, and *Dryopteris Linnaeana* disappear entirely or partly. Predominant among the trees are *Betula* and *Pinus*, but their proportional incidence may change greatly from place to place. *Salix*, which was common throughout the late-glacial time, often still holds an important position at the beginning of zone IV, but will then as a rule disappear rapidly, whereas *Populus* may occur quite frequently during the whole of this zone. *Juniperus* is very much on the decline and generally soon disappears. Some new pollen types, especially those originating from aquatics, such as *Nymphaea* and *Nuphar*, now appear.

Also the sediments are normally subject to alterations at the transition from zone III to IV; in most cases, for instance, the clay component will disappear and consequently the secondary pollen, too.

What has been said so far about the late-glacial pollen diagrams applies to Denmark in general, but conditions on Bornholm will require a few supplementary remarks.

From Bornholm only one late-glacial pollen diagram exists (Iversen, 1954, Pl. XI); it is, however, very detailed. It spans all of late-glacial time and has a large number of pollen types, among which are *Juniperus* and *Populus*. On certain points this diagram differs from any other Danish one, particularly in that *Pinus* reaches far higher values in zones II and III, more especially in the late portion of zone II, where it approaches 45 %. Elsewhere in Denmark *Betula* is by far the commonest of the arborescent plants during the entire late-glacial time, but on Bornholm *Pinus* exceeds *Betula* at the end of zone II, whereas in zone III they are of about equal incidence. The *Artemisia* curve is in general similar to that in the other Danish diagrams, but reaches higher values in all zones. The remaining characteristics are fundamentally the same as for other parts of the country.

It should in this connection be noted that dating of the few existing analyses from the Bornholm reindeer-finds has proved difficult and must be viewed with some reservation because the analyses have revealed a surprising lack of variation, and because there is only a single diagram for comparison.

As briefly touched upon in the foregoing statements, late-glacial freshwater sediments are often minerogenous whereas the post-glacial ones are normally clayless, zone II as a rule being less argillaceous than zones I and III. That, in fact, covers the essentials in respect to late-glacial stratigraphy, namely: that it is often immediately possible to recognize a deposit as late-glacial and also to distinguish between the different late-glacial periods.

Within the late-glacial sequence there are, however, many variations, and without going into detail I shall point out the most significant features.

The substratum of the late-glacial formations is generally glacial deposits, most frequently boulder clay, sand, or gravel.

The marked order of strata, clay in zones I and III and gyttja in zone II, occurs primarily in areas where the basin concerned is surrounded by fat clay, particularly that which was deposited in an ice-dammed lake. In such areas even zone II may be represented by clay gyttja or, indeed, clay which will then contain a little more organic matter than is the case in zones I and III.

Within boulder clay areas zones I and III will commonly appear as clay gyttja, zone II as gyttja or clay gyttja less rich in clay than zones I and III. However, both gyttja and clay gyttja may vary greatly in composition and appearance according to contents of clay, sand, gyttja, and lime. In a sequence like that the lower, or possibly the entire, part of zone I will generally be more clayey than zone III, occasionally having developed into pure clay.

In sandy districts the late-glacial strata will often prove to be very sandy, too, zones I and III having then developed into almost pure sand.

Now and then peat is found in the late-glacial strata, most frequently in zone II, occasionally in zone III. It is in most cases either telmatic or a more or less terrestrial peat, in zone II sometimes of a humus-like nature.

Even in typical sections where zone II can be immediately distinguished from zones I and III we often find pronounced dissimilarities in the nature and appearance of strata within the individual zones. Zone II, for instance, may have alternating layers of clay, clay gyttja, detritus gyttja, calcareous gyttja, and peat; similar alternations of different layers may be found within zones I and III; and, further, the boundaries between different zones may not be readily recognizable without pollen analysis. The variations may become so great that regular features are obscured and pollen analysis is required for differentiation of the individual zones. On the other hand, the stratigraphic uniformity in a section may be so pronounced that the zone boundaries will not be immediately recognizable. Zone III, for instance, may reveal traces of gyttja so strong as to preclude any perception of a boundary between this zone and those above and below.

In a great many instances a late-glacial stratification will be incomplete, generally in that the older part of the sequence is missing, but there are also instances of gaps in the sequence. Such phenomena may be observed, for instance, where a very irregular topography or changing conditions of inflow and outflow of water have caused mass movements of material. Such erosional processes may have created quite abnormal stratifications dominated by mineral materials, clay, sand, gravel, or stone to such extent that it becomes impossible to account for the stratigraphy even by means of pollen analysis.

The criteria here mentioned have been adhered to as regards pollen analytical zone determination and stratigraphy at the dating of the individual finds described in the following pages. It should be noted that great difficulties were encountered as regards a definite dating of finds from which samples were confined to a single or very few existing specimens—as already explained in connection with finds on Bornholm. Many such datings must, therefore, be subject to great reservation, and in but rare cases can they be ascribed with certainty to a pollen zone. The explanation of this fact is that late-glacial pollen zones to but a slight degree are determined by absolute characters, the absence or presence of individual pollen types. In the late-glacial pollen diagrams the variations are so great that a definite zone determination on the basis of only one single pollen spectrum requires very pronounced characteristics of the spectrum.

In applying the zone designations I, II, and III as corresponding to the periods of Older Dryas, Alleröd, and Younger Dryas, it is above all the vegetational periods that I have in mind.

Dating of the Reindeer-Finds

The following is a list of those reindeer remains which the author has attempted to date by the pollen-analytical or stratigraphic-geological methods discussed above. Numbers and sequence are identical to those employed by M. Degerbøl (pp. 7—48). The list primarily comprises finds not previously published and, secondly, some already published ones which I have considered to be in need of some further revision or comment.

Data relating to the conditions and circumstances of the finds have been included in so far as they are known or deemed to be of interest or importance for the dating. As a rule, a brief statement of the grounds for the dating is given for each find.

The pollen analyses of individual samples are listed in a table (p. 152—153), in which the numbers correspond to those in the list below. The pollen diagrams are presented on pp. 154—160.

The pollen-analytical work has been carried out by the author at Danmarks Geologiske Undersøgelse (Geological Survey of Denmark). A few analyses have been done by others, whose names are mentioned in the report on the particular find.

4. Mullerup.

Mathiassen (1938 a, p. 175) has stated that this antler was found in gravel at a depth of one metre at the western end of Mullerup Bog. There is good evidence that this antler has been shaped by man, and Mathiassen (*l. c.*) has ascribed it to the Meiendorf culture. Subsequently, MATHIASSEN (1946, p. 177) has noted that RUST, who in MATHIASSEN's opinion is more experienced within this sphere, has ascribed it to the Ahrensburg culture. The Meiendorf culture is dated at zone Ia, when this portion of the country can hardly have been ice-free. The Ahrensburg culture is placed within zone III.

The antler is unfortunately not datable geologically. As it was found in gravel it can, theoretically, be very old, provided that it has been rebedded. However, instances are known of both sand and gravel layers being formed in the Younger Dryas period, so there is also a possibility of the antler being in fact as young as zone III.

5. Hodde, 1942.

This find was made during the digging of the so-called Karlsgaarde canal, which branches off from Varde river about $2^1/_2$ km. E. of the village of Hodde. (NORDMANN (1944, p. 36) has mistakenly given Karlsgaarde, about 7 km. N.E. of Varde, as the finding place. This is due to a confusion of the names Karlsgaarde and the Karlsgaarde canal; the southeast end of the Karlsgaarde canal is about 7 km. N.E. of Varde, but the site is situated at the northeastern end of the canal, i.e. approximately 15 km. N.E. of Varde). The canal construction followed a natural valley stretching about $^1/_2$ km. from the Varde river towards the S.E., and it was in about the middle of the valley that the find was made. The find was promptly forwarded to the Zoological Museum with a comparatively detailed description of all relevant circumstances. The sequence of layers was stated to be the following:

0—45 cm:	peat soil.
45—85 – :	sand.
85—140 – :	clay.
140—170 – :	pebbles and gravel.
170—300 – :	clay. Under this, first, a thin layer of stones and, next, a layer of clay of indefinite thickness.

The reindeer antler with a small portion of the skull attached was found at the bottom of the lower clay. Samples of this and also of the upper clay were sent along with the find. The samples consisted of stoneless clay, mainly a rebedded tertiary micaceous clay. The clay samples did not at all lend themselves to dating by means of pollen analysis because tertiary pollen types were predominant.

The lower clay and the "pebble and gravel" layer immediately above it are considered by NORDMANN (1944, p. 36) to be meltwater deposits. As this part of the country was ice-free during the last glacial time, NORDMANN concludes that the find must stem from the penultimate interglacial period.

No geological investigation was made at the spot when the antler was found, and when I visited the place in 1952, investigations could be undertaken only by means of borings. The site is in a small valley with rather steep slopes on which is found tertiary micaceous clay. The bottom of the valley is covered with post-glacial layers of peat and sand, which increase very considerably in thickness as they approach Varde river. At several places the borings revealed rebedded tertiary clay below the peat and sand layers; this clay was generally rather soft and varied greatly in both thickness and depth. My attempts at finding a sequence of layers identical with the one described above were unsuccessful.

During glacial and late-glacial times conditions were ideal for the erosion of the tertiary clay from the slopes of the valley and the redeposition of it on the bottom. Erosion may also have taken place at the bottom of the valley, and there may have been mass movements. In a small valley like this one, such erosion and deposition as is in progress will easily be influenced by comparatively small quantitative changes in surface flow. I must, therefore, consider it a matter of doubt whether a dating of the layer of clay in which the find was made ought to be attempted on the basis of available data. In my opinion NORDMANN's dating cannot be rejected with absolute certainty though it seems to me that there is no particular reason which suggests such an old age. As far as I can see, the layer in question may very well have been formed as late as during the last glacial or the late-glacial time.

As this find, then, is conceivably of greater age than any of our other finds, it is much to be regretted that no immediate geological investigation of the finding place was undertaken, an investigation that would have been of very great interest from the geological as well as from the zoological point of wiew.

6. Christiansfeld, Holbæk, 1856.

According to NORDMANN (1944, p. 33) this antler was found in a marl pit five or six metres below the surface. In 1904 NORDMANN endeavoured to get further details. It was then considered most likely that the find must stem from an old marl pit approximately 10 m. deep and dug in boulder clay. The piece found had not been rounded "to any considerable extent", but "may very well have lain on a secondary bed". The possibility thus exists that this find is full-glacial or older still.

7. Villestofte, Funen, 1938.

The find is mentioned in V. MILTHERS (1940, p. 103). JOHS. IVERSEN has here supplied information on the relevant circumstances and presented the result of a pollen-analytical examination, an excerpt of which is given here in view of the find's zoological significance.

The reindeer skeleton was found at a depth of 190 cm., and the local sequence of layers was as follows:

0— 60 cm: humus layer.
60—125 - : clay.
125—160 - : sand.
160—250 - : clay.
250—270 - : peat mixed with sand.
270— ? - : sand.

According to IVERSEN the peat layer contained practically no pollen and was not indicative of a thermal oscillation.

A pollen analysis from the layer of the find (skull) yielded the following: *Salix* 5 %, *Betula* 22 %, *Pinus* 13 %, *Hippophaë* 6 %, herbs 4 % (of which *Artemisia* 2 %), *Gramineae* 20 %, *Cyperaceae* 30 %—a total of 100 %. There is an additional analysis from the bottom of the upper clay layer approximately 65 cm. above the layer of the reindeer find: *Salix* 6 %, *Betula* 10 %, *Pinus* 35 %, *Gramineae* 12 %, *Cyperaceae* 33 %, and *Ericales* 4 %. In the first and to a still greater extent in the second sample were found numerous secondary pollen types which could at once be excluded from the pollen sum, so that the percentages set down for *Betula* and, especially, *Pinus* must presumably be too high. The sample from the upper clay was noticeably poor in pollen.

In the analysis from the skull, the rather small quantity of *Betula* and, especially, the large quantity of *Hippophaë* are indicative of zone I. In the sample from the layer above the find some of the *Betula* pollen and nearly all the *Pinus* pollen must be assumed to be secondary so that this latter sample can with greater certainty than the former be ascribed to zone I. Consequently the reindeer can without any doubt be dated at an early part of zone Ic.

It should be added that V. Milthers (*l. c.*), in view of the geological features at and about the site, arrives at the conclusion "that the formation of the two to three metre thick layers of sand and clay can have occurred only in extremely high-arctic conditions."

8. Herlev, 1951.

Found during sewerage operations abt. 600 m. S.W. of Herlev railway station. There was a delay of about a month before the antler was sent to the Zoological Museum. It still carried a little material which was assumed to come from the layer of the find; samples for analyses were scraped off from three different parts of the antler. I visited the finding place on the 11th June, 1951, at which time the trench was still open, but shoring of the walls made it difficult to find a suitable place for sampling. About 4 metres from the spot where the antler had been found I succeeded in obtaining samples from the section specified below:

0—215 cm: disturbed top soil, at bottom peat and gyttja.
215—239 - : grey sand.
239—283 - : grey-blue clay gyttja.
283—310 - : yellowish brown, highly calcareous detritus gyttja.
310—340 - : olive-grey clay gyttja.
340—370 - : grey stoneless clay.
370— ? - : grey pebbled sand.

The shorings, especially at the lower levels, made it difficult to take the samples as close to one another as desirable.

P. 154 shows the pollen diagram and below that the analyses from the abovementioned samples of the antler.

According to information gathered from the workmen, the antler's placing in the diagram would be at a level of between 335 and 345 cm. The three antler analyses differ somewhat, but may fairly conclusively correspond to the 340 cm. level of the diagram; they do not fit in anywhere else. It should be borne in mind that the antler was found about 4 metres from the spot where the series of samples were taken, a circumstance that may very well lead to some divergence. Although the antler samples are not as good as might be desired, it is my impression that in no case has contamination caused their composition to deviate from that of the samples in the diagram.

The pollen diagram clearly begins in zone I and ends in zone III. In this diagram there is some difficulty in placing the border line between zones I and II, but I believe it should be set immediately above 340 cm. This is the level from which the antler must originate, and it can thus be referred to the transition from zone I to zone II.

9. Alleröd.

Three pieces. The depths of the finds are stated to be between 4 and 5 m. in one case and between 6 and 7 m. in the others. All three were found in "the blue clay" (Hartz, 1902, p. 24). These depths together with the information on the thickness of layers given by Hartz (*l. c.*) would indicate that the find at the 4—5 m. depth comes from either zone I or zone III (zone I the most likely), and that the two finds from the 6 m. level can come from zone I only.

11. Copenhagen, the Sound, 1936.

Found at a depth of $4^1/_2$ m. in clayey gravel, $12^1/_2$ m. below sea level. Ascribed by Iversen (1942, p. 146) to zone Ic. The sample displayed a noticeable paucity of pollen, and the pollen spectrum has not been published. Iversen says that "conditions attending the find are of a nature that makes a factor of uncertainty inevitable."

The piece is an artifact, and has been ascribed by MATHIASSEN (1938a) to the Hamburg culture (i. e. the Meiendorf culture which has been pollen-analytically dated at zone Ia). It is not very likely that the Copenhagen area was ice-free at that early date.

12. Askeby, St. Damme, Möen, 1949.

Found at a depth of one m. approx. in sandy blue clay under some 15 cm. of peat. Four samples of sandy clay gyttja, a—d, were taken from fresh and adequate material on the antler. In general the samples are remarkably similar. Especially notable is an abundant occurrence of *Helianthemum oelandicum* and a single pollen grain of *Plantago maritima*. The samples must be dated at the transition period from zone I to zone II.

13. Ore near Stubbeköbing, 1941.

A sample of slightly clayey detritus gyttja was taken from the antler. The pollen spectrum reveals a composition that may be found at the end of zone I, in zone II, and in zone III. There is every reason to compare this spectrum with the pollen diagram from Orenæs (p. 158) situated some 15 to 20 km. to the West. In this diagram the spectrum would fit in best at about the zone I—II transition. This dating is not, however, quite certain.

15. Copenhagen, Fuglebakkevej (factory Novo), 1949.

Found during the excavation for a factory foundation. I visited the locality on the 21st September, 1949, two or three days after the antler had been found, and took a series of pollen samples less than one m. from where the antler was found. The order of strata at the spot was the following:

0—235 cm:	disturbed layers, stratigraphically unreliable.
235—269 – :	moss sedge peat.
269—452 – :	gyttja and clay gyttja. Particularly the upper half very calcareous and with molluscs. The lower half a little clayey, at the very lowest level much clay. From approximately 310 to 330 cm. some stones, 5 to 10 cm. in diameter.
452—457 – :	layer of stones.
457—485 – :	bluish grey boulder clay.
485— ? – :	gravel.

The lower and upper portions of the pollen diagram (p. 155) are quite clear. At the bottom it starts at the close of zone I and continues in zone II; in the upper part is seen a fine and typical transition from zone III to zone IV. In the intermediate part, however, no clear zone III has been developed. There was nothing in the section to indicate a gap in the order of strata, the only deviation from the normal being the mentioned occurrence of stones at the 310—330 cm. level. Even so, I can only interpret the diagram to indicate that there must be a gap in the stratigraphic sequence so that zone III—apart from its final phase —is missing.

According to the workmen the antler was found at a depth of between 400 and 450 cm. It carried some fresh material which plainly came from the layer of the find, and three samples, a, b, and c, were taken for pollen analyses from different parts of the antler. The analyses are seen directly below the pollen diagram. They can be fitted into the diagram at between 433 and 440 cm., and at no other level. The find is thus dated to the very beginning of zone II.

Professor DEGERBØL, who likewise visited the excavation, found a lump of fresh clay gyttja with remnants of bones of perch, *Perca fluviatilis*, near the place of the antler. An anlysis of the lump, d, is set out below the diagram. It fits in at about 390 cm., and the perch must, therefore, be dated at zone II.

In the same excavation were found also a shoulder-blade and the lower jaw of an elk, *Alces alces*, but the exact location could not be specified; it may have been at a distance of 30 or 40 m. from the antler. The bones carried ample material, and samples had likewise been taken from the relevant layer. These samples consisted mainly of calcareous gyttja, but contained also a one or two cm. thick layer of dark detritus gyttja. The bones exhibited distinct traces of having lain between calcareous gyttja and dark detritus gyttja, for instance one half of the lower jaw is dark and the other half is light. Six analyses from this material are seen at foot of the diagram. The samples e, f, and g come from the layer of the find, h and j from the shoulder-blade, k from the lower jaw. In h and j are found low percentages of *Alnus*, *Corylus*, *Ulmus*, and *Tilia*, which may be due to contamination. The four other samples reveal no traces of these warmth-demanding plants. Although the samples vary a little in certain respects, all six must be ascribed to zone IV. For lack of adequate information concerning the find it can be dated merely to somewhere within zone IV.

16. Rungsted, 1944.

Found $2^1/_4$ m. below the surface in a layer of earth which contained some shells, on top of which was a thin layer of peat. A sample of clay gyttja was collected from the antler. The presence of *Dryopteris Linnaeana* spores in this sample would indicate either zone III or the close of zone II. There seems to be nothing to permit a more exact age determination.

17. Alleröd.

Based on information from a workman, Hartz (1902, p. 24) states definitely that this find originates from the Alleröd gyttja.

19. Mulstrup, near Ringsted, 1945.

Found during drainage at a depth of about 2 m. A sample of clay gyttja was taken from the antler. The only indicator of significance in the pollen spectrum is *Dryopteris Linnaeana*, for which reason the sample must be assumed to originate from the close of zone II or from zone III.

21. Idalund Brick-works, Lolland, 1912.

According to its label this antler was found in Dryas clay. A very small sample of clay containing gyttja was removed. The entire sample was used for the count. The presence of *Dryopteris Linnaeana* spores indicates the later part of zone II or zone III.

22. Kjellerup, S.E. of Ringe, Funen.

Nordmann (1915, p. 8 ff.) thoroughly discusses this find on the basis of an excavation undertaken by himself at the actual locality. He found the following sequence of layers:

0— 40 cm:	strongly humified peat, the upper part with some admixture of clay and sand.
40— 75 – :	greyish brown gyttja with some few stones.
75— 97 – :	*Amblystegium* peat containing twigs, seeds of *Menyanthes*, etc.
97—108 – :	light greyish brown gyttja.
108—151 – :	light grey freshwater clay with shells of *Sphaerium corneum* and *Pisidium* in small heaps close to the juncture with the gyttja-layer above.
151— ? – :	gravel and sand with much water; between 50 and 100 cm. thick, with boulder clay beneath.

During digging Nordmann found an impression of the antler at a depth of 75 cm. between the *Amblystegium* peat and the overlying gyttja. Samples for washing were taken during the digging, and on the basis of these Nordmann gives a long list of fossils.

The main features in this sequence of layers can now be interpreted without difficulty. It is obvious from the list of fossils that the upper layer of peat is post-glacial. In the underlying greyish brown gyttja (undoubtedly clay gyttja) is found, inter alia, *Betula nana*, and the layer must be ascribed to the Younger Dryas period. *Betula nana* did not occur in the *Amblystegium* peat, which on the other hand contained *Populus tremula*, which was not proved to be present in any of the other strata. There can be no doubt that this peat originates from the Alleröd period, and the reindeer antler must consequently be dated at the transition between the Alleröd and the Younger Dryas period.

For the sake of completeness it should be added that also the gyttja below the *Amblystegium* peat undoubtedly belongs to the Alleröd period, whereas the clay beneath was probably formed in the Older Dryas period.

In 1915 Nordmann regarded the find as post-glacial, but later (1944, pp. 67—68) considered it to be late-glacial.

23. Sattrup, 10 km. N. of Horsens, 1949.

Four samples of clay gyttja were taken from the antler. Though contaminated by younger material (therefore excluded from the table) all samples were of distinctly late-glacial character. The fact that *Dryopteris Linnaeana* was well represented would indicate a younger phase of late-glacial time, zone II or zone III.

24. Söborg Bog, 1926.

A sample of clay gyttja was taken from the left antler. The entire sample was used for the count. Much *Dryopteris Linnaeana* and *Artemisia*, and comparatively little *Betula* point to zone III as the most likely one. A pollen grain of *Plantago lanceolata* is no doubt due to contamination of which there were, however, no other indications.

25. Isteröd, 1953.

The antler was found during excavations for the purpose of water piping. I visited the locality shortly after the find, but found that open sections were no longer accessible. The workmen's information was very vague. As the antler was unwashed, good samples were obtained from different parts of it, all consisting of sandy clay with content of organic matter, in part rather peaty, but with comparatively little pollen.

Only one of the samples was counted. The pollen spectrum is characterized by much secondary pollen. This means that the percentages of *Betula* and, particularly, *Pinus* are too high. The only conceivable zones consistent with a spectrum like this are I or III, and the large quantity of *Dryopteris Linnaeana* narrows the dating down to zone III. It is to be noted that two other samples from the antler, submitted to a more cursory examination, do not appear to deviate much from the one counted. *Dryopteris Linnaeana* spores were observed in a sample from the side of the antler opposite to that from which the counted sample was taken.

26. Valby, North of Helsinge, 1956.

Found during drainage. A number of samples were collected by U. Möhl from the site, among which was a large one with an impression of the antler. I visited the locality during diggings undertaken by the sculptor H. Kapel in the summer of 1957 and took a more extensive series of samples about two m. from the spot where the antler was found.

The upper two m. or so was of a doubtful nature, but beneath was found the following undisturbed order of strata:

213—229 cm: very firm brown moss sedge peat.
229—237 – : light brown laminated detritus gyttja with many fruit-stones of *Potamogeton sp.* and some seeds of *Menyanthes.*

237—267 – : olive grey clay gyttja.
267—287 – : greyish blue gyttja-containing clay.
287—315 – : olive green detritus gyttja.
315—321 – : dark grey clay gyttja.
321— ? – : light grey stony and sandy clay (boulder clay).

The latter series of samples form the basis for a pollen diagram (p. 156) which passes from zone II to the beginning of zone IV. The antler is said to have been found in the topmost part of the 237—267 cm. layer, which according to the diagram represents the end of zone III or the transition from zone III to zone IV. From the above-mentioned impression of the antler a sample was taken for examination, and the analysis of it is seen under the diagram. This spectrum fits in perfectly between 245 and 260 cm. in the diagram—and at no other level. The find thus clearly dates from the end of zone III.

27. Holbæk, 1949.

In connection with road construction in the summer of 1949 an excavation was made about one km. south of Holbæk town. Several bones of animals were found during digging operations and given to the Holbæk Museum. At the suggestion of Mr. Thomsen, schoolmaster and at that time head of the museum, I visited the excavation on the 18th August, 1949. The reindeer antler had been found a few days before and cleaned already. However, the basal end near the rose still carried some clay gyttja emanating from the stratum of the find, and a sample of this was taken for pollen analysis. The place and depth of the find were pointed out by the workmen as being in an exposed portion of a former bog basin. The stratification here was undisturbed and representative of the basin; a number of samples were taken from the open wall. The sequence of layers is listed below:

0— 53 cm: disturbed layers.
53— 69 – : blackish brown, strongly humified peat.
69— 75 – : reddish brown moss sedge peat.
75— 79 – : *Equisetum* peat.
79—128 – : light grey clay gyttja.
128—138 – : greyish brown detritus gyttja.
138—142 – : reddish brown terrestrial peat (Alleröd mull). In this stratum a birch stem, about 6 cm. thick.
142— ? – : light grey, sandy and stony clay (boulder clay).

The pollen diagram could be carried down only to the upper part of the Alleröd mull layer because the pollen destruction in the lower part had progressed too far. The diagram (p. 157) passes from zone II to zone IV. The analysis of the sample from the antler is seen beneath it. According to the workmen the antler was found at a depth of about 90 cm., but the analysis from the antler can be fitted into the 110—120 cm. level only, cf. especially the values for *Dryopteris Linnaeana* and *Sphagnum*. In both cases, however, the dating is clearly zone III, according to the workmen's statement at the end, and according to the antler sample at the beginning.

28. Görlev, 1938.

Sample of sandy gyttja was taken from the antler. The pollen spectrum is characterized, inter alia, by comparatively little *Betula* and much *Filipendula*. The final stages of zone III seem the most likely.

29. Ondlöse Mark.

This find has been dealt with in detail by NORDMANN (1915, pp. 16—18), who among JAP. STEENSTRUP's posthumous papers found a drawing with the following sequence of strata at the locality:

0— 22 cm: water with tufts of grass.
22—113 – : peat.
113—151 – : grey mud.
151—176 – : calcareous mud.
176—192 – : black mud.
192— ? – : sand.

Our present knowledge of late-glacial deposits makes it comparatively easy to interpret the main features of this section. The peat must be post-glacial, the grey mud is no doubt clay gyttja from the Younger Dryas period, and the black mud Alleröd gyttja. It is, however, open to question whether the calcareous mud originates from the Younger Dryas or the Alleröd period. The reindeer antler was found at the bottom of the 113—151 cm. layer and must therefore date from the Younger Dryas period.

It likewise appears from STEENSTRUP's notes that remnants of three pike (*Esox lucius*) were found in the lowest part of the black mud. By the above interpretation they must date from the Alleröd period.

In 1915 NORDMANN naturally considered the reindeer antler to be of post-glacial age, but later (1944, pp. 67—68) revised his opinion.

30. Kirke Såby, 1934.

A sample of peaty clay gyttja was taken from the antler. The small quantity of *Betula* would indicate zone I or III, *Filipendula* and *Urtica* a comparatively favourable climate, and *Juniperus* either zone II or zone III. The close of zone III appears most likely.

31. Mullerup, 1901.

Samples a and b from the antler, c from the skull, all clay gyttja. Apart from differences in respect of *Helianthemum oelandicum*, *Empetrum*, and *Juniperus* the three analyses are very similar, and the differences mentioned are not too pronounced to exclude their being of a statistical nature. It is justifiable, therefore, to consider all three analyses jointly. In view of the fairly frequent occurrence of *Empetrum* the samples are likely to originate from zone III.

32. Flintemose, Næstved.

Found at a depth of 1.5 m. in "late-glacial clay". Sample of clay gyttja from the antler. In view of the small quantity of *Betula* and large quantity of *Dryopteris Linnaeana* this spectrum cannot very well be dated at any other time than zone III.

33. Orenæs, Falster, 1956.

Found during drainage in March, 1956. Mr. O. WILHJELM, owner of the land where the find was made, informed Professor DEGERBØL by telephone and sent in the carefully removed antler with fresh, reliable samples and a detailed description of conditions attending the find. On the 10th April, 1956, I visited the locality which at that time was still accessible. In the open section I took out a series of samples about 0.5 to 1 m. from the spot where the antler had been collected. The stratigraphic sequence is listed below:

0— 44 cm:	strongly humified peat.
44— 52 – :	reddish brown moss peat.
52— 54 – :	transition layer, brown, sandy gyttja.
54—131 – :	grey and yellowish grey clay gyttja, generally very calcareous, very sandy at the top.
131—161 – :	olive brown detritus gyttja.
161—164 – :	finely sanded, dark grey clay gyttja.
164— ? – :	greyish blue, stoneless clay.

The pollen diagram (p. 158) passes from the end of zone I to the beginning of zone IV.

The antler's location was stated to have been about 10 to 15 cm. down in the 54—131 cm. layer of clay gyttja, and this tallied very well with the result of a thorough investigation at the site during which impressions as well as minute fragments of the antler were found at the said depth. Moreover, before my visit to the locality a pollen analysis had been made of a sample from the antler. This analysis is seen beneath the diagram, into which it will fit perfectly at a depth of 65 cm. approx. It is thus beyond doubt that the find must date from the close of zone III.

34. Rykkerup, Thoreby, Lolland, 1954.

The antler was found in clay at a depth of about two metres and was sent in together with a sample from the layer in which it was collected (a). A good sample was also taken from the antler (b), which like (a) consisted of gyttja-containing clay. The analyses of the two samples are quite concordant. There is a rather large proportion of secondary pollen, so that the values recorded for *Betula* and, especially, *Pinus* are obviously too high. Both *Artemisia* and *Dryopteris Linnaeana* are of frequent occurrence. The two samples must undoubtedly date from zone III.

35. Odense, 1941.

Found in January 1941 during digging at the corner of Österbæksvej and Sonnesvej, Odense. The antler and a sample from the relevant layer were sent in. In October 1941 Dr. J. Troels-Smith visited the site, where he made a survey and took samples from the section listed below:

0—15 cm:	redug.
15—31 – :	yellowish brown clay gyttja.
31—33 – :	calcareous detritus gyttja with mollusc shells.
33—46 – :	lake marl with many mollusc shells.
46—57 – :	greyish yellow, calcareous clay gyttja with occasional mollusc shells.
57—70 – :	greyish yellow, laminated clay, fine-grained sand.
70— ? – :	boulder clay.

The pollen diagram (p. 159) begins in zone I and ends at the beginning of zone III. Beneath the diagram are shown analyses of three samples, a and b taken from the antler, c from the sample sent in of the layer of the find. They can all plainly be fitted into the diagram, a and b in zone III, c, however, in zone II. The sample c stems, as mentioned, from the sample taken by the workmen whereas a and b are taken by U. Möhl and myself from material carried by the antler sent in. As the latter two are probably the most reliable, this find can be dated at the beginning of zone III.

36. Ejby, Funen, 1949.

A sample of sandy clay gyttja from the antler. The sample was much contaminated by younger material, for which reason the analysis has been excluded from the table. It was, however, of a distinctly late-glacial character. Its content of *Empetrum*, *Filipendula*, and *Dryopteris Linnaeana* points to zone III.

37. Skröbelev, Langeland, 1943.

Found near Skröbelev railway station in April 1943. Dr. J. Troels-Smith has examined the locality and taken a series of pollen samples from the sequence of strata set out below:

0— 30 cm: top soil.
30— 43 - : sand with clayey streaks.
43— 57 - : greyish brown, gyttja-containing clay.
57—107 - : yellowish brown, fine sand with streaks of clay gyttja.
107—220 - : greyish clay gyttja with many streaks of sand.
220—230 - : reddish brown clay gyttja.
230—245 - : yellowish brown detritus gyttja, faintly clayey.
245— ? - : stoneless clay.

The pollen diagram (p. 160) begins at the bottom near the transition from zone I to zone II and ends late in zone III. There were no post-glacial deposits, for which reason the transition between zones III and IV does not appear either. At a depth of some 100 cm. Troels-Smith found a remnant of the reindeer antler. This level, which in the stratigraphic column is marked in black, lies plainly in zone III. Beneath the diagram is seen an analysis of a sample taken from the reindeer cranium. Also this analysis belongs plainly to zone III and fits in perfectly near to the 100 cm. level in the diagram.

Troels-Smith has formerly, on the basis of a less thorough-going investigation, dated the find at zone III (J. Winther, 1943).

38. Overgård Marlbed, Glud, 1943.

The following information concerning the find is available: At the top was found approximately two metres of fat peat soil, under which was 2 to $2^1/_2$ m. of marl. The antler and various other bones were found just beneath this stratum. Next followed alternating thin strata of moss and marl, and below these about 25 cm. of compressed mud, an approximately 2 m. thick layer of marl, and, finally, black quicksand.

A sample of clay gyttja from the antler was examined by Dr. Iversen immediately on the appearance of the find. The spectrum, which is here reproduced in the table, may be ascribed to zone III, among other things because of a rather low *Betula* percentage, some *Empetrum*, and a single *Dryopteris Linnaeana* spore. This dating is further made probable by the recorded sequence of strata, in which the compressed mud can reasonably be assumed to be Alleröd gyttja.

39. Rask Lake, 1919.

According to Nordmann (1944, p. 68) this find was made at a depth of 1.15 m. at the transition between Dryas clay and post-glacial gyttja. One antler protruded downwards for a short distance into the Dryas clay, which contained leaves of *Dryas* and *Betula nana*. The upper 60 cm. or so of the gyttja belonged to the oak-mixed forest period. This led Nordmann to the assumption that reindeer lived at the transition between the Younger Dryas period and post-glacial time. He may be right, but the information available is insufficient to lend certainty to any such statement. The find was made in 1919, i.e. at a time when geologists were unaware of the fact that it is possible to find gyttja (or clay gyttja) from the Younger Dryas period. It is thus just as likely that the lower portion of the gyttja, overlying the Dryas clay, still belongs to the Younger Dryas period, and that the find may have its origin in this period.[1]

40. Ålstrup, Falling, 1948.

Found "in clay in a boggy hollow". The beam was found first, the brow tine shortly afterwards. Dr. J. Didriksen, the local general practitioner, took out two samples: (a) from the gyttja-containing layer of clay in which the beam was found, and (b) from the layer of sandy clay gyttja in which the brow tine was found. The pollen spectrum from sample b with its fairly high representation of *Juniperus*, *Empetrum*, and *Filipendula* obviously belongs to the close of zone III. As to sample a, comparatively few pollen have been counted; it is, however, clearly lacking in the characteristics distinguishing b, but may very well be ascribed to an earlier phase of zone III. The occurrence of *Plantago lanceolata* is no doubt due to contamination, although no other evidence of this was present. It would be reasonable to consider the find as originating from a late phase of zone III.

41. Hjorthede, E.S.E. of Viborg.

Found in a marl pit. Sample of clay gyttja from grooves in the antler. *Juniperus*, *Empetrum*, and *Dryopteris Linnaeana* would indicate an advanced phase of late-glacial time, zone II or zone III. The rather low *Betula* percentage makes zone III the more likely one.

A pollen analysis of the find was previously made by K. Jessen (Nordmann, 1936, p. 47), but at a time when counting of herb pollen was not yet common practice. Jessen could not, therefore, make any dating.

42. Fabjerg, Lemvig, 1955.

A sample of sandy clay gyttja was collected from the antler. As *Betula* occurs very sparsely and *Empetrum* abundantly, this spectrum must presumably be dated at zone III.

43. Tranebjerg, Samsö, 1924.

A sample of clay gyttja was collected from the antler. The entire sample was used for the count. *Dryopteris Linnaeana* indicates the close of zone II or zone III. The latter appears most likely.

76. Faurbo, Snertinge, 1920.

According to V. Milthers (1943, p. 149) this antler was found together with numerous bones of elk (*Alces alces*). The site in question had a bed of stony sand on which a 10—15 cm. layer of peat (mostly *Phragmites* peat), and above that an approximately 60 cm. thick layer of gyttja. The peat contained numerous bud-scales of *Populus tremula* and leaves of *Betula pubescens*, and the gyttja much bark of pine, a leaf of *Betula verrucosa* and a fruit of *Najas marina*. During the geological investigation some of the bones were still left in situ at the transition between peat and gyttja. Further away in the bog were found typical late-glacial strata.

It is fairly certain that both the peat and the gyttja are post-glacial, and the elk bones, too. From Knud Jessen's 1920-journal it appears, however, that the reindeer antler had been removed from the bog before his visit at the place, and there is no proof as to

[1] By a reinvestigation during the printing minute remains of clay gyttja were discovered in the brain-case. They yielded the following numbers of pollen grains: *Salix* 3, *Betula* 18, *Pinus* 9, *Empetrum* 2, *Gramineae* 15, *Cyperaceae* 18, *Rumex acet.* 2, *Artemisia* 5, *Chenopodiaceae* 1, *Urtica* 1, *Plantago media* 1. Six grains were presumed to be secondary or due to contamination. The sample is clearly late-glacial, and zone III is the only date possible.

where in the bog the antler has been found. Unfortunately the antler was cleaned completely. It is thus impossible to carry out any dating, and there is no real reason to accept V. MILTERS' view of post-glacial age.

80. Hove River, Nybölle, 1945.

The antler was found one or two m. down in gravel, which in turn was covered by one m. of peat. An accompanying sample of the overlying "peat" (actually a coarse detritus gyttja) could obviously be referred to the close of zone III, which of course merely signifies that the find is still older. There are no indications to rule out the assumption that the gravel may be late-glacial.

97. Svaleklint, Sejrö, 1902.

The antler was found in 1902 in peat that had been washed ashore. NORDMANN (1915, p. 8) refers to the find as post-glacial. The data, however, are so sparse that no conclusion can be drawn from them. The occurrence of late-glacial peat was unknown in 1915, hence NORDMANN's conception of the antler as post-glacial. In recent years late-glacial peat has indeed been found on the sea floor in Sejrö bay, so that the antler may very well be late-glacial.

NORDMANN has long since abandoned his original theory of post-glacial age.

110. Nellemose Mark, Langesö, 1936.

The antler was found in a marl pit on the margin of a deep bog. The site had an upper layer of about 16 cm. of peat, under which some 32 cm. of marl, in which the antler was found. Beneath the marl was clay. A sample from the antler (not in the table) was much contaminated by younger peat but had distinctly late-glacial characteristics, for instance pollen of *Helianthemum oelandicum* and spores of *Dryopteris Linnaeana*. No exact dating is possible.

127. Kolderupgård, Jelling, 1943.

The antler was found during drainage at a depth of $2^1/_2$ m. A small sample, extremely poor in pollen, was taken from the antler and examined by Dr. IVERSEN in 1943. Only nine pollen grains and one spore of *Dryopteris Linnaeana* were found. The piece is distinctly late-glacial, but a more exact dating cannot be established.

132. Trige Bærmose, Århus, 1944.

The antler was found during drainage at a depth of 1.5 m. in stoneless clay, and a sample of clay gyttja was taken from it. The sample proved to be contaminated by younger material, but was of a distinctly late-glacial character.

141. Söhjem, Östermarie, 1919.

A sample of clay gyttja from the antler was examined in 1958 by SV. JÖRGENSEN, Curator of the Department of Natural Science at the National Museum. The entire sample was used up during the counting. The most conspicuous feature in the pollen spectrum is the high percentages for *Pinus* and *Artemisia*, which in conjunction with the comparatively large amount of herb pollen is clearly indicative of zone III.

It is stated that the antler was found at the bottom of an approximately 1.25 m. thick layer of calcareous marl, which was overlain by about one m. of blue clay, on top of which was some 3 m. of peat and 0.5 m. of soil. The immediate impression is that the blue clay (presumably clay gyttja) derived from zone III and the calcareous marl from zone II. No definite conlustion, however, can be drawn from the available data as they do not give any information on the further sequence of layers. There is no evidence to exclude the possibility that both layers may stem from zone III. On the basis of the pollen analysis I believe that the find must date from zone III.

144 b. Thor West's Bog, Klemensker, 1882.

A sample of clay gyttja was taken from the cranium. The pollen spectrum is characterized by a moderate amount of *Betula*, comparatively much *Pinus* and *Artemisia*, and the occurrence of *Dryas*. This find can probably be ascribed to zone III.

145. Præstegårdsmosen, Klemensker.

A sample of clayey calcareous gyttja was taken from the antler. The presence of *Dryopteris Linnaeana* in the pollen spectrum is indicative of zone III or the close of zone II. Apart from this, the spectrum does not afford any clues. The occurrence of *Sambucus nigra* is probably due to contamination from dust. The same may apply in the case of *Centaurea Cyanus*.

149. Strangegård, Klemensker.

A sample of clay gyttja taken from a cavity in the lower jaw was used up during the counting. *Betula*, *Pinus*, and *Juniperus* are not very strongly represented in the pollen spectrum, but there is much *Artemisia* and a single grain of *Helianthemum oelandicum*. It all points to zone I or zone III, of which zone I may be the more likely.

150. Skinderbygård, Klemensker.

The antler appeared during peat-digging and, according to the available information, lay between the peat and the underlying "freshwater clay with glacial plants, partially submerged in it". The information is not very clear in that the antler is also said to have lain partly in the peat. It is likewise stated that there was no "bog marl" at this particular spot.

A sample from the nasal cavity is clearly late-glacial. The pollen spectrum exhibits comparatively little *Betula*, *Pinus*, and *Juniperus*, abundant *Gramineae* and *Cyperaceae*, but not much *Artemisia*. The spectrum presents no clear indicators, but seems to point to either zone I or zone III, perhaps most likely to zone I. According to the collecting data, zone III would appear the more likely. The remark about the lack of bog marl may possibly be construed to mean that the late-glacial sequence of layers is incomplete, and thus precludes a precise dating.

165. Knudegårdsmosen, Klemensker.

A sample of calcareous gyttja was taken from the antler. It was slightly contaminated, inter alia with *Plantago lanceolata*, for which reason the spectrum is not reproduced. The sample contained *Artemisia* and *Betula* in equal amounts, a fact that may be indicative of either zone I or zone III.

173. Lundegård, Olsker.

The spectrum from a sample of clay gyttja from the antler is not reproduced because it seemed somewhat contaminated. It was, however, distinctively late-glacial.

185. Bornholm's Museum, No. 190.

A sample of clay gyttja from the antler was used up during the counting. Neither *Betula* nor *Pinus* is strongly represented in the pollen spectrum, but there are many *Gramineae* and much *Artemisia*. The indications are either zone I or zone III, the latter perhaps the more likely.

186. Bornholm's Museum, No. 15.

A sample of clay gyttja was taken from the antler. The pollen spectrum shows fairly low percentages for *Betula* and *Pinus*, but rather high ones for *Gramineae*, *Cyperaceae*, and *Artemisia*. Two pollen grains of *Dryas* and one spore of *Dryopteris Linnaeana* were found. The spectrum points to zone I or zone III, perhaps mainly to zone III. The occurrence of *Sambucus nigra* is probably due to contamination from dust. No other definite signs of contamination are present.

210. Bornholm's Museum, No. 179.

A sample of clay gyttja taken from the antler was used up during the counting. The spectrum is fundamentally very similar to the two previous ones, even though both *Filipendula* and *Urtica* were found here, but no *Dryopteris Linnaeana*. The spectrum seems nevertheless to point to zone III.

Appearance and Survival of the Reindeer in Denmark, Southern Sweden, and Northern Germany

A perusal of the list of dated reindeer-finds in Denmark outside Bornholm (concerning Bornholm, see p. 140) will show that 32 are ascribed to zone III, 9 to zone II, and 8 to zone I, while 3 are considered glacial, and 3 either glacial or late-glacial. As already mentioned, the dating of several finds is more or less uncertain and cannot be accepted absolutely.

The greatest uncertainty in the dating concerns the nine finds ascribed to zone II. Four of them are estimated to belong to either zone III or the end of zone II, one (No. 15) is dated at the very beginning of zone II, and one (No. 22) at the transition between zone II and zone III. Of this group there are thus only three that can be ascribed with a greater measure of certainty to the Alleröd period proper. Two of these (Nos. 17 and 20) were found in Alleröd gyttja, but we do not know from what part of the gyttja. The last and most reliable Alleröd specimen (No. 18) originates from the culture-layer at the Bromme settlement, which contained many remnants of bones from elk (*Alces alces*), but merely two fragments of reindeer antlers (Degerbøl, 1946).

The distribution of the other dated finds is conspicuous in that the majority are referred to zone III. Even though a great many of these datings are demonstrably uncertain, there still remains a number of absolutely or practically certain finds, sufficient to dispel any doubts that the great majority of our dated reindeer-finds do indeed derive from zone III.

Only eight specimens have been referred to zone I. Two of these (Nos. 11 and 13) are open to some doubt, whereas the six others can with reasonable certainty be considered as belonging to this zone and its transition to zone II. No. 8 can be ascribed to this transition, and presumably also No. 15, which has been dated at the very beginning of zone II.

Of the six finds that may conceivably be older than late-glacial, most were found in a secondary position and none of them can be dated precisely. It appears likely that the reindeer lived in the ice-free region of Western Jutland during the maximum of the last glacial time. We have no proof, however, of this or of any still earlier occurrence.

For several reasons the available material does not enable us to form any immediate conception of the incidence of reindeer in the various sections of late-glacial time, even if the figures actually express the temporal and areal distribution of the finds.

The bulk of our reindeer-finds have appeared during excavations unassociated with scientific investigations. Some specimens derive from peat-digging where the interest is concentrated on the post-glacial peat, so that the late-glacial deposits, in most cases layers from the Younger Dryas period, are reached only occasionally. Numerous specimens have appeared during the laying of water mains and similar operations, where the upper late-glacial layers are more exposed to removal than the lower ones. The laying of foundations and digging for brick clay, on the other hand, often give occasion for digging through the entire late-glacial stratification.

The sections often show that the older late-glacial strata are not only of considerably less thickness than the younger ones, but also that they are sometimes missing entirely. In several cases the explanation is that the basins in the early phases of late-glacial time were filled with dead ice, and not until the melting of this could deposition begin. As stated above, gaps in the older parts of the stratification can sometimes be due to erosion.

As already mentioned, in that region of Jutland which was ice-free during the last glacial time, zone I was of longer duration and divisible into more sub-zones than in the rest of the country. Further, this part of the country is poor in freshwater formations and consequently in reindeer finds. In the northern and eastern parts of the country, which were ice-covered during the last glacial time, the duration of zone I generally decreased eastwards along the direction of the melting ice, and the melting of the ice occupied an increasing part of the period. In a great many cases this explains why zone I in those parts of the country, even in complete and undisturbed sections, is often of slight thickness as compared with zone III. This feature is indeed so striking that we must consider the zone I/II transition as not being synchronous all over the country. This fact is reflected in several of the southeastern Danish pollen diagrams in which the very short zone I is younger than, and only vegetationally corresponds to, the end of the same zone in the more westerly parts of the country.

In the light of these considerations it will be difficult to draw conclusions as to the difference in frequency from a comparison of dated finds from the zones I and III. It clearly appears that the reindeer was common in zone III. The number of finds from zone I is much smaller, but even if the reindeer be assumed to have been equally common in the two zones, there will, as demonstrated, always be greater possibilities for finds from zone III than from zone I—particularly in the southeastern part of the country, from where most of our finds derive. The only sure conclusion to be drawn is that the reindeer was of common occurrence in both zone I and zone III.

Although the number of certainly dated finds does not come up to what might be desired, I still think that the demonstrable infrequency of finds in zone II goes to show that the reindeer must have been rare in the Alleröd period.

The above reflections do not, as noted before, apply to Bornholm although many reindeer finds have occurred there. However, only 10 of them have offered opportunities for attempts at dating, and in but one case has it been possible to ascribe the find fairly certainly to a pollen zone (zone III). In at least two other cases zone III must be considered as very likely, five must be presumed to derive from either zone I or zone III, and one may originate from either zone III or the end of zone II.

Admittedly there are few dated finds from Bornholm, but they generally show the same tendency as the material from elsewhere in the country: Infrequent in zone II, frequent in zones I and III.

As will de discussed below, there might be reason for expecting the reindeer in zone II to have been commoner in Northern and Western Jutland than in other parts of the country. On this point, however, no conclusion can be drawn from the available material. There are, to be sure, a number of finds from Northern Jutland (Nörre Lyngby, for instance, is particularly well represented), but few of these have proved datable, and then invariably to zone III. Our material merely proves that the reindeer of the Younger Dryas period was common in North Jutland. As stated above, the pronounced infrequency of finds from that region of Jutland which was ice-free during the last glacial time is due primarily to the scarcity of late-glacial clay and gyttja in these generally sandy districts. It does not, however, afford grounds for believing that the reindeer was rare in Western Jutland in late-glacial time.

We have thus extremely few clues for any assumptions as to the former incidence of reindeer in Northern and Western Jutland.

In late-glacial and early post-glacial time Denmark was not separated in islands but formed part of a larger continuous territory, which also included Southern Sweden and Northern Germany. Information on the former occurrence of reindeer in our neighbouring countries is therefore of very great interest.

In several papers (1930, a and b, 1931, 1942) O. Isberg has discussed the reindeer's former range in Sweden, particularly in Scania. His procedure is similar to the one followed in this paper, and he has, like myself, had a very heterogeneous material to work on. He, too, has had to deal mainly with finds made many years ago the datings of which generally had to be based upon pollen analyses of single samples and, occasionally, of finds offering opportunities for pollen diagrams from the relevant locality and thus a more precise dating.

Isberg states (1930, a) that over 150 reindeer finds are recorded in Sweden, but few of them are datable. Of 32 carefully examined specimens he estimates 14 to be late-glacial ("arctic") and 18 to be post-glacial. Of the latter group 13 are dated at Boreal time (our zone V) and 3 at the transition between Boreal and Atlantic time (our zone VI). In subsequent publications he even dates a few specimens as late as the oak-mixed forest period.

It is indeed tempting to compare Isberg's results with those obtained here, especially because of the obvious discrepancies. However, as pointed out by Brorson-Christensen (1949), it is difficult to evaluate Isberg's analyses because of the progressive development within the field of pollen analysis since his results were published. Isberg paid no attention to berb pollen or secondary pollen and both of these groups are essential for determining whether a pollen spectrum is late-glacial or post-glacial, or from which late-glacial zone it dates.

As to Isberg's material, I am inclined to believe that some of the analyses ascribed to Boreal time must be late-glacial. He has, as far as I can see, in several instances based his datings mainly on secondary pollen types. The various cases, however, are not always discernible, and this applies especially to those specimens that Isberg considers to be the youngest, i. e. the very ones whose ages it would have been so very important to determine with certainty.

Nevertheless, it appears clear from Isberg's datings that in late-glacial time the reindeer was common in Southern Sweden, and Brorson-Christensen (1949) has demonstrated by pollen analysis that a more recent Scanian find dates from the Younger Dryas period. It has not, however, been possible to form any idea of the distribution within late-glacial time, and the question is still open as to whether the reindeer persisted in Southern Sweden after the end of late-glacial time, and if so, as to the duration of its existence.

In Northern Germany, too, the reindeer was common in late-glacial time, which has been demonstrated above all by the excavations of late-glacial cultures in Holstein undertaken by A. Rust in the 1930's. Among the specimens collected, reindeer antlers alone amount to over 100 from the Oldest Dryas period (corresponding to our pollen zone Ia) at Meiendorf and to over 1100 from the Younger Dryas at Stellmoor (Gripp, 1937, 1943), whereas these excavations do not appear to have discovered any specimens that are clearly datable to the Alleröd period. In recent years Rust has continued his excavations of other late-glacial settlements in the same area, and his latest publication (Rust, 1958, a)—in which W. Herre & H. Requate write on the bone material and R. Schütrumpf on the pollen-analytical examinations—contains data on several new reindeer finds, the number of which is, however, small as compared with the large discoveries from Meiendorf and Stellmoor. Among these specimens recently found, two or three are considered post-glacial and the rest late-glacial and ascribed to the Oldest Dryas, the Alleröd, and the Younger Dryas periods.

The finds referred to the Alleröd period and post-glacial time call for a more detailed study.

Herre & Requate state (p. 26) that the occurrence of reindeer in Schleswig-Holstein at any time after the Younger Dryas period was unknown previous to their discovery of reindeer bones in the material from the pre-Boreal, i. e. early post-glacial, peat from Poggenwisch. At the same site, however, is found material from the Oldest Dryas period, and the authors dare not rule out the possibility of an admixture from the latter material.

The same authors (p. 26) publish a faunal list from Hoffenbach in which are found reindeer, wild horse, and bison together with species, for instance pond tortoise, that are clearly post-glacial. The age is stated to be early to late mesolithic, which must be taken to mean post-glacial, but the authors emphasize that the animals represented were not coexistent. It appears from Rust's account of the locality in which the material was found (p. 121, ff.) that some of the reindeer at any rate were late-glacial, and there is no particular reason to assume the reindeer in the faunal list to have been post-glacial.

Schütrumpf has presented a pollen diagram from Borneck, and by fitting the relevant analyses into it he has dated several bones found separately at that place. Among the specimens are two vertebrae of reindeer dated at pre-Boreal time and the Alleröd period. The pre-Boreal specimen is an Atlas-vertebra found in gyttja, which Schütrumpf has dated at the end of his pollen zone V. According to Schütrumpf's diagrams, his zones V and VI cover our zone IV, but I am not convinced that, in the relevant diagram, the lower part of zone V is really post-glacial inasmuch as the sediment still shows traces of mineral material and has a fairly high percentage of herb pollen, and thus does not differ fundamentally from the vegetation of late-glacial time. This question could presumably be settled if the occurrences of *Juniperus, Populus, Filipendula,* and *Urtica* were known. It seems certain at any rate that the reindeer concerned must date from the early phases of pre-Boreal time, and in my opinion probably from its very beginning. So far this is the only definite proof of post-glacial occurrence of reindeer in North-western Germany and Denmark.

The vertebra which Schütrumpf (p. 12) has dated at the Alleröd period seems identical with the one mentioned by Rust (p. 89) as deriving from the Younger Dryas —at any rate, both of them have an arrow-hole. Schütrumpf's analysis from this vertebra appears to me to fit in just as well, if not better, at the upper border of the Alleröd or the beginning of the Younger Dryas.

Rust (p. 88) says that fifteen bones were dug out at Borneck from a culture-layer known as "the lower culture-layer" in Chamber III, and these bones seem to be identical with those referred by Herre & Requate (p. 25) to the Alleröd period and determined as reindeer, elk, and aurochs or bison. Although Rust repeatedly refers to this culture-layer as belonging to the Alleröd, his description of the site (p. 88) does not seem to make it clear whether the layer dates from the last phases of the Older Dryas or the beginning of the Alleröd. Seeing that this layer has given proof of the existence of not only reindeer but also of elk and bison or aurochs, the beginning of the Alleröd period would seem the most likely. Most of the fifteen bones are presumably from reindeer, but on this point nothing definite can be gathered from the text.

Finally, it is noteworthy that Rust's excavations at Pinnberg, near Ahrensburg, have unearthed a rib of reindeer which Schütrumpf (1958, b, p. 22) has dated at the transition from late-glacial to post-glacial time. Incidentally, the immediate replacement of the reindeer by red deer in pre-Boreal time seems to be a characteristic of this locality. On this point Requate (1958, b) remarks that nowhere in Holstein have bones of these two animals been discovered in the same layer.

The many reindeer finds that have come to light during Rust's excavations in Holstein nearly all originate from the Oldest and Younger Dryas periods. Of definitely dated specimens outside these periods there are but two from Borneck, of which one is pre-Boreal, and the other from either the beginning of the Alleröd or the end of the Older Dryas.

Whereas most Danish reindeer finds have come to light through random digging, the Holstein ones have appeared as the result of a systematical excavation of culture-layers, which have, incidentally, proved to stem almost exclusively from reindeer hunters of the Dryas periods. This explains why the German finds have been so numerous, but may on the other hand cause a certain distortion in the picture of reindeer occurrence in Northern Germany. In many ways, however, the Danish and German finds are complementary. From the earliest phases of the Older Dryas there are no reliably dated finds in Denmark, but many in Holstein. From the close of the Older Dryas and from the Alleröd the finds in Holstein are very scarce and uncertain, whereas some Danish finds definitely date from the end of the Older Dryas, and the excavation of the Danish Bromme settlement has proved that Alleröd man in this area was primarily a hunter of elk while reindeer as a quarry played no particular role. From the Younger Dryas period there are numerous finds both in Denmark and Holstein.

There is no discrepancy as regards the finds from Denmark and from Northern Germany. On the contrary, they exhibit a fundamental similarity and supplement each other very well. Between them they prove that the reindeer was common in this region during the entire Older Dryas period (we have no concrete knowledge, however, of its incidence in the short Bölling period, zone Ib), rare in the Alleröd period, and common once more during the whole of the Younger Dryas period. It was, moreover, the commonest of the larger mammals in the Dryas periods. At the close of late-glacial time it seems, broadly speaking, to have left the region, although a single specimen is known in Holstein from the beginning of post-glacial time. The largest number of finds both in Denmark and Holstein derive from the Younger Dryas period, but as already mentioned, this fact cannot justify any conclusion that reindeer must have been more frequent in the Younger than in the Older Dryas.

As stated above, these observations do not apply to Northern and Western Jutland where the finds are too few and too uncertainly dated for any real conception of the former incidence of reindeer.

It may be briefly mentioned here that Rust (1958, a, p. 138) has advanced the hypothesis that the reindeer of the Alleröd period was perhaps to be found in the region only in winter, and in summer moved farther northwards. In the zoological part of this paper, M. Degerbøl, too, discusses this idea. Our material from the Alleröd period is, however, too scanty to throw sufficient light on this problem.

We must assume that the reindeer lived in the ice-free regions during the maximum of the last glacial time. It seems to have been proved in the case of Northern Germany (according to Guenther, 1955, inter alia), whereas no proof exists in the case of Denmark.

Isberg is, as we have seen, of the opinion that in Scania, which is naturally an integral part of the Danish-North German region, the reindeer remained common far into post-glacial time, but that can hardly have been the case, even though a few roving animals from the north may occasionally have left their native range. If Isberg's idea is tenable, it would seem peculiar that no similar finds have been made in Denmark, which up to and during Boreal time was continuous with Southern Sweden, and which can, moreover, show many other finds of mammals from these periods.

The Late-Glacial Time and Its Mammalian Fauna

Our present knowledge of physical conditions in late-glacial time has in no small measure been enlarged by the finds of late-glacial mammals. Iversen's description (1945), for instance, of the conditions of life of the large herbivorous mammals in late-glacial time is based mainly upon pollen-analytical examinations on deposits at those sites in Denmark where bison has been found, and in his work on the late-glacial flora (1954) he has been able to utilize some of the pollen-finds that have resulted from the reindeer-datings described in this paper. The following review draws to a very great extent on the two works mentioned, to which the reader is referred for further details.

It is not surprising for the reindeer to have preferred the Dryas periods to the Alleröd period seeing that the former offered physical conditions similar to those in which the reindeer lives today, i.e. a predominantly subarctic climate and a vegetation dominated by herbaceous plants and shrubs, whereas the Alleröd was a forest period with a temperate climate.

Conditions have nevertheless differed somewhat, especially vegetationally, from those of the reindeer's present range; during the Dryas periods the climate was not uniform, climate and vegetation taking a course that varied to some extent in the different parts of our country.

As mentioned above, large districts in Western Jutland were ice-free during the maximum of the last glacial age while the rest of the country was covered by inland ice, and a full-arctic climate prevailed in the ice-free areas. Late-glacial time begins with an amelioration of the climate which causes an initial melting away of the ice from Jutland, and by degrees the entire country is becoming ice-free. It has been demonstrated geologically that the melting process was interrupted by several periods of stagnation, of which the longest was the one reflected in the moraines in Central Sweden and must be correlated with the Younger Dryas period. We know from pollen analysis that the three sub-zones into which the Older Dryas period in Western Denmark can be divided, have been rather diverse climatically. Zones Ia and Ib have both had a subarctic climate, zone Ib, however, distinctly milder than Ia. The inference is that the ice-recession in zone Ia was moderate, in zone Ib fairly strong. Zone Ic, the coldest of the three sub-zones, had an arctic climate and must represent a period of stagnation in the ice-melting process. The temperate Alleröd climate must undoubtedly have made Alleröd the predominant ice-melting period in late-glacial time, whereas the Younger Dryas was characterized by a subarctic climate and, as mentioned before, represents a period of stagnation. Not until the end of the Younger Dryas period did the melting of the huge ice-cap, which still covered the bulk of Scandinavia and Finland, really gather way. We have no definite knowledge as to when the eastern parts of Denmark were freed of the inland ice.

In pollen diagrams from the south-eastern parts of Denmark, the Older Dryas period is represented solely by zone Ic, which in point of time and climate—at any rate in its final phase—seems to correspond to the beginning of zone II further west. This may be an indication that South-eastern Denmark did not become ice-free until the beginning of the Alleröd period, though it may possibly have happened during the Bölling period, zone Ib.

The late-glacial vegetation has changed concurrently with the erratic climatic course and the corresponding spasmodic melting of the ice so that the landscape by turns took on the aspect of treeless tundra, park tundra, and forest. Tundra and park tundra were the prevailing forms of vegetation during the Dryas periods, whereas forest could thrive only in the more favourable climate of the Alleröd period.

The tundra vegetation was dominated by herbs, grasses, and *Cyperaceae*, but was rich in shrubs, too, especially in dwarf birch and willow. The park tundra (the term introduced by IVERSEN) was a transitional stage between tundra and forest, an open grass and brush land with low, scattered bushes of broad-leaved birch and juniper in addition to the tundra's small shrubs. The late-glacial forest was fairly open, so that herb vegetation still played a great role, and brushwood, particularly juniper and willow, was quite common. Apart from Bornholm, where the Alleröd forest appears to have consisted almost entirely of pine, the birch was practically everywhere in Denmark the most conspicuous tree, whereas pine seems to have been of no importance. However, southward from Holstein it was prominent in the later part of the Alleröd.

These three types of vegetation were not, of course, sharply defined but presented gradual transitions. The pollen diagrams tell us that throughout late-glacial time the vegetation in West and North Jutland was more open and more dominated by herbs than in the south-eastern parts of Denmark, a circumstance which in itself makes for sliding transitions in vegetational types from N.W. to S.E. The Alleröd forest has consequently been at its densest and strongest in South-eastern Denmark while the landscape in Northern Jutland at that time was characterized rather by park tundra. Correspondingly, the Younger Dryas period saw park tundra in South-eastern Denmark and tundra in Northern Jutland. We must assume that tundra dominated the landscape during the greater part of the Older Dryas period, apart from the Bölling period, which probably had park tundra.

As appears from this general outline, the late-glacial time was characterized by a more or less pronounced paucity in trees, and the herbs had consequently very favourable conditions as regards light in the same way as applies today in the arctic and subarctic regions of the northern hemisphere. However, the arctic and subarctic vegetation in Scandinavia is generally rather monotonous and poor in species, widely characterized by acidophilous plants, and with ericaceous heaths playing a large part. A perusal of our pollen diagrams will show the vegetation in late-glacial time to have been richer in herbs and grasses while acidophilous plants played no outstanding role; on the contrary, calciphilous plant species dominated, *Empetrum* being the only calcifuge plant of some importance — and only during the later phases of the late-glacial time. The whole pattern of species exhibits greater similarity to the alpine flora of Central Europe than to that of Scandinavia, and among the numerous heliophytes, a distinctive feature of late-glacial time, is found an element of now existing Eastern and South-eastern species (*Ephedra, Helianthemum oelandicum, Hippophaë,* etc.), which in conjunction with the abundant occurrence of *Artemisia* indicate dry and sunny summers.

The soil was presumably unstable and affected by solifluction during the entire late-glacial time, particularly in the Older Dryas period. It has likewise, especially in the early late-glacial time, remained unaffected by leaching and by any former vegetation. This particular kind of soil favoured such open vegetation of pioneer plants as characterizes the early phases of late-glacial time, and that also explains why acidophilous plants played but an insignificant part. The fact that *Hippophaë, Helianthemum,* and *Dryas* were common at the beginning of the late-glacial time and later replaced by *Empetrum* must no doubt be due to a progressive leaching which has soured the soil.

Even though our knowledge of the late-glacial fauna is by no means complete, it is unquestionable that the late-glacial time with its open land and abundant vegetation of grasses, herbs, and shrubs was a favourable period for large mammals, more particularly the herbivorous ones. As mentioned above, the reindeer was the commonest and must be considered the animal most representative of the Dryas periods. The bone material from the Bromme settlement constitutes one of the reasons for believing that elk (*Alces alces*) must have been the commonest large animal in the open birch forests of South-eastern Denmark during the Alleröd period. It is, on the other hand, quite conceivable that the reindeer was common also during the Alleröd period in North-western Jutland where the climate was less favourable, but this is a point on which we are not yet sufficiently well informed. In this context it may be mentioned that in late-glacial time the reindeer was found in Ireland, too, where it seems, however, to have been most frequent in the Alleröd period, like the giant deer (Mitchell, 1941, Mitchell & Parkes, 1949). During that period the climate in Ireland, like that in Northern Jutland, was less favourable than in South-eastern Denmark.

Several finds of giant deer (*Megaloceros giganteus*) have been made in Denmark (cf. Degerböl, 1952), and of these at least three from recent years are late-glacial. There are two finds from Scania, of which one is late-glacial, the other of uncertain age (Berlin & Mohrén, 1942). Attempts at definite datings of the Danish finds have been successful in only two instances, both belonging to the Alleröd period.[1]

The assumption that the giant deer had lived in glacial and inter-glacial time only has been discarded in consequence of more recent investigations, especially by Mitchell & Parkes (1949), which have proved that the giant deer was representative of the late-glacial time in North-western Europe. There are a great many finds from Ireland and some from England, and Mitchell & Parkes have demonstrated that nearly all the Irish ones are late-glacial, the great majority from the Alleröd period, and that a considerable percentage of the English specimens are likewise late-glacial, while others are supposed to be inter-glacial.

Of other large mammals to be mentioned specially are bison and wild horse. The former lived in Denmark at the end of the Younger Dryas period and in pre-Boreal time (Degerbøl & Iversen, 1945), while the latter is known from the transition between late-glacial and post-glacial time (Iversen, 1934), probably also from the Alleröd period (Degerbøl, 1946); in addition to these is known a late-glacial, but not precisely dated, specimen (Nordmann, 1944). In recent years, and thanks to Mr. Sv. P. Svenningsen of Ö. Svenstrup, we have received from Northern Jutland several specimens of bones of horse, some of which at any rate seem to derive from wild horse. The specimens have not been precisely dated yet, but the provisional pollen-analytical examination indicates that they originate from the end of late-glacial time.

The aurochs (*Bos primigenius*), too, probably lived in Denmark at the close of late-glacial time or at the transition from late-glacial to post-glacial time. The evidence consists in an old find from Fåborg, Funen.[2]

Finally may be mentioned finds of bear, wolverine, and beaver from the Alleröd, and of wolf, mountain hare, and suslik (*Citellus rufescens*) from the Younger Dryas period.

With the close of late-glacial time the forest moves into the country in no uncertain way, but it has probably not been much denser in the opening phase of post-glacial time than in the Alleröd period, so that conditions of life remained favourable to the large mammals. The reindeer seems to have disappeared very soon, whereas the bison held out for some time. Of the large animals, the elk no doubt was the commonest, but also aurochs, red deer, and bear ranged the country in pre-Boreal time.

[1] One of these is from Funen, the other from South-Western Zealand near the Holsteinsborg estate and has been briefly commented upon by Degerbøl (1952). The material was found in 1948 and comprised bones from three animals, one adult and two calves. Mr. U. Möhl and the author participated in the excavation of the site, from which we took pollen samples and were enabled to prove that the bones originated from Alleröd gyttja. Only a few of the pollen samples have been examined so far.

[2] This find, which consists of a particularly large cranium with horn-cores, is discussed and well depicted by H. Winge (1904, p. 289, pl. XIII, fig. 2). The hollows of the cranium yielded abundant material of clay gyttja, from which I took two samples in 1948: (a), from the skull and (b), from a cavity at the occipital condyle. The corresponding pollen spectra are shown at the bottom of Table 17, marked Ua and Ub. They can both be dated definitely at zone III. Sample b with its large contents of *Juniperus*, *Empetrum*, and *Filipendula* is clearly from the final phase of zone III. Sample a, too, must be ascribed to the late part of this zone on account of the fairly frequent occurrence of *Empetrum* and *Filipendula*.

The Holstein finds tell us that during the Dryas periods the reindeer there was contemporaneous with several of those mammals which in Denmark are known only from the Alleröd period and post-glacial time, thus in the Younger Dryas period lynx and wild boar. These and other mammals must be assumed to belong also to the late-glacial fauna in Denmark, for which reason new and interesting mammal finds may be expected.

A List of Plants Determined by Pollen-Analysis

As mentioned above, some pollen and spore types have been left out from the seven accompanying pollen diagrams, either because they were of no dating-significance or because they were found in very small numbers. The most important of these types are enumerated in the following list. The main reason for not including all the finds in this list is that I hope to publish the pollen-analytical results later in another context. For the same reason I do not subject these finds to a discussion here.

Some of the determinations have been substantiated by microphotographs, and in such cases the photo relevant to a pollen grain has been indicated by the letters DGU a, followed by a number, e. g. DGU a 574.

A considerable number of the pollen and spore finds given here appear in the list of determined late-glacial vascular plants published by Iversen (1954).

The place-indications in this list correspond to those given in the seven diagrams, and derive from the following reindeer finds: No. 8, Herlev, No. 15, Copenhagen, No. 26, Valby, Helsinge, No. 27, Holbæk—all from Zealand. No. 33, Orenæs, Falster, No. 35, Odense, Funen, and No. 37, Skröbelev, Langeland.

Astragalus alpinus. A few pollen grains in all three late-glacial zones in the five diagrams from Zealand and Falster. A continuous curve is indicated at only a few places (see the diagrams from Copenhagen and Valby). Several pollen grains have been photographed.

Astragalus cf. *arenarius*. Zone I (Herlev, 370 cm, DGU a 412), zone II (Copenhagen, 410 cm, DGU a 385).

Cf. *Bartsia alpina*. Zone I (Copenhagen, 450 cm, DGU a 1172), zone II (Herlev, 335 cm, Copenhagen, 380 cm) and zone III (Orenæs, 105 cm).

Botrychium cf. *Lunaria*. A few spores of sporadic occurrence in all three late-glacial zones.

Bupleurum cf. *falcatum*. Zone II (Copenhagen, 380 cm, DGU a 913, 415 cm, DGU a 1162, Valby, 290 cm).

Caltha palustris. Zone II (Copenhagen, 330 cm) and zone III (Herlev, 250 cm).

Campanula sp. Zone I/II (Orenæs, 160 cm) and zone III (Valby, 260 cm, Skröbelev, 95 cm).

Chamaenerion angustifolium. Zone II (Valby, 292 cm, 300 cm, Orenæs, 140 cm) and zone III (Orenæs, 75 cm).

Epilobium sp. Zone I/II (Orenæs, 160 cm) and zone II (Valby, 290, 292, and 295 cm).

Ephedra distachya s.l. Zone I (Copenhagen, 450 cm), zone I/II (Herlev, Sample b from antler), zone II (Copenhagen, 360 cm), and zone III (Holbæk, 110 cm, Orenæs, 60 cm).

Ephedra strobilacea-type. Zone I (Orenæs, 165 cm) and zone III (Valby, 250 cm and from antler-sample).

Gentianella cf. *Amarella s.l.* Zone III/IV (Orenæs, 53 cm).

Melampyrum sp. Zone II (Orenæs, 133 and 135 cm).

Ophioglossum vulgatum. Zone IV (Copenhagen, 290 cm).

Parnassia palustris. Zone I (Copenhagen, 450 cm, DGU a 72, Odense, 48 and 60 cm), zone II (Copenhagen, 425 cm, DGU a 452, Valby, 300 cm), and zone III (Valby, 270 cm).

Plantago major. Zone II (Copenhagen, 420 and 425 cm) and zone III (Orenæs, 130 cm).

Plantago media. Zone I (Herlev, 340, 360, and 370 cm, Odense, 54 cm), zone II (Herlev, 335 cm, Copenhagen, 430 cm), and zone III (Herlev, 250 cm).

Pleurospermum austriacum. Zone I (Copenhagen, 450 cm, DGU a 912) and zone III (Orenæs, antler-sample).

Polygonum aviculare. Zone III (Orenæs, 125 cm).

Polygonum Bistorta vel viviparum. Zone III (Herlev, 265 cm).

Polypodium vulgare. Zone III (Orenæs, 155 cm).

Prunus Padus. Zone II (Copenhagen, 430 cm, DGU a 352) and zone III/IV (Holbæk, 80 cm, DGU a 523).

Sanguisorba minor. Zone I (Odense, 54 cm), zone I/II (Herlev, sample a from antler, DGU a 382), and zone II (Copenhagen, 415 cm, DGU a 163, Valby, 292 cm).

Sanguisorba officinalis. Zone II (Valby, 286 cm, Orenæs, 140 cm) and zone III (Valby, antler-sample).

Saussurea alpina. A few pollen grains of sporadic occurrence in all three late-glacial zones.

Sedum sp. Zone II (Valby, 314 cm) and zone III (Valby, 250 cm).

Solanum Dulcamara. Zone II (Copenhagen, 370 cm, DGU a 121, Holbæk, 130 cm, DGU a 574).

Tofieldia sp. Zone I (Copenhagen, 445 cm, DGU a 33), zone II (Valby, 320 cm), and zone III (Holbæk, 85 cm, DGU a 563).

Typha latifolia. Zone II (Orenæs, 155 and 158 cm).

Utricularia cf. *vulgaris.* Several pollen grains from the beginning of zone IV (Holbæk, 77.5, 75.5 and 73 cm, DGU a 512).

Valeriana officinalis aggr. Zone II (Orenæs, 145 cm).

Summary

This work is an account of attempts that have been made to obtain as far as possible a pollen-analytical dating of reindeer finds in Denmark. Most of the specimens examined have been kept in museums for a number of years, and their datings have been based on pollen samples from the individual specimens. All the relevant spectra are listed in a table, pp. 152—153. Several of the more recently discovered pieces, however, have presented opportunities for a geological investigation of the site concerned and for an immediate collection of material for pollen diagrams. The datings of such specimens are the most reliable. A few finds have been dated solely on the basis of geologico-stratigraphical data on the sites. Each of the datings undertaken by the author is commented on in the section "Dating of the Reindeer-finds", pp. 124—138.

The investigations have, as their main result, demonstrated that nearly all our reindeer finds must originate from late-glacial time. Only a very few may be older, and none are known from post-glacial time. The reindeer must be assumed to have lived in the ice-free areas of Western Jutland during the maximum of the last glacial time, but we have no proof of this or of any earlier occurrence.

The majority of the dated finds have been ascribed to the Younger Dryas period, and comparatively few, in about equal numbers, to the Older Dryas and the Alleröd periods. A critical study, however, will show that only three finds can be referred to the Alleröd period proper with practical certainty, and the data concerning two of these are meagre. For various reasons the opportunities for finding bones are greater in the younger than in the older deposits of late-glacial time, in consequence of which the small number of finds from the Older Dryas period affords no ground for assuming that the reindeer was rarer in the Older than in the Younger Dryas period. It must be presumed that the reindeer was common in the Older as well as in the Younger Dryas period, but rare in the Alleröd period. In the Dryas periods the reindeer was the commonest of our large mammals.

The many reindeer remains that have appeared in consequence of Rust's archaeological excavations in Northern Germany (the Hamburg area) exhibit a fundamental temporal concordance with the Danish specimens, and the finds from the two regions supplement each other very well. A single reindeer find from the beginning of post-glacial time has been made in Northern Germany (Schütrumpf, 1958, a).

A fairly comprehensive material of reindeer finds from Southern Sweden, especially Scania, dated by Isberg (1930—1942) does not lend itself to a critical evaluation because his pollen analyses are outdated. According to Isberg the reindeer was common in Scania far into post-glacial time, and he has even dated a few finds to Atlantic time. Some of Isberg's datings at any rate are incorrect.

The text also mentions a few not previously published datings of other animals than reindeer: *Alces alces* from zone IV (p. 129, No. 15), *Bos primigenius* from the close of zone III (p. 147, footnote 2), and *Perca fluviatilis* from zone II (p. 128, No. 15, p. 132, No. 29).

POLLEN DIAGRAMS

The diagrams are divided into three or four parts, each one corresponding analysis by analysis. All pollen grains and spores from terrestrial plants are included in the total, on which the percentage calculation for all pollen and spore curves in Parts A and B of the diagrams is based. In Part C the *Sphagnum* spores are included in the total, in Part D the rebedded pollen is included.

A. Main diagram, showing the proportions between the pollen originating from trees and shrubs (white area), herbaceous plants (hatched area) and ericaceous plants, chiefly *Empetrum* (dotted area).

B. Curves and silhouettes for the more important plants included in the total curves for "trees and shrubs" and "herbs" in A.

C. The percentage of *Sphagnum* (only shown in some of the diagrams).

D. The percentage of rebedded pollen.

n Total = Pollen total.

The zonal division is given on both sides of the diagrams.

TABLE

No. in text	Salix	Betula	Pinus	Juniperus	Populus	Hippophaë	AP %	Caryophyllaceae	Chenopodiaceae	Compositae: Artemisia	Compositae: Tubuliflorae	Compositae: Liguliflorae	Cyperaceae	Dryas	Ericales: Calluna	Ericales: Empetrum	Ericales: Ericales, unspec.	Filipendula	Galium	Gramineae	Helianthemum oeland.	Leguminosae	Plantago maritima
12a . . .	4.4	29	12	1.7	—	—	48	—	—	3.1	—	—	32	—	—	—	0.3	0.7	1.0	13	1.4	—	—
12b . . .	7.7	33	11	2.2	—	—	55	—	0.9	3.1	—	—	26	—	—	—	—	0.3	0.9	12	0.9	—	0.3
12c . . .	7.0	44	8.8	1.8	0.4	—	62	0.4	0.7	1.5	—	0.4	20	—	—	—	—	—	0.7	13	0.4	—	—
12d . . .	4.8	33	12	2.9	1.0	—	55	—	—	1.4	—	—	23	—	—	—	0.5	—	1.0	15	1.4	—	—
13	6.9	38	13	0.5	—	0.2	59	0.2	0.2	1.1	—	0.2	26	—	—	0.2	—	0.5	0.3	10	—	—	—
16	16	45	5.5	0.6	—	—	67	0.3	0.3	2.2	0.3	—	13	—	—	0.3	—	—	—	14	—	—	—
19	3.9	48	13	—	—	0.2	65	0.2	0.7	1.7	0.2	—	17	—	—	0.4	—	0.2	—	12	—	—	—
21	2.7	50	23	—	—	—	76	—	—	—	—	—	12	—	—	—	1.3	—	—	7	—	—	—
24	8.5	31	8.5	—	—	—	48	1.9	—	5.1	—	0.9	13	—	—	—	—	—	—	23	—	—	0.9
25	4.8	15	18	1.0	—	—	39	—	0.3	2.4	0.3	—	37	—	0.3	—	—	—	0.7	11	—	0.3	—
28	3.9	21	15	1.1	—	—	42	—	0.6	1.7	—	—	40	—	—	0.6	—	2.0	0.3	12	—	—	—
30	3.6	11	12	3.6	—	—	30	—	—	0.5	1.0	—	48	—	—	—	—	0.5	—	15	—	—	—
31a . . .	4.1	37	19	—	—	—	60	0.6	—	3.0	—	—	20	—	—	0.6	1.2	—	—	14	0.6	—	—
31b . . .	7.7	40	13	0.6	—	—	61	0.3	—	4.0	—	—	18	0.3	—	1.4	—	—	0.3	13	0.3	—	—
31c . . .	4.1	38	17	1.7	—	—	60	—	—	4.5	—	—	20	—	—	2.4	—	—	0.7	12	—	—	—
32	3.3	14	14	3.3	—	—	35	0.4	0.4	0.4	0.8	0.4	14	—	—	1.3	—	—	—	33	—	0.4	—
34a . . .	6.1	30	20	0.8	—	—	56	0.3	0.5	2.4	1.3	0.3	24	—	—	0.5	—	0.3	—	11	—	—	—
34b . . .	6.0	29	16	1.0	—	—	53	0.5	1.3	4.7	0.8	—	21	—	—	1.3	0.5	—	—	14	—	—	—
38	1.2	22	14	?	?	—	37	—	0.4	0.8	0.4	0.4	51	—	—	1.2	—	—	—	8	—	—	—
40a . . .	5	35	9	1	—	—	51	—	—	2	—	—	26	—	—	1	—	—	—	16	1	—	—
40b . . .	4.4	42	8.2	7.7	0.5	—	62	—	—	2.2	—	—	7.7	—	—	2.2	—	6.6	1.1	16	—	—	—
41	3.5	32	3.2	2.2	—	—	40	—	0.6	1.0	0.3	0.3	34	—	—	1.6	—	—	—	19	—	—	—
42	9.0	9.9	5.1	0.9	—	—	25	1.2	0.2	0.3	2.0	—	32	—	—	6.3	—	—	0.5	33	—	—	—
43	5.0	44	7.0	0.4	—	—	56	—	—	2.1	0.4	—	24	—	—	0.8	—	—	—	14	—	—	—
141	2.4	15	35	1.9	1.0	—	54	0.5	2.9	8.3	1.0	0.5	14	—	—	—	—	—	—	18	—	—	—
144b . . .	7.2	20	24	2.7	—	—	54	—	1.0	9.2	0.2	—	21	0.2	—	0.5	—	0.5	0.5	11	—	0.5	—
145	7.6	25	23	1.5	—	—	57	—	0.4	1.9	—	—	12	—	—	—	—	0.6	0.2	24	—	—	0.4
149	8.3	22	14	0.8	—	—	46	—	0.4	9.1	—	—	16	—	—	0.8	—	—	—	27	0.4	—	—
150	1.5	17	12	0.4	—	—	31	0.2	—	2.5	0.6	—	21	—	0.4	0.2	—	0.4	—	43	—	0.4	—
185	2.9	18	17	—	—	—	38	0.3	—	7.3	0.6	—	15	—	—	—	—	—	—	38	—	—	—
186	3.0	16	13	0.3	—	—	32	—	0.9	6.9	0.6	0.3	15	0.6	—	—	—	—	—	41	—	—	—
210	5.7	20	19	3.3	—	—	48	—	2.5	6.6	—	—	16	—	—	0.8	—	0.8	—	22	—	—	—
Ua	4.1	34	14	1.4	—	—	54	—	—	1.7	—	—	16	—	—	2.4	—	1.4	—	20	—	—	—
Ub	5.3	34	8.3	6.9	—	—	55	—	—	1.5	—	—	20	—	—	2.1	—	2.6	—	14	0.2	—	—

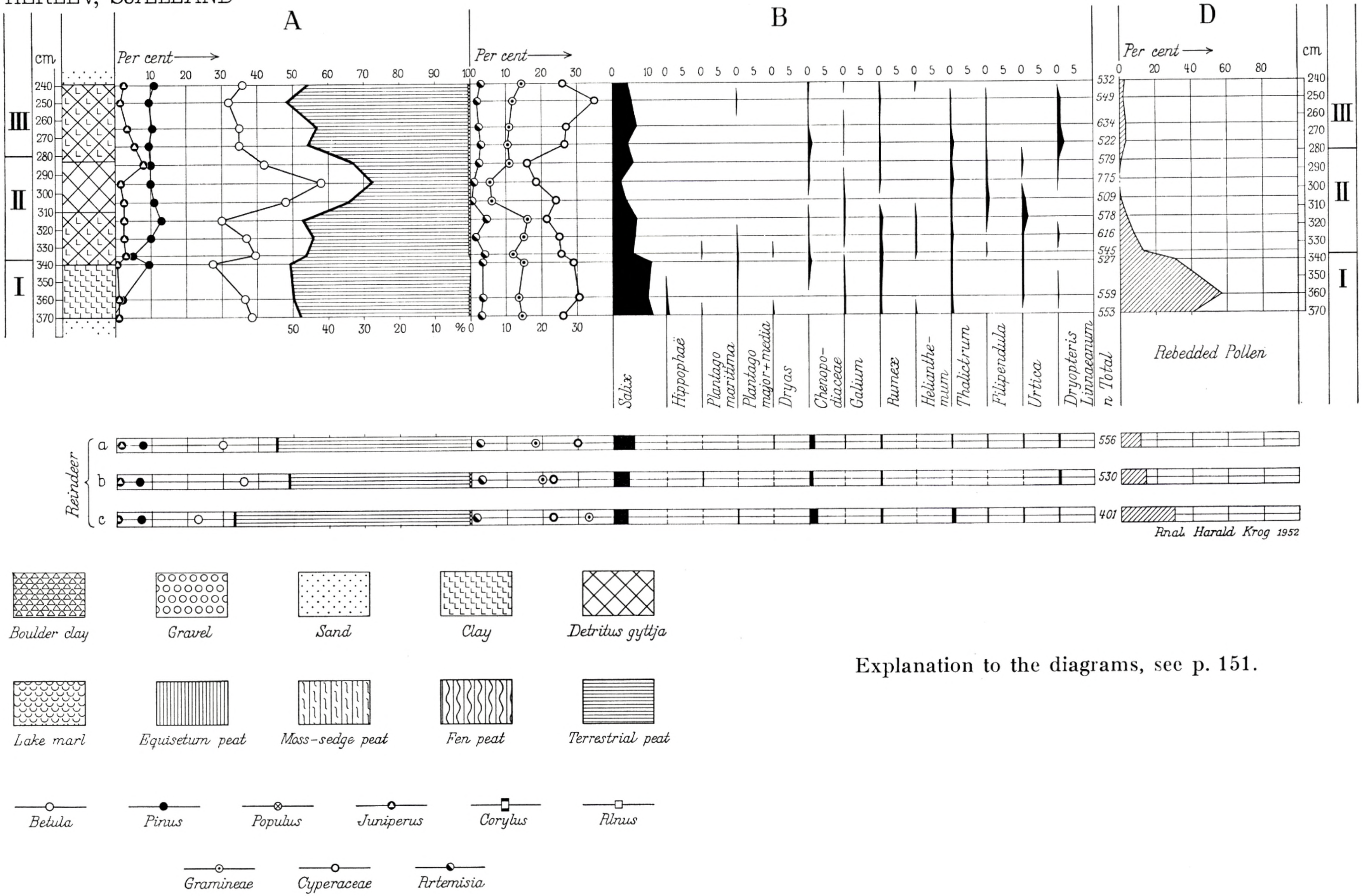
Pollen analyses. The reliability is varying. In a few cases contamimination is evident. Cf. the text.

17.

Rumex acet.	Thalictrum	Umbelliferae	Urtica	Botrychium	Dryopteris Linnaeana	NAP %	n Total	Menyanthes	Myriophyllum spicatum	Potamogeton	Potentilla	Ranunculaceae	Typhaceae	Lycopodium annotinum	Selaginella selagin.	Sphagnum	Rebedded pollen	
0.3	0.3	—	—	—	—	52	293	—	0.7	7.5	—	0.3	—	—	—	0.3	5.4	
0.6	0.6	—	—	—	—	45	323	—	0.6	7.1	—	1.2	—	—	—	0.9	2.8	
0.4	—	—	—	—	—	38	272	—	1.1	4.4	—	—	—	—	—	0.4	2.6	
0.5	—	0.5	—	—	—	45	209	—	0.5	5.7	1.0	—	—	—	—	0.5	2.4	
0.3	0.3	0.7	0.3	—	0.2	41	611	0.2	0.2	—	0.5	0.2	0.2	—	0.7	0.3	3.0	Geum sp. 0.3
—	—	—	—	0.3	2.2	33	325	—	—	—	—	—	—	0.6	—	0.3	2.7	
—	0.4	0.2	0.2	—	2.0	35	460	0.7	—	—	0.4	—	—	—	—	1.1	6.1	
—	—	—	—	—	4	24	75	—	—	—	—	—	—	—	—	19	29	
—	—	—	—	—	7.7	52	117	—	—	—	—	0.9	0.9	—	—	0.9	7	Plantago lanc. 0.9; Epilobium 0.9
0.3	0.3	—	—	0.7	7.1	61	294	—	—	0.7	0.3	0.3	0.7	—	—	1.4	29	
—	0.3	—	—	—	0.3	58	359	—	—	—	—	—	0.3	0.3	0.3	1.1	1.4	Crucifer 0.3
—	2.1	0.5	1.0	0.5	0.5	70	193	—	—	—	—	—	—	—	0.5	2.1	2.5	
—	—	—	—	—	—	40	169	—	—	—	—	—	—	—	—	—	10	Saxifraga opposit.-typ. 0.6
0.3	0.3	0.3	—	—	0.3	39	349	—	—	—	—	0.3	0.3	—	—	1.2	10	Plantago media 0.3
—	—	—	—	—	—	40	292	—	0.6	—	—	—	—	—	—	0.3	10	
—	0.8	0.4	—	—	12	65	239	—	—	—	—	—	—	—	0.4	2.9	8	Saussurea 0.4
—	0.3	—	—	—	2.9	44	376	—	—	0.3	—	—	—	—	0.5	1.6	17	Crucifer 0.3; Saussurea 0.3
—	0.5	—	—	—	2.6	47	386	—	—	—	—	—	—	0.8	—	1.0	16	Astragalus alpina 0.3
—	—	0.4	—	0.4	0.4	63	251	—	—	—	—	—	—	—	—	0.4	8	Helianthemum numm. 0.4
—	—	1	—	—	—	49	96	—	1	60	—	—	—	—	1	2	16	Plantago lanc. 1
—	0.5	—	—	—	1.1	38	183	—	—	—	—	1.6	—	—	0.5	—	6.1	
0.6	0.3	0.6	—	—	1.0	60	314	—	5.7	—	—	0.6	—	—	—	—	5.4	
—	0.2	—	—	—	—	75	666	—	1.4	—	0.2	0.8	—	—	—	0.6	1.0	Myriophyllum altern. 0.2; Campanula 0.2
—	0.8	—	—	—	1.7	44	241	—	—	—	—	—	—	—	—	—	1.6	
0.5	0.5	—	—	—	—	46	206	—	—	—	—	2.9	—	—	4.4	—	0.5	Papaver 0.5
0.5	0.2	—	—	—	—	46	415	—	—	—	—	—	—	—	0.2	0.2	0.5	Trollius 0.2; Geum 0.2
1.3	0.6	0.4	—	0.2	0.6	43	537	—	—	0.2	—	0.2	—	—	0.4	1.3	0.6	Centaurea Cyanus 0.2; Ephedra strobil.-typ. 0.2; Nymphaea alba 0.2; Parnassia 0.2; Sambucus nigra 0.9
—	—	0.4	—	—	—	54	253	—	—	—	0.4	—	—	—	2.4	—	0.4	Crucifer 0.4
0.2	0.2	—	—	—	—	69	477	—	1.5	—	0.2	1.0	—	—	0.2	0.2	0.6	Crucifer 0.4; Polygonum Bistorta 0.2
0.3	—	0.3	—	—	—	62	316	—	—	—	0.3	—	—	—	—	0.3	2.5	
2.7	—	—	—	—	0.3	68	332	—	—	—	0.6	—	0.3	—	2.4	0.3	1.5	Sambucus nigra 0.3; Saussurea 0.3; Saxifraga opposit.-typ. 0.3
0.8	1.6	0.8	0.8	—	—	52	122	—	—	—	—	2.5	—	—	1.6	0.8	0.8	Astragalus alpina 0.8; Lycopodium clavatum 0.8
0.3	—	1.4	—	—	2.1	46	290	--	1.0	—	—	2.8	2.8	—	—	—	1.4	
—	—	0.3	—	0.2	3.8	45	580	—	1.5	0.2	0.3	4.7	1.7	—	—	0.5	0.5	Ophioglossum 0.2

No. 8

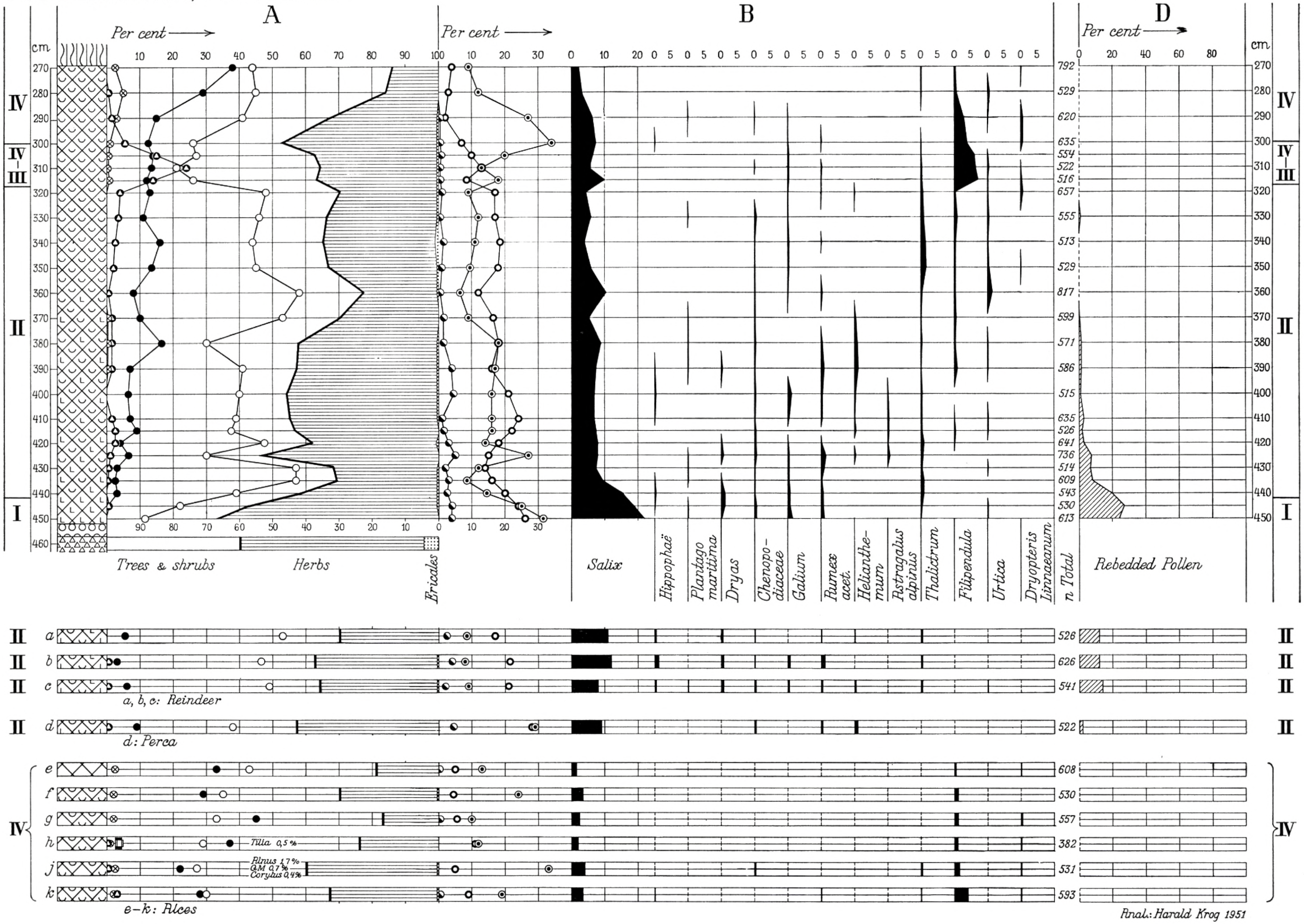
HERLEV, SJÆLLAND

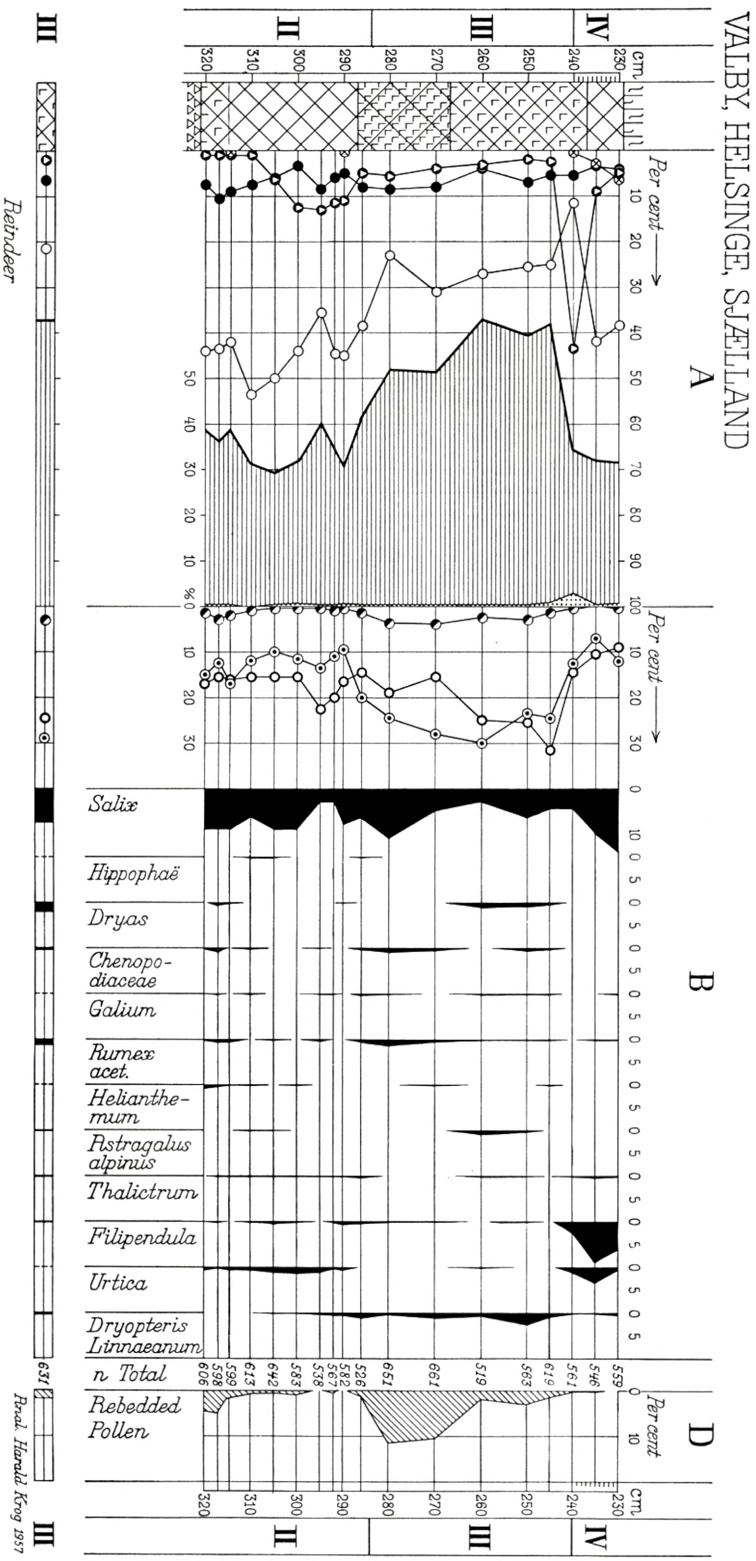


Explanation to the diagrams, see p. 151.

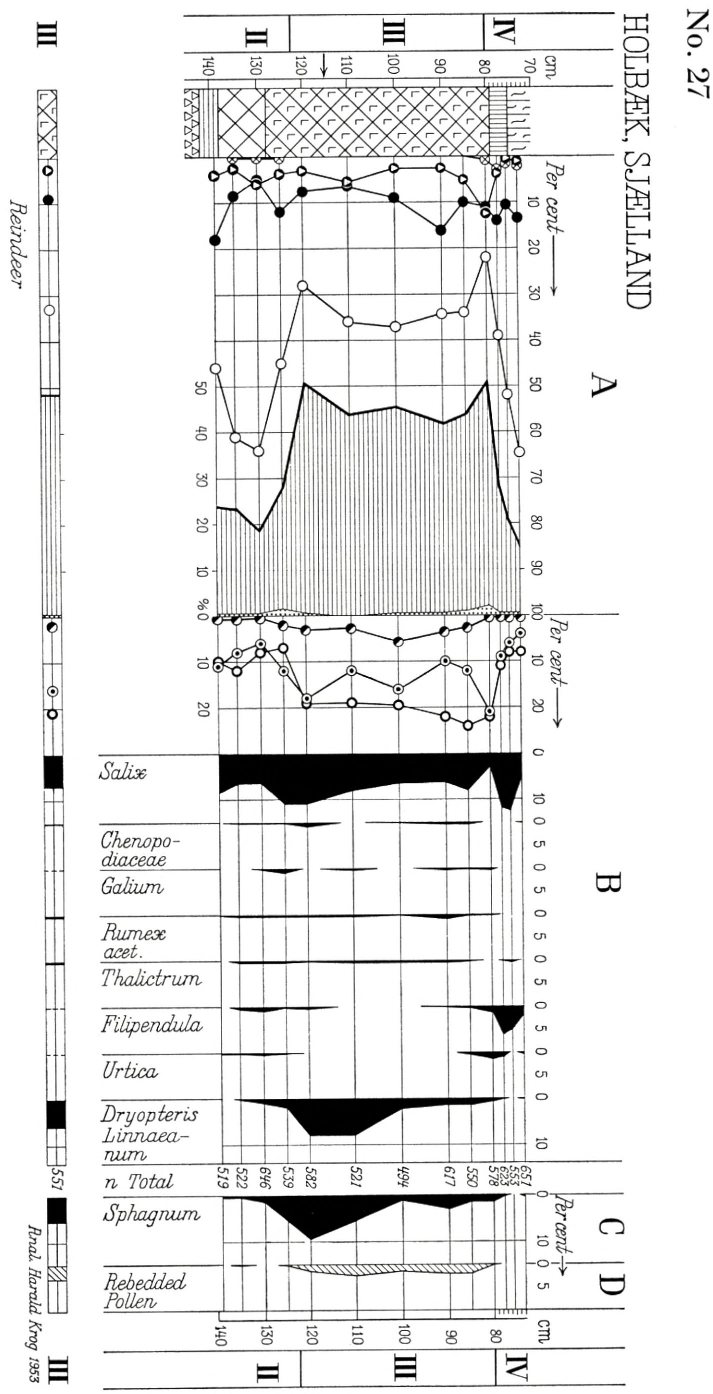
No. 15

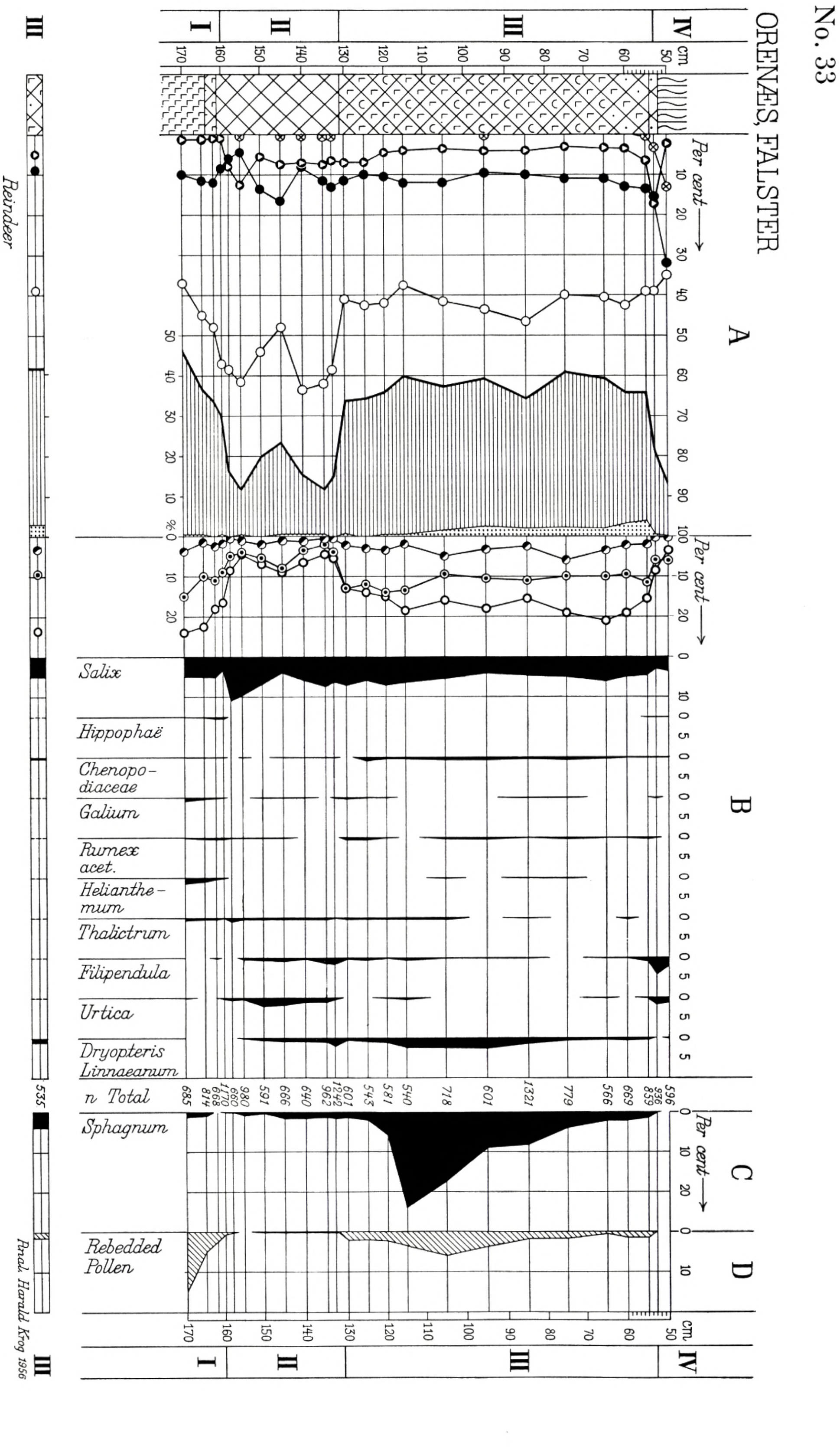
FUGLEBAKKEVEJ, COPENHAGEN





No. 26
VALBY, HELSINGE, SJÆLLAND
A
B
D
II
III
IV
cm.
Per cent
Reindeer
Salix
Hippophaë
Dryas
Chenopodiaceae
Galium
Rumex acet.
Helianthemum
Astragalus alpinus
Thalictrum
Filipendula
Urtica
Dryopteris Linnaeanum
n Total
Rebedded Pollen
Anal. Harald Krog 1957


No. 27
HOLBÆK, SJÆLLAND
A
B
C
D
Per cent
Salix
Chenopodiaceae
Galium
Rumex acet.
Thalictrum
Filipendula
Urtica
Dryopteris Linnaeanum
n Total
Sphagnum
Rebedded Pollen
Reindeer
Rtal. Harald Krog 1953


No. 33
ORENÆS, FALSTER
A
B
C
D
Per cent
Salix
Hippophaë
Chenopodiaceae
Galium
Rumex acet.
Helianthemum
Thalictrum
Filipendula
Urtica
Dryopteris Linnaearum
n Total
Sphagnum
Rebedded Pollen
Reindeer
I
II
III
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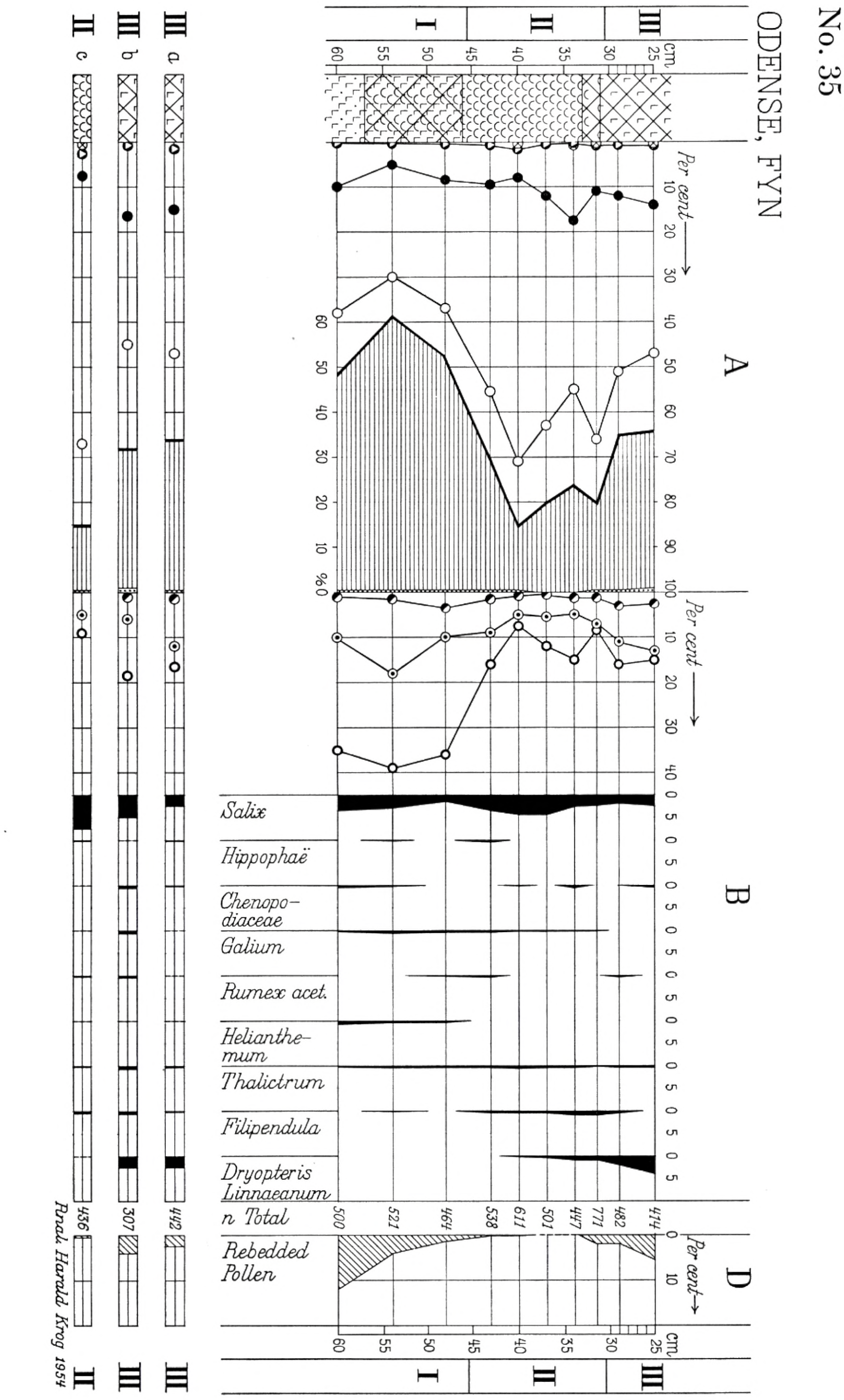
cm.
Fmal. Harald Krog 1956


No. 35
ODENSE, FYN
A
B
D
Per cent
cm.
Salix
Hippophaë
Chenopo-diaceae
Galium
Rumex acet.
Helianthe-mum
Thalictrum
Filipendula
Dryopteris Linnaeanum
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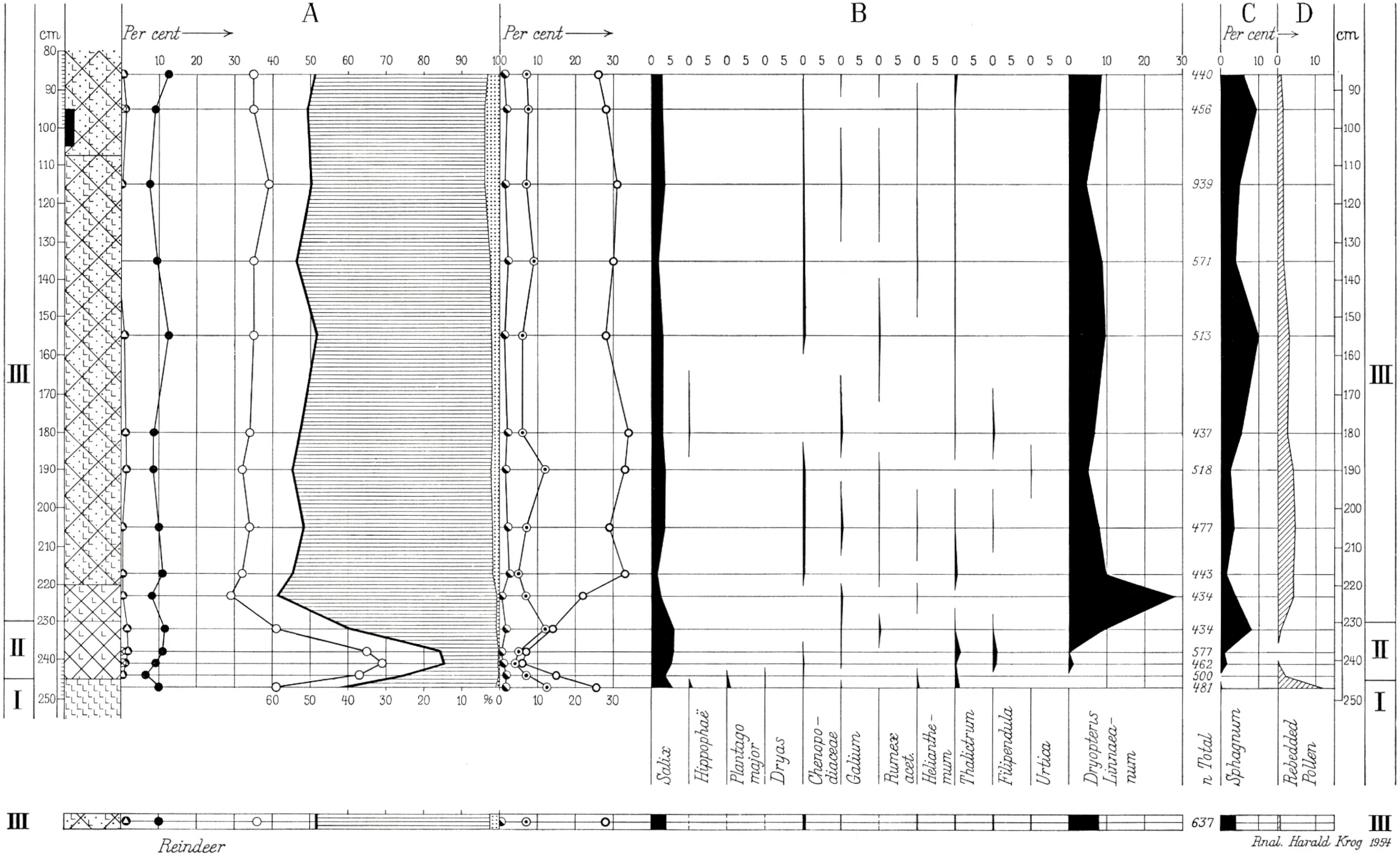
Rebedded Pollen
Harald Krog 1954

No. 37

SKRÖBELEV, LANGELAND



LITERATURE

Abbreviations

Aarb. = Aarbøger for nordisk Oldkyndighed og Historie. København.
D.G.U. = Danmarks Geologiske Undersøgelse (Bulletin of the Geological Survey of Denmark). København.
Oversigt = Oversigt Kongelige Videnskabernes Selskabs Forhandlinger. København.
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Indleveret til selskabet den 10. marts 1959.
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