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THE HYDROMEDUSÆ OF THE DANISH WATERS

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D. KGL. DANSKE VIDENSK. SELSK. SKRIFTER, NATURVIDENSK. OG MATHEM. AFD., 8. RÆKKE, XII. 1.

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI
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Preface.

This work presents itself to two different circles of readers. The Special Section, dealing with the regional and seasonal occurrence of each separate species, is chiefly intended for Medusologists, whereas Planktologists in general will certainly be more interested in the General Section, more particularly in the Discussion in which the results of the medusa studies are applied to the general principles of Plankton Research.

In translating from the Danish text, the question arose as to how far place-names etc. should be translated, or allowed to retain their original form. In some cases recognised English forms exist, and here the matter is simple; in others, translation is unnecessary or impossible. It is in the intermediate group that difficulty arises. The principle followed has been, to translate where English forms are familiar (Copenhagen, The Sound), and also where geographical terms are involved (Læsö Channel, Jammer Bay). Any such arrangement, however, must inevitably be of an arbitrary character; it is hoped that the present may serve the purpose which Author and Translator have had in view: to convey the needful information without pedantry or awkwardness of style.

The map used as foundation for the charts in the text was originally drawn for other purposes, and provided with Danish place-names. Chart 24 includes some further names used in the text, and these additions have been made according to the rules stated above.

The writer is greatly indebted to the Carlsberg Foundation for a grant which enabled me to carry through my investigations during the first years from 1915 onward.

I also wish to express my best thanks to the following:

Professor, Dr. C. H. Ostenfeld for unlimited access to the plankton material collected by the Danish Commission for Investigation of the Sea.

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Professor, Dr. L. Kolderup Rosenvinge for information on the distribution and biology of algæ.

The translation is by Mr. W. Worster, M. A.

Copenhagen, October 1927.

P. Lassenius Kramp.

Introduction.

The Work and its Origin.

In the autumn of 1912, I was appointed Assistant to the Danish Commission for Investigation of the Sea, where I worked for a little over two years, chiefly upon fish eggs and larvæ, but also occupied in the plankton investigations, where I had more especially to deal with the medusæ, ctenophores and chætognaths in plankton samples from the Danish waters. I completed the work on the material from the plankton collections made in the Langelandsbelt in 1909 (published in 1915) and continued with further material. I had by then already conceived the idea of compiling, in course of time, a general survey of the biology of the Danish medusæ. My work with the Commission for Investigation of the Sea was, however, interrupted by the outbreak of the war in 1914. Nevertheless, I did not relinquish my plan. The Head of the Plankton Department, Dr. C. H. OSTENFELD, very kindly placed the whole of the Commission's material at my disposal; I received a grant from the Carlsberg Foundation, and set to work eagerly upon the task. To begin with, I went through all plankton samples suitable for my purpose, determined all medusæ therein, noted down my observations, and took out several specimens for closer investigation. At the close of 1915, the Danish Commission for Investigation of the Sea kindly transferred the material I had thus selected to the Zoological Museum of the University of Copenhagen, where I had received an appointment that year. The information procurable from the plankton samples as to the medusæ of the Danish waters was supplemented partly by examination of the material already lodged in the Zoological Museum, and further by collections of my own, these last being made especially during the year 1915, when I devoted part of the grant received from the Carlsberg Foundation to excursions in suitable localities (*vide infra*). In this manner I procured a considerable amount of material, but scientific treatment of this was hindered by other work; I was also soon aware that the material itself was still inadequate for the purpose, but it was impossible, during the war, to fill up the gaps I had discovered. In the autum of 1922, however, and the spring of 1923, I took part in two cruises on board the new and well-equipped research vessel "Dana", covering nearly all the Danish waters. The abundant material I was thus enabled to procure, and the numerous interesting

observations made on board, made such a valuable addition to my knowledge of our medusæ that I determined now to complete the treatment of the material and publish the results. I am well aware that the present work does not by any means solve all problems concerning the Danish medusæ. The physiology I have had no means of studying; this would require laboratories such as are not yet to be found in this country; and a satisfactory solution of the general biological problems calls for periodical observations both of the appearance of the organisms and of the physical constitution of their surroundings in several different, favourably situated, localities. As a matter of fact, the material I have had to work on presents a very casual appearance, having been collected for the most part with altogether different objects in view, and in the case of some species, it is altogether insufficient for the formulation of definitive conclusions as to their distribution and biology; this applies, for instance, to all the Scyphomedusæ, which I have therefore omitted altogether from the present work, though it was my original intention to include them. There are, however, also several species in regard to which I feel justified in saying that I have been able in the main to elucidate their biological features. In any case, I believe that the data I have collected in this work constitute so essential a contribution to the understanding of the life history of our medusæ that they may serve as a foundation for future research, if the requisite means should be forthcoming. I hope that I may, in the following pages, be able to show that biological researches of this kind can be of great importance, not only from the scientific, but also from the practical point of view; and thus arouse fresh interest in a subject which to my mind, is interesting in itself. I also wished, however, to say something on behalf of the methods and views which I consider should be followed in plankton research to a greater extent than has hitherto been the case. I was not myself aware of these when I entered upon the work; they developed in my mind as I went on — as will be apparent to the attentive reader, from a certain lack of uniformity in the treatment of the material, due to the fact that I had not yet realised the importance of certain features at the time when I was going through the first of the plankton samples. I have endeavoured in some degree to amend this by subsequent revision; all selected samples of medusæ were revised, and also a quantity of the unsorted plankton samples; I could not, however, very well go through all these again, nor did I consider it necessary.

From the very first I set myself to study and describe, as closely as possible, the life history of all the Danish medusæ, their distribution in the Danish waters, and their dependance on the hydrographical conditions there prevailing. The idea that the occurrence of medusæ, on the other hand, might furnish an aid to the study of hydrographical conditions had, it is true, occurred to me, but my conception of this side of the question was very vague and in some respects incorrect; it was not until much later that I arrived at a clearer view, and now, I am inclined to attach far greater weight to this aspect than I had then considered possible. There is, however, one fundamental idea which I have had before me from first

to last: faunistic and zoo-geographical problems can only be solved by knowledge of the biology of the separate species. It is not a new idea, but it is a principle which needs to be reiterated again and again; and one which has not always been sufficiently respected.

The main object of the series of investigations which I undertook on my own account in 1915 was to study the appearance of the hydroids at different seasons. On my excursions, I invariably took some plankton samples, and on one or two occasions between each two such excursions, Mr. cand. mag. A. Otterström collected plankton for me in the Little Belt. From the very first it was my intention to devote myself principally to the investigation of the rich hydroid fauna in the narrow northern part of the Little Belt (Middelfart Sound), which I knew something of from earlier years. I also wished, however, to make collections in the Thyborön Channel — the western entrance to the Limfjord — where I had once found a luxuriant growth of hydroids. Accordingly, I commenced my excursions by making a journey, in January 1915, to Lemvig, and, with the assistance of the S. S. "Vesterhavet" of the Danish lifeboat service, making investigations in the Thyborön Channel. I, however, soon gave up further investigations in this locality, partly because the journey was a lengthy and expensive one, and partly because the silting up of the channel renders the state of the bottom at Thyborön so unstable that I could never be sure of obtaining any advantage from the journey. In Middelfart Sound, on the other hand, I always obtained an abundance of material, and succeeded here in getting a good idea as to the annual life cycle of the principal medusa-producing hydroids. For these investigations I used, sometimes the motor boat belonging to the Fishermen's High School, sometimes a large motor boat belonging to a fisherman of Middelfart, a man thoroughly acquainted with the locality, who took a great interest in my work and rendered valuable assistance.

It is only too rarely that Danish biologists have undertaken studies of marine fauna during winter; and certainly, it is not always pleasant to be out in an open boat during the inclement season. My dredgings at Thyborön in January were carried out during frosty weather, and on the 26th of March, when I was working in the Little Belt, the boat had to be cleared of snow before starting. The results, however, were as satisfactory as could be expected when working under such primitive conditions, where the material had to be sorted out and preserved on the spot, all examination being postponed until my return to Copenhagen. It would, of course, have been better if I could have taken the material to a laboratory immediately on landing, where a preliminary investigation could be made, and then at once proceeded to collect further material wherewith to supplement and confirm my first results; as it was, in going through the material after my return home, I frequently made discoveries which made me wish I had had more or better material of one sort or another. — The plankton fishery was carried out with a Nansen net (without closing apparatus) towed horizontally for 15 minutes at a time, partly at the surface, partly 5—10 m below.

From Nyborg, in the Great Belt, I obtained a number of medusæ during the months of March—May, both in 1915 and 1916. The transport boat belonging to the Danish Biological Station has a well, with holes in the sides of the vessel clean through to the open water outside. In this well one might at times find hosts of medusæ, which could then be taken up at leisure and entirely undamaged. Now and again the Assistant at the Station, Dr. BLEGVAD, would inform me by telegram when a host of medusæ had appeared, and I would then at once set off for Nyborg, where I was most kindly received by the Director of the Station, Dr. C. G. JOHS. PETERSEN, bringing home many finely preserved medusæ.

Material.

General Survey. (For details, see General Section, Chapter I).

1909.

Off Spodsbjerg, east coast of Langeland, depth 35 m. 10 April—27 June, daily. Hensen net. "Thor" (see KRAMP 1915).

Great Belt and Kattegat. 20—28 April. Ring trawl, Cutter "Karen" (see KRAMP 1915).

1910.

Schultz's Grund Lightship. 1 Aug.—14 Sept., daily. Hensen net (Table VII).

North coast of Sealand and the Sound, 26—30 Oct. Hensen net. "Thor"s motor boat (Table XIII).

1911.

Horns Rev Lightship. 1 Jan.—30 Decr., weekly. Nansen net (Table V).

Anholt Knob Lightship. 1 Jan.—15 Decr., twice monthly. Nansen net (Table VI).

Schultz's Grund Lightship. 14 May—26 Decr., weekly. Hensen net (Table VIII).

Kattegat, Great Belt, and Western Baltic. 11—17 May. Hensen net. Fishery Inspection vessel "Havörnen" (Table IX).

All waters. 30 May—17 July. Hensen net and young fish trawl. "Thor" (Table X).

West coast of Jutland. 3—10 Aug. Hensen net. "Thor"s motor boat.

1912.

Horns Rev Lightship. 1 Jan—30 Decr., weekly. Nansen net (Table V).

Anholt Knob Lightship. 1 Jan—15 Decr., twice monthly. Nansen net (Table VI).

Schultz's Grund Lightship. 2—30 Jan., 5 March—23 July, 17 Sept.—5 Novr., weekly. Hensen net (Table VIII).

1913.

Horns Rev Lightship. 6 Jan—29 Decr., weekly. Nansen net (Table V).

Anholt Knob Lightship. 17 Jan—15 Decr., twice monthly. Nansen net (Table VI).

Schultz's Grund Lightship. 19 Aug.—27 Decr., weekly. Hensen net (Table VIII).

Gniben—Hasenöre. 9 July. "Thor"s motor boat, horizontal hauls with Nansen net with closing apparatus.

Ringköbing Fjord. February—July. "Thor"s motor boat.

1914.

Horns Rev Lightship. 5 Jan.—30 March, weekly. Nansen net (Table V).

Anholt Knob Lightship. 1 Jan.—1 April, twice monthly. Nansen net (Table VI).

Schultz's Grund Lightship. 1 Jan.—31 March, weekly. Hensen net (Table VIII).

Skagerrak. 4—5 April. "Havörnen". Vertical hauls with Nansen net with closing apparatus.

1915.

Middelfart Sound. Jan.—Decr. Kramp.

Nyborg. March—May. Biological Station.

1916.

Middelfart Sound. 17—18 Jan. Kramp.

Nyborg. 10 April and 17 May. Biological Station.

1922.

North Sea, Skagerrak and Kattegat. 28 Sept.—19 Oct. Young-fish trawl. "Dana" (Table XI).

1923.

All Danish waters. 1—2 April, 17 April—19 May, 28 May—24 June. Ring trawl and young-fish trawl. "Dana" (Table XII).

With the exception of that collected by myself from Middelfart and Nyborg in 1915 and 1916, the whole of the material here noted was collected by the Danish Commission for Investigation of the Sea. From time to time, especially during the last few years, I have also received a few medusæ or unsorted plankton samples from the Danish Biological Station, as well as from private persons. Dr. Th. Mortensen, who was on board the "Thor" during part of the cruise in 1911, took out several medusæ from the contents of the young-fish trawl, and these were included in the collections of the Zoological Museum. A few medusæ have occasionally been preserved from other cruises of the "Thor" (since 1903) and these have as a rule been handed over to the Zoological Museum. On the cruises of the "Dana" in 1922 and 1923, I was myself able to take out as many medusæ as I wished from the hauls, for my own investigations. I have also, at the Zoological Museum, revised the medusæ still preserved from the periodical plankton collections of the Biological Station during the years 1898—1901, previously dealt with by A. C. Johansen and Chr. Levinsen (1903).

The large implements employed on board the "Thor", "Karen", and "Dana", the ring trawl and Petersen's young-fish trawl, are furnished with stramin bags

(abt. 19 threads per 3 cm). The Hensen net (Hensen's egg net), which is used solely for vertical hauls, has an opening diameter of 67 cm; the forepart, in the shape of an inverted cone, is made of canvas, and the bag of miller's gauze No. 3 (23 threads per 1 cm); The Nansen net is cylindrical in front, with an opening diameter of 50 cm, the bag of miller's gauze No. 3; it is likewise used for vertical hauls, and can be closed by means of a falling weight. The closing mechanism, however, was only used in the hauls made by "Havörnen" in the Skagerrak in 1914. In 1913, I experimented successfully with the Nansen net with closing apparatus for horizontal hauls.

A great amount of the material was procured by vertical hauls from bottom to surface, which afford no information as to the depth at which the organisms were taken. In some cases, however, hauls were also made through the upper water layers alone, *viz.* in the "Thor" collections in the Langelandsbelt in 1909, on part of the cruise of "Havörnen" in May 1911, and in all the hauls made from Schultz's Grund Lightship. This method, though not sufficing to determine the precise vertical distribution of the organisms, does at least indicate whether they are mainly to be found in the upper or lower water layers, a point of the very greatest importance. The hauls made on the cruise of the "Thor" in 1911, and from the lightships at Anholt Knob and Horns Rev, on the other hand, were unfortunately made solely from bottom to surface. This is partly due to the fact that the International Investigations have to a very great extent recognised and employed the HENSEN method.

Methods employed.

As Assistant to the Plankton Laboratory, I had the task of examining plankton samples from the permanent station of the "Thor" in the Langelandsbelt in 1909; the Hensen method was here employed, the number af specimens of each species being accurately counted by means of a specially constructed counting microscope, after which I calculated the number per sq. metre of surface, and drew various conclusions (KRAMP 1915). My present work is not based on the Hensen method. In order to ascertain the regional or seasonal occurrence of the different species, it is of course essential to note their frequency in the various samples; the counting method, however, is subject to such enormous sources of error that it can only be employed with the greatest caution, and its value is in disproportion to the time it takes. — The value of the quantitative methods of research is essentially dependent on the sufficiency of the material. Observations and investigations, however careful, can only yield unreliable results if the material itself be insufficient. In all cases where an adequate amount of material can be procured, quantitative methods are of the utmost importance, and such cases are, fortunately, many; but where the supply of material is small, the methods in question are risky. It is in recognisation of this fact that genetic research operates mainly with organisms of high reproductive capacity, while physiologists take their experimental material from species of

which they can procure a great number of specimens. As regards plankton investigations in particular, it is of course easy enough to obtain a great number of plankton samples; these will, however, only be of value when the organisms have been classified and counted; and anyone who has tried it knows what an enormous task this is. It requires the services of scientifically trained operators, acquainted with the organisms concerned, and able to determine them while counting; and the staff of such assistants available in any institution is necessarily limited. Not until the samples have been thus dealt with can they serve as the basis for quantitative investigations. The counting method would therefore be valuable in plankton investigations if a really large number of samples could be dealt with in a short time, but this is, practically speaking, an impossibility; and in addition, we have the enormous sources of error involved by the methods of collection.

I have in the present work found it quite sufficient to make use of the ordinary terms for degree of frequency:

rr — very few specimens
r — few
\+ — neither rare nor common
c — common
cc — very numerous.

The determination of frequency of a species by this method is of course somewhat arbitrary, and the results will depend on the subjective judgement of the investigator. But one very soon becomes habituated to the determination of the frequency of species in a sample, and as I have myself carried out the entire investigation in person, I think I may say that the frequency notations as they appear in this work are comparable. In making the determinations, I have of course taken into consideration the size of the implements used. The justification of the method and its mode of employment depend, for the rest, on the object of the investigations. My aim here has been, not to determine the relative importance of the medusæ in comparison with other organisms among the plankton, but to ascertain the fluctuations in the quantity of medusæ throughout the year, or from place to place. The frequency terms are therefore applied to medusæ without regard to whether there were few or many diatoms, copepods etc., in the same samples. Furthermore, I have taken it for granted that the main point of interest is to note any remarkably low or remarkably high numerical values in the occurrence of a species, variations within the extreme limits being of minor importance, more especially as these may be due to a number of accidental circumstances. It is indeed one of the dangers of the numerical method, that one is tempted to attach undue importance to the minor variations. I have therefore employed the term + in a rather wide sense, so that the r, rr, c and cc really mean something where they occur.

The above remarks must not be taken as indicating that I do not recognise the importance of quantitative methods in plankton research. The total absolute

number of individuals in a plankton sample is not, to my mind, so important as the Hensen school would consider it, especially as a basis for far-reaching calculations as to the stock and production of plankton for miles round in the case of each sample. Relative numerical values on the other hand may often be of great importance. By way of example I may note the relative number of specimens of different species from a series of localities leading from a very salt to a less salt area; the quantitative proportion between young and adult specimens of a species at different places or at different seasons of the year, or, in the case of gemmiparous medusæ, the percentage of gemmiferous specimens found under different conditions. For the determination of such numerical values it is not always necessary to know the total number of individuals in the plankton sample. Where the species in question occurs only in small numbers, one should, of course, count or examine all the specimens found; if common, a representative portion may be taken from the total sample. Certain precautions are necessary in so doing. When a plankton sample has been left undisturbed for some time, the organisms sink to the bottom, but not all at the same rate of speed, so that a kind of selective action is produced. Before taking a representative sample therefore, the whole hatch should be shaken up and thoroughly mixed, a suitable quantity being then quickly poured off into a basin, and all specimens of the species in question found therein at once counted or examined. This method I have often employed myself, not only when dealing with preserved samples, but also on board the "Dana", when I wanted to get a representative sample of the contents of the young-fish trawl.

The examination of samples taken in fine-meshed nets has been made throughout under a binocular preparation microscope; the material was poured out in small quantities at a time, into a square petri dish, which was then moved backwards and forwards under the microscope, so that no portion of the sample escaped observation. For lifting out the medusæ, a pipette was used, or a needle, preferably with the point slightly bent; occasionally tweezers, never a brush.

The material was invariably preserved in formol. Now and again the solution was too strong, which is unpleasant for the operator examining the sample; more often, it was too weak, with the result that the organisms were more or less dissolved, and therefore difficult to determine. As a rule however, the solution was of suitable strength. For the preservation of marine organisms, one should never use anything weaker than 1 part of the ordinary formalin of commerce to 9 or 10 parts of water. The contents of a net should never be poured off into a vessel already containing the prepared formol, as the latter thus becomes further diluted with water, and this to an indeterminable degree. The fresh sample should be turned out into a glass jar containing sufficient sea water for the gauze at the bottom of the plankton bucket (if such has been used) to be rinsed therein; the jar is then filled nine-tenths with sea water (after a little practice, this can easily be judged by the eye) and finally, filled up with 40% formalin; the jar is then corked, and turned upside down a few times so that the whole of the material becomes fixed

at once. The strength of the solution will then be, practically speaking, 1 part of formalin to 9 parts of water, including the water-content of the organisms. By this method, it is thus not necessary, as with alcohol or prepared formol, to allow for the quantity of water contained in the living organisms. Any stronger solution is liable to render the organisms so stiff and brittle that they crush one another to pieces as they sink to the bottom of the jar.

Classification and nomenclature are only mentioned briefly here and there in the present work.

The geographical distribution of the separate species, and their seasonal occurrence, are dealt with only in brief summaries, all of which however, are based on my own thorough studies of the literature, as well as of alien material; for details, I would refer to HARTLAUB's treatment of the Anthomedusæ in the "Nordisches Plankton" (1907—1917), and also to my own works on northern medusæ, especially in the Danish Ingolf Expedition (Leptomedusæ 1919, Anthomedusæ 1926); and in KRAMP & DAMAS: Les Méduses de la Norvège, 1925. — In the summaries given, special attention has been paid to the occurrence in waters immediately adjacent, particularly round Helgoland and off the west coast of Norway. I have given a detailed, and, as far as possible, complete list of all records in the literature of the occurrence of each separate species in the waters round Denmark, including the German shores of the Baltic, the west coast of Sweden and the south coast af Norway.

In the case of every species, a survey is given of the material I have had to work on, arranged in chronological order; for the years 1911—1914 however, the material from the lightships has been put first, and any other material after. These surveys give in themselves an idea as to the occurrence of the species, and should also help the reader to find more easily the detailed records in the tables. In the case of certain species, (such as are only found in a few localities, or forms in which the size of the individuals is of particular importance to the subsequent discussion) the localities of all finds are noted in the text. Otherwise, size and stage of development etc. of the specimens in general are not given in detail, as this would involve, practically speaking, the printing of all my original notes, which would be out of the question; where I considered it advisable, such data are given briefly in the text.

Hydrography.

In regard to the relation between fauna and hydrography, the Danish waters present a remarkable number of interesting problems, forming as they do the connecting route between two widely dissimilar areas of sea, the Baltic and the outer ocean, and receiving water masses of very heterogeneous origin. In the Special Section, the dependence of the individual medusa species on the hydrographical conditions will be investigated; in the first chapter of the General Section I shall endeavour to show how the medusa fauna can help to explain the hydrographical

Approximate mean values of Temperature and Salinity in the Danish Waters.

	Depth m	Salinity ‰				Temperature C°			
		Febr.	May	Aug.	Novr.	Febr.	May	Aug.	Novr.
Baltic proper W. of Bornholm ..	0	8	8	8	8	1.5—2	6	16	9
	10	9	8	8	8—9	1.5—2	6	15	9.5
	20	10	8—9	8—9	9	1.5—2	6	12—13	9
Western Baltic ..	0	11—17	9—15	9—15	11—16	1.5—2	6—7.5	16.5—17	9
	10	13—17	11—16	11—17	12—17	1.5—2	6—6.5	15.5—16	9.5
	20	18—19	15—19	20—23	18	2—2.5	5	11.5—12	10
Great Belt.....	0	15—17	11—14	13—15	15—17	2	7	16.5—17	9
	10	17—21	14—17	16—19	16—18	2	6	15—16	9.5
	20	19—24	19—24	23—26	19—21	—	5	11—12	10
Little Belt.....	0	17—19	15—18	15—19	16—18	1.5—2	7	16—16.5	9
	10	18	16—18	17—20	17—18	—	6.5	15	9.5
	20	—	—	21	18—19	—	—	14	9.5
Samsö Bay.....	0	17—21	14—19	15—22	17—22	1.5—2	7	16—16.5	9
	10	21—24	17—24	19—24	19—24	2	6	15—16	9.5
	20	24—28	25—30	27—28	22—27	3	5	10—11	10
The Sound	0	11—13	9—12	10—12	11—15	1.5	6—7	17	8.5
	10	15—17	13—18	13—18	15—18	3	6	16	9.5
	20	25	29	26	25	4.5	4	10	10.5
Kattegat, southern part	0	17—23	15—19	16—19	16—22	1.5—2	7	16.5—17	9
	10	23—24	20—22	19—23	22—23	2.5	6	16—17	9.5
	20	28—29	30—31	28—30	27—30	4—5	5	10—15	10.5—11
	40	31	32.5	32	33.5	5	4	8	11
Kattegat, eastern part	0	18—31	15—29	17—29	17—29	1.5—2.5	7	16.5—17	9—9.5
	10	23—31	21—30	20—30	22—30	2.5—3	6	16—17	10
	20	29—33	30—33	28—31	29—31	4—5	4.5—5.5	12—16	10.5—11
	40	33—34	33—34	33	33—34	4—5	4.5—5	7—15	10—11
Kattegat, western part	0	24—31	19—29	19—30	22—30	2—2.5	7	16—16.5	9
	10	25—32	22—33	23—31	24—32	3	6	15	10
	20	33	33	32	32—33	4	5	14	10
Skagerrak at the Skaw	0	30—32				3—4	8	15	8
	20	32—34				4—4.5	6	10—15	9
	40	34—34.8				5	5.5—6	7—12	9—10
North Sea N. of Jutland Bank..	0	33—34				3—5	7.5—8	14.5—15	8—9
	20	34—34.6				4—5	6—6.5	13—14	9
	40	34.6—34.8				5	6	8—10	8—9
North Sea S. of Horns Rev	0	32—34				3—4	8	15	9—10
	20	32—34.4				3.5—4	7	14.5—15	9—10
	40	34.6				5	6	13—14	10—11

conditions and their deviations from the normal in the different years; in the chapter next following, the composition of the fauna in different parts of the Danish waters will be considered in relation to the hydrographical conditions. As a preliminary guide, I give a survey, in tabular form, of the salinity and temperature in the

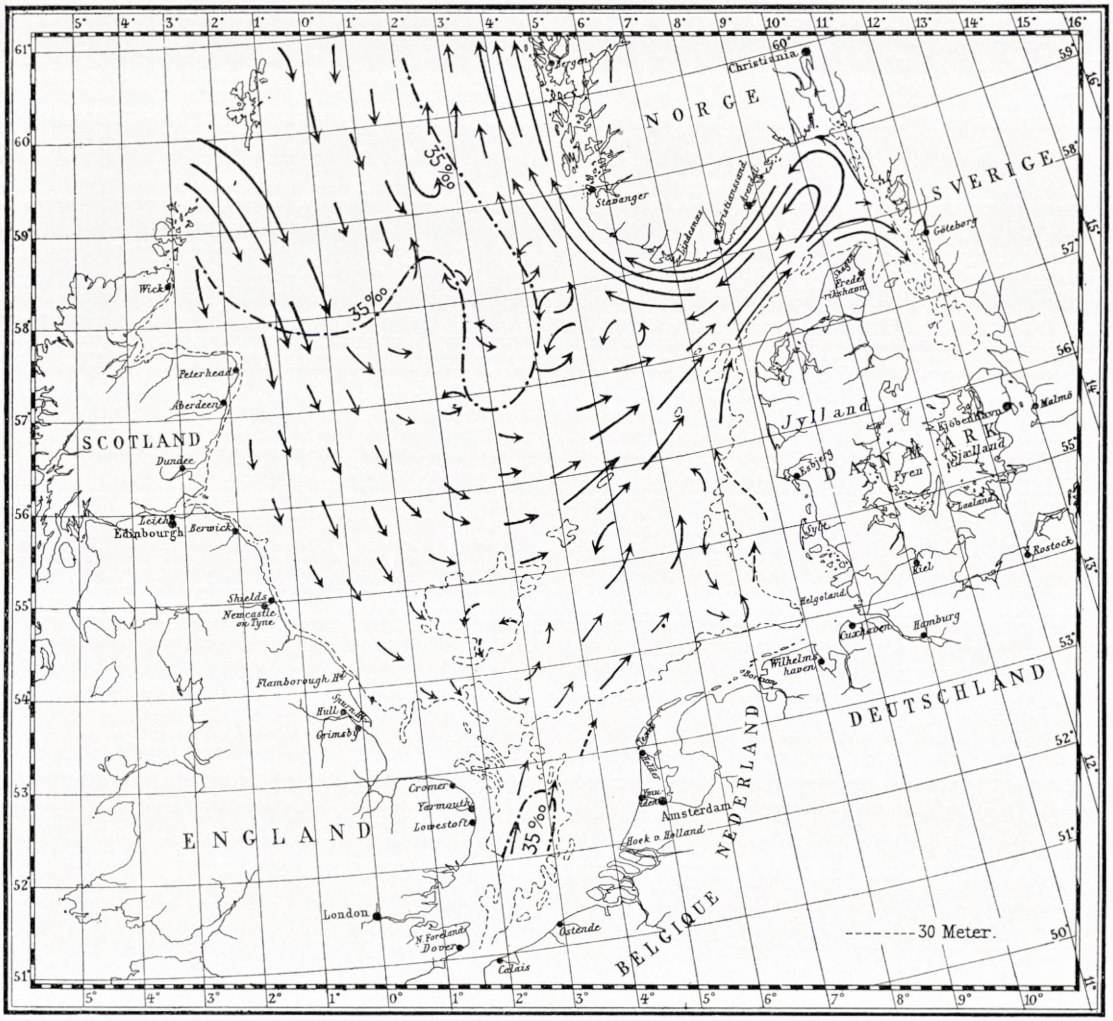

Chart 1. The direction of the resulting Currents at ca. 30 meter's depth in the North Sea and the Skagerrak. After A. C. Johansen 1925.

different waters, together with two charts (Nos. 1 and 2), showing normal course of the more important currents. Chart 1 shows the circulation of the water in the North Sea, whence a considerable volume of water penetrates into the Skagerrak, mainly along the coast of Jutland, and thence as an undercurrent through the deep channels of the Kattegat and the Belts into the Baltic (Chart 2) This water from

the coastal banks of the North Sea is briefly designated as "bank water". In winter and spring, the main bulk of the bank water comes from the northern part of the North Sea through the Norwegian Channel (the cold "northern bank water"); in summer and autumn, the Jutland Current is at its height, and carries the warm "southern bank water" in to the inner waters. In the Belt Sea and the Kattegat, the bank water is submerged by Baltic water of low salinity, moving northward, attaining its greatest volume off the Swedish coast; in the eastern Skagerrak, this Baltic Current carries part of the bank water with it out along the south coast of Norway, whence the light Baltic surface water can at times spread far out over the bank water. The deeps of the Skagerrak, are filled up with "Atlantic water" (salinity 35—35.2‰); in the middle of the Skagerrak, this water reaches up to 50—100 m below the surface, but lies deeper on either shore, 150—250 m down off the coast of Norway, 80—150 m down off the coast of Jutland. This is a direct continuation of the northern branch of the Gulf Stream, and comes in round the northern edge of the North Sea Plateau, through the Norwegian Chan-

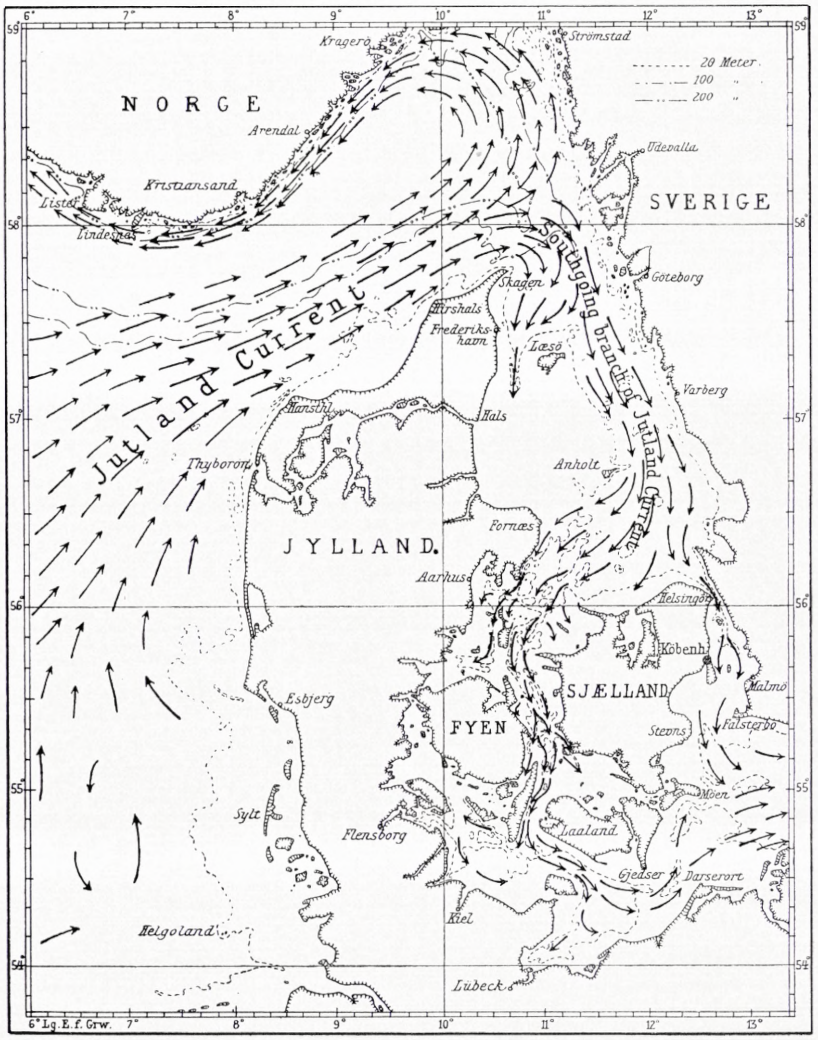

Chart 2. The main direction of the Currents in the intermediate layers (ca. 30—100 m) in the Skagerrak and in the lower layers in the Kattegat and Belt Sea. After A. C. Johansen & A. J. C. Jensen 1926.

nel. It moves as a rule very slowly, and is very poor in oxygen. — It should further be noted that while the tide in the southern part of the North Sea gives rise to an intensive mixing of the water layers, tidal action in our inner waters is practically confined to a submarine wave periodically raising and lowering the boundary layer between the upper and lower water layers; a movement which is doubtless of but very slight importance to the organisms.

Literature: KNUDSEN 1905 and 1907; EKMAN, PETTERSSON & TRYBOM 1907; JACOBSEN 1908; HELLAND-HANSEN & NANSEN 1909; Resumé de l'Hydrographie 1909; KNUDSEN & GEHRKE 1913; OSTENFELD 1913, Cap. II; BÖHNECKE 1922. See general list of literature.

Hydrographical Observation Material. From all the Danish lightships, the direction and velocity of the current at the surface are noted every four hours throughout the twentyfour; in addition, water samples are taken at eight every morning from different depths (0, 5, 10, 15, 20, 30 m and bottom), the temperature and salinity of these samples being determined on board; in the case of the last one, by areometer. This observation material is published in the "Nautisk-Meteorologisk Aarbog", issued by the Danish Meteorological Institute. The publication in question also gives, for each month, the calculated mean velocity of the current (irrespective of direction) at each of the six hour-points, with averages for temperature and salinity at each of the depths noted. For comparison with the monthly averages for temperature and salinity recorded by the lightship at Horns Rev, Skagens Rev, Anholt Knob and Schultz's Grund for each of the years 1911—1914, I have here given, in Tables I—IV, the corresponding mean values for the period 1901—1923, calculated at the Nautical Department of the Meteorological Institute by the courtesy of Captain C. I. H. SPEERSCHNEIDER, Head of the Department in question.

The individual current observations are of but slight value for our purpose; both direction and velocity frequently vary, and the current can, in the course of the twentyfour hours, flow backwards and forwards several times, carrying with it the same organisms. The occurrence of a species cannot therefore be explained by the current observed at the same time. — I. P. JACOBSEN, in his "Beitrag zur Hydrographie der dänischen Gewässer" (1913 a, p. 9) established and defined the term "resulting mean current for a month". This value is a very useful one to work with, as it gives a good indication of the volume of water which has passed a given spot in a certain month, and shows how far the movement of the water has been predominantly inward (from the North Sea towards the Baltic) or the reverse. In certain cases, it may be interesting to supplement the information afforded by the monthly figures, by individual observations. Jacobsen has, in his mentioned work, dealt with the lightships' observations of the surface currents for the years 1897—1908, and determined, *inter alia*, the boundaries of the in- and outflowing currents and the mean direction of the main composants, calculating also the resulting mean current per month for each year. In Table 2 (p. 8) of the work in question will

be found the mean value of the resulting current at the surface for the whole of the period from 1897—1908. For the period after 1908, no calculations of the resulting surface current have been made. I have therefore been obliged to make these calculations myself according to the method indicated by Jacobsen, from the observation material in the Nautisk-Meteorologisk Aarbog (See Tables I—III).

As the plankton collections were made by vertical hauls through all water layers, it would of course have been better to have observations from different depths, as the currents in the upper and lower water layers often flow in different directions. Current measurements have been made at various depths from some of the lightships at the instigation of the Danish Commission for Investigation of the Sea, and this material has been kindly placed at my disposal by the Hydrographical Laboratory of the Commission, despite the fact that some of it is as yet unpublished. — At Schultz's Grund, current measurements have been carried out at $2^1/_2$, 5, 10, 15, 20 and 25 m depth since March 1910, and the resulting mean current per month at each of these depths calculated at the Laboratory. These figures will be found in Table IV. At Anholt Knob, current measurements below the surface were made only for a short period in 1910. The results are published in J. P. Jacobsen's work of 1913 b. — At Horns Rev, current measurements have been carried out for a long time, but from here, only the "raw material" is available, in the form of a huge mass of individual observations (publ. Jacobsen 1923). I have not considered it necessary to work out the monthly averages for these numerous observations, as the current at Horns Rev is mainly uniform in direction at all depths. The mean values found from the usual surface observations appear to me to give an adequate view of the current here for our purpose.

The observations at Horns Rev give a view of the Jutland Current, and the material from Schultz's Grund furnishes information as to the movement of the water through the boundary between the Kattegat and the Belt Sea. The observations from Anholt Knob should show the current in the eastern Kattegat. It is necessary, however, to use these figures with some reserve. A glance at the chart will show that this lightship lies at the eastern end of a reef; the inward current keeps along the north-eastern side of this reef, the outflowing current following the south-eastern side, and the mean direction of the main composants at the surface were found by Jacobsen to be, at the lightship itself, S. 37 E and N. 41 E, thus forming a little over the right angle (102°); undoubtedly also, eddies are often produced at the point of the reef, where the currents meet, confusing the general impression as to movement of the water. In order to obtain a fuller view of the movement of the water in the Kattegat, I therefore wished to include observations from yet another lightship, even though no plankton material might be available from there. But none of the lightships of the northern Kattegat are very well suited to the purpose. The currents at Östre Flak and Læsö Trindel are too dependent on the coastal banks. At Læsö Rende, current measurements have been made at different depths, but this is not a suitable spot, as the Baltic Current does not pass there, and the surface

current is determined by local conditions. Only a small portion of the water flowing in from the Skagerrak finds its way down into Læsö Rende, and is checked here by the Aalborg Plateau (see Chart 2). There remained then only Skagens Rev lightship; this again is not on the ordinary line of the Baltic Current, but there is the Jutland Current, which as a rule still reaches to the surface here. The surface observations from Skagens Rev can therefore to some extent serve to indicate the course of the inflowing water, though we have to reckon with disturbing influences due to local conditions. As regards the current deeper down, we must, in cases where no measurements are available, make do with such conclusions as can be drawn from the salinity of the water — a particularly high or low salinity in the deeper layers indicating as a rule a strong or weak inflowing current.

Apart from the lightship material, I have had at my disposal a considerable quantity of medusæ from the cruises of the "Thor" and "Dana". On these cruises, hydrographical observations were, as a rule, made at all the localities investigated, often only at bottom and surface, but sometimes at several depths. The most important of these observations will be found in the tabular lists of material.

Bibliography of Hydromedusæ in Danish and adjacent waters.

Until about 1900, our knowledge of the hydromedusæ of the Danish waters was extremely slight; save for the single mention, by O. Fr. Müller, in his "Zoologiæ Danicæ Prodromus", 1776, of "*Medusa hemisphœrica*" (*Phialidium hemisphœricum*)[1]) from the Christiania Fjord, we find nothing whatever by Danish writers concerning medusæ in our home waters until 1891; the few Danish zoologists who had taken any interest in these organisms up to that date had dealt solely with the fauna of the west coast of Greenland (O. Fabricius 1780, Mørch 1857, Lütken 1875, Levinsen 1893) or Iceland (Faber 1829). Denmark's hydroids on the other hand have twice been subjected to special treament (Winther 1880, Levinsen 1893). As regards the medusæ, the species mentioned in the literature for the first 100 years after the appearance of the "Zoologia Danica", are not even, properly speaking, from Danish waters at all. — I shall in the following pages mention all those works in which I have found mention of the occurrence of hydromedusæ within the area dealt with in the present work. For exact titles, see the general list of works.

"*Medusa hemisphœrica*" L., is mentioned at some length by O. Fr. Müller in the second edition of "Zoologia Danica" 1781, p. 25—26.

In the well-known work by C. G. Ehrenberg: Die Akalephen des Rothen Meeres und der Organismus der Medusen der Ostsee, 1836, p. 77, (explanatory notes to Pl. VIII) there is mention of two medusæ from the Christiania Fjord, viz. *Oceania pileata* (*Leuckartiara octona*) and *Melicertum campanulatum* (*M. octocostatum*).

S. L. Lovén: Bidrag til kännedomen af slägtena *Campanularia* och *Syncoryna*, 1836: description of *Syncoryne sarsii*, the hydroid of *Sarsia tubulosa*.

[1]) The names given in parentheses are those now in use.

Chr. Lovén: Till utvecklingen af *Hydractinia*, 1857: description of *Podocoryne carnea*.

Then come a series of German works, in which individual medusæ are mentioned, *viz*: H. A. Meyer & K. Möbius: Kurzer Ueberblick der in der Kieler Bucht von uns beobachteten wirbellosen Thiere, 1862; K. Möbius 1873a (brief note of *Stomobrachium octocostatum* (*Melicertum octocostatum*), from the Bay of Kiel); K. Möbius: Die wirbellosen Thiere der Ostsee, 1873b; K. Möbius: Coelenterata etc.: Die auf der Fahrt nach Arendal gefangenen Thiere, 1873c; Fr. E. Schultze: Ueber den Bau von *Syncoryne Sarsii* Lovén und der zugehörigen Meduse *Sarsia tubulosa* Lesson, 1873; Fr. E. Schultze: Coelenterata. Zoologische Ergebnisse der Nordseefahrt etc. 1875. In this last-named work we find the first mention of a medusa from the Danish waters proper, viz: *Corymorpha nutans* (*Steenstrupia nutans*) from the Great Belt.

The hydroids *Laomedea geniculata* and *Podocoryne carnea* are recorded from the Christiania Fjord in G. O. Sars: Bidrag til Kundskaben om Norges Hydroider, 1873.

G. J. Allman: Diagnoses of new Genera and Species of Hydroida, 1876; in this is described, as a new species, the hydroid *Podocoryne inermis*, from specimens taken in the Little Belt; the species in question must, however, be regarded as identical with *P. carnea* Sars.

G. Winther: Fortegnelse over de i Danmark og dets nordlige Bilande fundne hydroide Zoophyter, 1880. This is the first collected list of hydroids known from Danish waters; a work notable especially for the excellently detailed indications of locality. With regard to Winther's determinations of species, the following should be noted: *Perigonimus vestitus* and *linearis* are both = *P. repens; Obelia gelatinosa* is in some cases *Laomedea longissima*; *O. flabellata* is sometimes *L. geniculata*, sometimes *L. longissima*. — No species of medusa-producing hydroids have since been found in Danish waters beyond the nine species mentioned by Winther.

H. Lenz: Die wirbellosen Thiere der Travemünder Bucht, II, 1882.

K. Möbius: Nachtrag zu dem im Jahre 1873 erschienenen Verzeichniss der wirbellosen Thiere der Ostsee, 1884.

M. Segerstedt: Bidrag till kännedomen om Hydroid-faunan vid Sveriges vestkust, 1889.

In 1891, we find the first mention in Danish literature of a medusa from the Danish area: C. G. J. Petersen, in his first Report from the Danish Biological Station, mentions *Sarsia tubulosa* from Holbæk Fjord. In the third report, Beretning III, 1893, some medusæ are noted from Fænö Sound.

G. M. R. Levinsen's revised list of the Danish hydroids in the cruises of the "Hauch", 1893, contains no medusa-producing species beyond those known from Winther's work.

In a little work by Th. Mortensen: Om Limfjorden's Fauna, 1897, there is mention of the medusa *Cladonema radiatum* from the Limfjord.

C. W. S. Aurivillius' well known plankton works 1896 and 1898, mark an important advance in our knowledge of the occurrence of medusæ in our waters, especially in the Skagerrak. The information given concerning medusæ in the first of these works, Das Plankton des Baltischen Meeres, 1896, is, however, derived entirely from the German writers above mentioned (Möbius, etc.). The great work: Vergleichende Thiergeographische Untersuchungen über die Plankton-Fauna des Skageraks, etc., 1898, does on the other hand, afford the first contribution of notable importance to our knowledge of the medusæ of the Skagerrak. Aurivillius mentioned no fewer than 19 species of hydromedusæ, of which the following have not since been found again in the waters round Denmark, and will therefore not be considered at length in the present work: *Amphinema Titania* (*A. dinema*), *Eleutheria dichotoma*, *Polycanna grönlandica* (*Æquorea forskålea*, sec. Mayer 1910). — In the work entitled: Om hafsevertebraternas utvecklingstider etc. 1898, Aurivillius mentions some few of the same species from Kristineberg, in Bohuslän.

At the close of the century we have yet two works on hydroids to note, *viz.*: E. Lönnberg: Om Öresunds djurlif, 1898 and 1899, and Cl. Hartlaub: Hydroiden, Beiträge zur Fauna der südöstlichen und östlichen Nordsee, 1900.

We now come to the first general description of the medusa fauna of the Danish waters; a work which it will perhaps be well to consider more closely, since it served, in some respects, as the model for the present work. In the publication in question: De danske Farvandes Plankton i Aarene 1898—1901, A. C. Johansen and Chr. Levinsen (1903, Kgl. danske Videnskabernes Selskabs Skrifter) have dealt with a whole series of groups, including that of the Coelenterata. The questions which the writers seek to answer are noted in an Introduction (p. 265 ff.) and are in the main the same as those which I am endeavouring to deal with in the case of the medusæ. In the section entitled "Oversigt over Goplernes Fordeling i vore forskellige Farvande" (pp. 174—275) 37 species of hydromedusæ are noted. Of these, 10 are recorded after other authorities; of the remaining 27, the writers themselves have had material for investigation, and these species are further discussed in the subsequent pages. Some of the material is lodged in the Zoological Museum at Copenhagen and fortunately, nearly all the rare species are preserved, so that it has been possible to revise the determinations. In the case of the commoner species, however, only a small portion of the material referred to in the work has been preserved. On the other hand, there were, in the collection at the Museum, a number of specimens of which the species had been determined, and which, from the labels, originated from the same plankton collections, but are not mentioned in the text. The revision of this material has involved a rather considerable alteration of Johansen & Levinsen's species list, partly owing to the fact that recent research has given several of the species a different delimitation, or different names, and partly on account of actual errors in the original determination. The Margelidæ and Tiaridæ have been examined and revised by Hartlaub, of Helgoland, who has made use of the material in the "Nordisches Plankton". — The 27 species are as follows:

Codonium pulchellum Allman (*Sarsia tubulosa* (Sars)).

Sarsia tubulosa (M. Sars). — Of the specimens from Skagens Rev 4. IV. 1900, one belongs to *Hybocodon prolifer*. Of three specimens from Schultz's Grund, 20. III. 1901, one is *Eucodonium brownei* Hartlaub.

Dipurena ophiogaster Haeckel (*Purena gemmifera* Forbes).

Steenstrupia galanthus Haeckel (*Steenstrupia nutans* (Sars)).

Euphysa aurata Forbes.

Hybocodon nutans M. Sars (*Steenstrupia nutans*).

Amphicodon fritillaria Steenstrup (*Hybocodon prolifer* L. Agassiz.) — The writers are very properly "doubtful as to the value of the specific characters utilised by Haeckel" in distinguishing between the species *fritillaria*, *globosus* and *amphipleurus*.

Tiara pileata Forskål. None of the material of "Tiara pileata" noted in Table I is preserved; there are, however, from various localities, 19 tubes whose contents were determined by Johansen & Levinsen as Tiara pileata; most of the specimens actually belong to *Halitholus cirratus* Hartlaub; the remainder to *Leuckartiara octona* and *Neoturris pileata* (Forskål).

Margelis principis Steenstrup (*Bougainvillia britannica* (Forbes)).

Margelis ramosa van Beneden. — The specimen from Tusbjerg Dyb is not determined; of the specimens from 23 miles N. of Skagen, 9. VII. 1898, one is *Bougainvillia superciliaris* L. Agassiz, 12 are *B. britannica* (Forbes). All the remaining material of "Margelis ramosa" is *Bougainvillia superciliaris*. The true B. ramosa is not represented in the material.

Margelis flavida Hartlaub (*Bougainvillia britannica* (Forbes)).

Cladonema radiata Dujardin (*Cl. radiatum*).

Rathkea octopunctata M. Sars.

Thaumantias eschscholtzi Haeckel (*Tiaropsis multicirrata* (Sars)).

Thaumantias forbesi Haeckel (*Phialidium hemisphæricum* (L.)).

Melicertidium octocostatum M. Sars (*Melicertum octocostatum*).

Eucopium quadratum Forbes (*Eutonina indicans* (Romanes)).

Obelia.

Tiaropsis multicirrata M. Sars (some this species, some *Eutonia indicans*).

Euchilota maculata Hartlaub. — The specimens from Thyborön, 31. X. 1900, are correctly determined. Those from the Skagerrak 29. VII. 1898, are *Mitrocoma polydiademata* (Romanes).

Eutonina socialis Hartlaub (*E. indicans* (Romanes)).

Phialidium variabile Claus (*Ph. hemisphæricum* (L.)).

Saphenia mirabilis Wright (*S. gracilis* (Forbes & Goodsir)).

Eutimeta gentiana Haeckel (*Eutima gegenbaurii* (Haeckel)).

Octorchandra germanica Haeckel (*Eutima gegenbaurii* (Haeckel)).

Tima bairdi Forbes (*Tima bairdii* (Johnston)).

Aglantha digitale O. Fr. Müller.

The actual number of species in the material investigated by Johansen & Levinsen is thus 25. — From the revision here effected it will be seen that our fauna is thus augmented by the following 11 new species (the 4 in brackets are not mentioned by the writers themselves, but are from Hartlaub's or my own revision): *Purena gemmifera*, (*Eucodonium brownei*), (*Bougainvillia britannica*), (*B. superciliaris*), *Rathkea octopunctata*, *Neoturris pileata*, (*Mitrocoma polydiademata*), *Tiaropsis multicirrata*, *Eucheilota maculata*, *Saphenia gracilis*, *Eutima gegenbaurii*.

In a small work entitled Zur Medusenfauna von Norwegen, 1905, Hj. Broch mentions a number of medusæ from the south coast of Norway.

In a work by Hj. Théel: Om utvecklingen af Sveriges zoologiska hafsstation Kristineberg, 1908, some medusæ are noted; all were known to Aurivillius.

In 1909, E. Jäderholm dealt with the Swedish hydroids in his large and handsome contribution to the "Northern and Arctic Invertebrates". The medusa-producing species mentioned in this were all known from Danish waters as far back as the days of Winther (1880). — The same applies to the species from the Christiania Fjord mentioned by Broch in the Fauna droebachiensis (1911).

The International Plankton Lists have not added any new species of medusæ to our fauna. Surveys of the contents of the plankton lists are given in three catalogues in the Publications de circonstance, 1906, 1909, and 1916. Some of the species have been further dealt with in the Resumé Planktonique published by the International Commission, Part III, No. 8 (Kramp 1913 a).

Hartlaub has, in his treatment of the Anthomedusæ in the "Nordisches Plankton" (1907—1917) included the Danish finds, partly on the basis of his own studies in the Zoological Museum at Copenhagen. The material is the same as that utilised by Johansen & Levinsen. Hartlaub's statements therefore contain nothing essentially new, but are of importance as a revision of the determinations made by the writers in question, especially as regards the Bougainvillia species and the Tiaridæ; particularly important is the new delimitation of the genera and species of northern Tiaridæ, and the demonstration of the fact that the ordinary Tiarid of the Baltic, noted by previous writers as "*Tiara pileata*" is a new species, *Halitholus cirratus*.

The most recent work on the medusæ of the Danish waters is my biological treatment of the medusæ collected in the Great Belt and Kattegat during 1909 (Kramp 1915). Eleven species are here mentioned, all previously known from our waters.

Finally, I must note Aslaug Sverdrup's investigations of the medusæ of the Christiania Fjord (1921).

SPECIAL SECTION.

Anthomedusæ.

Fam. *Codonidæ.*

Sarsia tubulosa (M. Sars).

Chart 3.

Hydroid: *Coryne sarsii* (Lovén).

The question as to the validity and delimitation of the numerous more or less doubtful northern species of *Sarsia* belonging to the *tubulosa* group is one that I have treated at length in my work on the Anthomedusæ of the North Atlantic area (KRAMP 1926 a). It will here suffice to say that I consider it most likely that *Sarsia tubulosa*, *mirabilis*, *pulchella*, *litorea* and "*blue Sarsia*", with probably *decipiens* and *densa*, all belong to one and the same species, *Sarsia tubulosa* (M. Sars), though some of the forms mentioned must be said to be fairly well defined local varieties. Further, that on the cruise of the "Dana" in 1923, I was able to ascertain that we have in our Danish waters three such varieties, differing mainly in point of colour:

Everywhere inside the Skaw and in the eastern Skagerrak the "blue Sarsia" is found, distinguished by the fact that its manubrium and tentacles are of a rich, clear and pure azure hue, the medusa itself being also in its whole structure finer and more slender than the other two forms.

In the North Sea we occasionally find the typical *Sarsia tubulosa*, which is the most heavily built of the three; the manubrium is as a rule brown or brownish yellow, but occasionally green; this is the form common on the west coast of Norway, the one described by SARS (1835). For the sake of brevity, I shall refer to this form hereafter as "brown Sarsia".

In the North Sea, again, there is found a "red Sarsia", distinguished by the fact that the proximal, gonad-free part of the manubrium is relatively long, and the apical chamber and tentacle bulbs are a brilliant fiery red, whereas the manubrium is almost colourless; this is probably identical with "*Sarsia densa*" Hartlaub.

I must further add that I was for some time of opinion that the Danish waters sheltered a stock of the small *Sarsia eximia* Allmann, which differs from *S. tubulosa* in its short, thick manubrium, which has no proximal, gonadless portion. I considered that a great number of the small Sarsia which swarm in our inner waters (notably in the Belt Sea) during the first few months of the year, belonged to *S. eximia*. Later, however, I realised that all these small medusæ were in reality young *Sarsia tubulosa*; even the largest of them (4—5 mm high), have no trace of gonads; the short, barrel-shaped manubrium, so much like that of *S. eximia*, is merely a result of contraction. The distinction made between the two species in my work on the medusæ from the Langelandsbelt 1909 (KRAMP 1915) is thus incorrect.

As the three forms of *Sarsia tubulosa* differ considerably as regards their dis-

tribution in the Danish waters, it will be most proper to treat them separately. But here we are faced with the difficulty that the colours soon disappear in the preserved specimens. After careful examination of some of the older material, however, I think I can say that everything taken inside the Skaw and in the eastern Skagerrak comes under blue Sarsia. From the North Sea, prior to 1923, we have only 4 specimens in all, and these can all without doubt be referred to the brown Sarsia. The older material contains no representative of the red form.

"*Sarsia tubulosa*" is often recorded in the journals of the "Thor". As far as our own inner waters are concerned, we can doubtless safely assume that the specimens in question were blue Sarsia; I have therefore entered them as such in the list, Table XIII, to which reference may be made. The records of Sarsia in the Skagerrak and North Sea are very few in number (I have only found five); as we have here no means of ascertaining which form it was, I have omitted them from the list. The most important point, however, is this very fact of their being so few, showing that any form of *Sarsia tubulosa* is rare in the North Sea and on the Danish coasts of the Skagerrak.

Geographical distribution. It is impossible to give any further account of the geographical distribution of the three varieties individually. I will therefore briefly say that *Sarsia tubulosa*, in the wider sense, is found throughout all the North Atlantic coastal waters from the shores of France to the Barents Sea, and from Newport in North America to the Umanak Fjord on the west coast of Greenland. It is also met with in the Pacific, from San Francisco to Puget Sound. In all the boreal and temperate regions it is a pronounced spring form, but in more northerly waters it appears later on in the summer.

The Hydroid. — Just as there are different medusa forms of *Sarsia tubulosa*, so also different hydroids have been described to correspond. S. L. Lovén (1836) described *Coryne sarsii* from Bohuslän where it has also been found since then; these, as well as the "*Syncoryne sarsii*" found at Kiel and Warnemünde are presumably the hydroid of the blue Sarsia. On the west coast of Norway, according to G. O. Sars and Bonnevie, *Coryne sarsii* occurs all the way from Bergen to Lofoten. From the British Isles we find the hydroid mentioned under the same species name from two localities (Hincks 1868, p. 53). Hartlaub holds that in the waters round Helgoland, distinction can be made between two species, *densa* Hartlaub and *decipiens* Dujardin; the last-mentioned form was first discovered off the coast of France. — In Icelandic waters, Sæmundsson (1902, p. 50) has found *Coryne sarsii* in quantities at Reykjavik. Off the coasts of North America, we find *Coryne mirabilis* L. Agassiz. — I have found the hydroid of the blue Sarsia in the Little Belt and the Great Belt (*vide infra*), it differs in various respects from *Coryne sarsii* as the latter is described in extant works, but agrees fairly well with the description given by Schultze (1873) of *Syncoryne sarsii* from Warnemünde.

Works dealing with Sarsia tubulosa and Coryne sarsii in the waters round Denmark. — *Sarsia tubulosa* is often recorded in the literature from our

waters. As to the Hydroid, on the other hand we have but very little information. Nevertheless, the hydroid was actually discovered long before the medusa; it was described by S. L. Lovén (1836) from Måsön, off the coast of Bohuslän. It has also been found since in that neighbourhood, but very sparsely (Jäderholm 1909, p. 40). The hydroid has also been found at Kiel, Travemünde and Warnemünde (*vide infra*). — From the Danish waters, there is no mention of the hydroid in extant literature; Levinsen (1893) mentions *Syncoryne sarsii* from the Little Belt, but the specimens are not in the Zoological Museum, and we have no means of knowing whether the determination is correct.

The Medusa is first mentioned from waters round Denmark by Meyer & Möbius (1862, p. 231), who found it in great numbers in the Bay of Kiel in the spring; the hydroid was also found. Schultze (1873) found both the hydroid and the medusa at Warnemünde; the medusa was found at the surface on calm days in April—June. Lenz also (1882, p. 171) found both the hydroid and the medusa in the spring, in the Bay of Travemünde. — *Sarsia tubulosa* is the first hydromedusa to be mentioned in Danish works as occurring in Danish waters; it was found by Johs. Petersen in Holbæk Fjord (1891, p. 180), and in Fænö Sound in April and May (1893, p. 2—3). — *Sarsia tubulosa* is mentioned from all the permanent plankton stations 1898—1901 (Johansen & Levinsen 1903, p. 276). — Broch (1905, p. 4) mentions *Sarsia tubulosa* from Risör and neighbourhood on the south coast of Norway, in May 1904 and March—April 1905; whether this is *S. tubulosa* proper or the blue form cannot be decided. It is, however, doubtless the blue form which Théel (1908, p. 58) records as occurring en masse in the Gullmarfjord, Bohuslän, in April and May (also Aurivillius, 1898a, mentions it among the endogenetic plankton organisms of the Skagerrak). — In the international plankton lists, *S. tubulosa* is often noted from Danish waters; I have given a summary of these finds in the "Resumé Planktonique" (Kramp 1913, p. 526); this is, however, not of very great value; the most important feature is the finding of *S. tubulosa* off Stolpmünde Long. 17° E, this representing the most easterly find of the species in the Baltic up to now. More interesting are the results of the investigations in the Great Belt and Kattegat in 1909 (Kramp 1915). — Hartlaub (1907, p. 23—24) quotes earlier records of Sarsia in the Baltic and then, on the basis of the "Poseidon" collections, states that the medusa is still found in fair quantities in the longitude of Rügen, but shows a marked decrease east of there, and keeps to the salter undercurrent. Hartlaub draws attention to the small size of the Baltic Sarsia compared with specimens from the North Sea, as also the extraordinary extensibility of the manubrium. — Finally, Aslaug Sverdrup states (1921, p. 14) that *S. tubulosa* was found in the Christiania Fjord in 1915 and 1916, but only "scattered specimens at the surface during the last days of June and early July".

Blue Sarsia.

The Hydroid. — On the 26 March 1915 I found several colonies of this hydroid in Middelfart Sound off Snoghøj, at abt. 10 m' depth; they were attached,

some to *Flustra*, some to *Halidrys*. The colonies were remarkably well developed, and carried masses of medusæ at all stages, several with well-developed tentacles. I did not see the hydroid again until 18 December of the same year, when I found, at about the same spot, some few colonies attached to *Laminaria* and *Delesseria*; these colonies had hydranths, but no gonophores. I also found a small colony at Nyborg, in the Great Belt, in April.

The Medusa. There is a considerable amount of older material of blue Sarsia, from which it appears that this medusa penetrates into several of the inshore waters as for instance Frederikssund, Kallundborg harbour, and the Limfjord.

Recent material (Summary).

1909. Spodsbjerg (Langeland), 10 April—27 June, frequent throughout the period. April 20—28, at all stations of the "Karen" in the Great Belt and Kattegat, numerous in the lower water layers (see KRAMP 1915).

1911. Anholt Knob, 1 April—15 May, rare; one large spec. 1 July (Table VI).
Schultz's Grund, 14 May—6 June, every week, large specimens in small numbers, only in the deepest and intermediate water layers; 27 June common, 16—0 m; 25 July one large specimen, 26—0 m (Table VIII).
"Havörnen", 11—17 May, from the Skaw to the Baltic (Table IX).
"Thor", 28 June—7 July: few in northern Kattegat near coast of Jutland; common in Bay of Aalborg. — July 7—12: SW Kattegat several localities, but few specimens, large. — Kolding Fjord, 12 July (Stat. 1643); SW of Skjoldnæs, Ærö, 13 July (Stat. 1647); E. of Samsö, 16 July (St. 1657), specimens fairly numerous and very large. — The Sound, 17 July (St. 1665), some fully mature but rather small specimens (Table X).

1912. Anholt Knob, 15 April (Table VI).
Schultz's Grund, 5 March—24 April, all water layers, rare save on 14 March, none over 6 mm (Table VIII).
According to the journals of the "Thor", Sarsia was more or less common at several places in the western Baltic and in the Great Belt 4—6 May, also west of Samsö 8 May, only in the lower water layers.

1913. Anholt Knob, 15 April and 1 June (Table VI).

1914. Schultz's Grund, 3—31 March (Table VIII).
Anholt Knob, 15 March (Table VI).

1915. Middelfart Sound, 15 Jan.—21 May, numerous from 11 March to 4 May.
Nyborg, 28 March—17 May; 14 April numerous spec. both small and large.

1916. Middelfart Sound, 18 Jan.
Nyborg, 10 April.

1920. Near Lögstör, Limfjord, 13 April, R. Spärck.
E. of Slipshavn, Great Belt, 13 April, depth 20 m, intermediate hauls, in great numbers, Biol. Stat.
Bogense, abt. 15 April, large specimens; sent in by Mr. Trautner.

1921. Nyborg, 8—9 April, in great numbers, specimens of all sizes from 2 to 9 mm.
S. E. of Slipshavn, Great Belt, 19 April, some few specimens, at surface and near bottom (14 m), 2.5—7.5 mm, Biol. Stat.

1923. "Dana". 1—2 April and 17—30 April: almost everywhere throughout the western Baltic, the Great Belt, and Kattegat, as also off the coast of Bohuslän, and at a single locality in Tannis Bay (St. 2996). — 13—19 May: Kattegat. — 28 May—13 June: The Sound, southern Kattegat, Belts, and a few localities in the Baltic proper as far as north of Bornholm (St. 3103) (Table XII and Chart 3).

The blue Sarsia is very rare on the Danish coasts of the Skagerrak; this is plainly apparent from the "Thor" journals for 1904, 1906 and 1907, when the medusa was found but once in the Skagerrak, but recorded from several stations as soon as the vessel moved inside the Skaw (see Table XIII, cf. also the distribution as noted on the cruise of the "Dana" 1923). It is very common, however, in the fjords of Bohuslän, and in the Kattegat it is met with everywhere, though evidently commoner in the southern than in the northern portion. It is numerous in Samsö Bay, in the Belts and in the western Baltic; throughout the whole of this area it is indigenous, and it may be carried by the undercurrent right in to the Baltic proper, where it is met with in the lower, salter water layers as far as east of Bornholm. The entries in the "Thor" journals for May 1908 are particularly interesting in this respect (see Table XIII): from Femern to a little E. of Falster, a few Sarsia were taken at the surface (surface salinity 10.7—8.7 ‰), but the species was numerous in the deeper layers; east of here (surface salinity below 8‰) neither this nor any other medusa was taken at the surface, but Sarsia was often numerous in the deeper layers (for salinity see Table XIII) and was met with as far east as 15° 37′ E, to the SE of Bornholm (St. 1216). In June 1923 also, Sarsia was found far up in the Baltic (*vide infra*). In areas where the species properly belongs, the young medusæ are liberated first in January or February, culminating in March and continuing until some way on in May; adult specimens are found from April to July; the life of the medusa appears, from the data at present available, to last abt. two to two and a half months. The rate of growth appears to depend in some degree on the temperature of the water; in 1920 and 1921, when the weather was unusually mild in early spring, large fully grown specimens were met with in the Belt Sea as early as the first half of April. In 1911, on the other hand, at the "Thor" St. 1665, in the cold bottom water of the Sound (temp. 5° 7) several mature but remarkably small specimens were found as late as 17 July; their development had doubtless been impeded by the low temperature. Highly remarkable is the finding of blue Sarsia out in the middle of the Skagerrak in November 1904, when one large and one smaller specimen were taken by the "Thor" at St. 286 (see Table XIII); there can be no doubt as to the accuracy of the determination of species, so that unless the labels have been changed by accident we have here a unique instance of the finding of this species in the autumn. — By far the greater part of the stock found in our waters inside the Skaw probably originates from the littoral waters of this area; the specimens drift hither and thither with the current, and may be carried in, by minor local currents, to fjords and bays where they can still be found in the middle of summer in small shoals, after the bulk of the stock for the year has disappeared from the current waters proper (cf. cruise of the "Thor" 1911). Importations of any extent from the Skagerrak via the eastern channel of the Kattegat are doubtless only of exceptional occurrence (the medusa is remarkably rare at Anholt Knob); in 1909, however, great numbers of Sarsia appear to have come in from the north through the Kattegat, penetrating right down into the

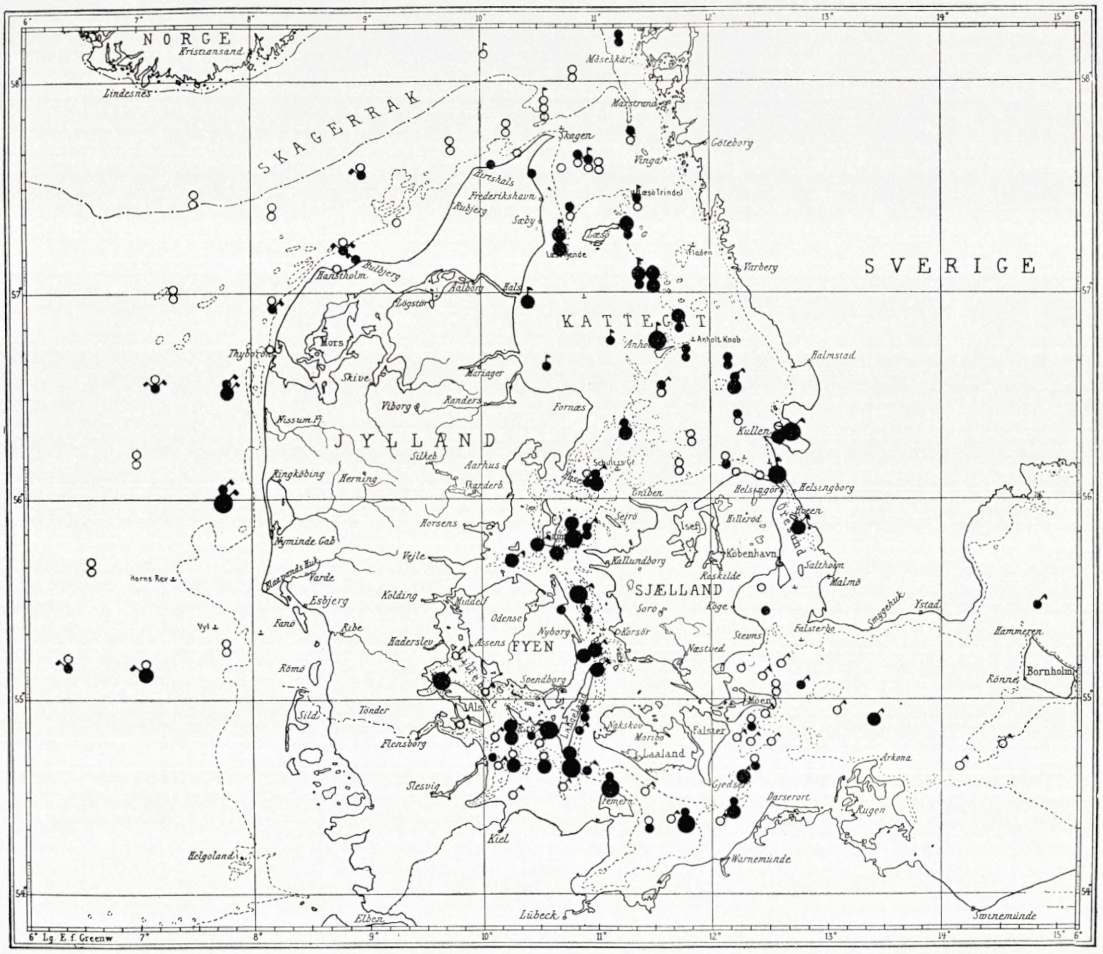

Chart 3. *Sarsia tubulosa.* Occurrence on the cruise of the "Dana" in April—June 1923. All pelagic stations up to St. 3103, 13 June, are marked on the chart. Two circles, one on top of the other, denote hauls made in upper and lower water layers. Blank circles indicate that the medusa was not taken in the hauls so marked; the three different sizes of filled circles represent the frequency of the species. West of Hirtshals, special signs are used to indicate finds of red and brown Sarsia; everything taken east of Hirtshals is blue Sarsia. The signs used are as follows:

West of Hirtshals: = red Sarsia; = brown Sarsia.
East of Hirtshals: o = stat. 2944—2996, 17—30 April.
♂ = — 3036—3054, 13—19 May.
♂ = — 3055—3103, 28 May—13 June.

Great Belt, while in May 1911, a large stock was located outside the mouth of the Limfjord ("Havörnen" St. 1511), these having apparently come from the eastern Skagerrak (see General Section Chap. I). The Belt Sea doubtless receives regular supplies of Sarsia from the Kattegat, as some of the numerous large specimens found in

May—June (or even as early as April), and which keep almost entirely to the lower salt water layers, must be presumed to have come down from the north.

The results of the cruise of the "Dana" in the spring of 1923 are very instructive, both in the information they afford as to the distribution of this species and its drifting with the currents, and also as showing the value of careful examination of representative material (see Chart 3 and Table XII).

During the first few days of April the "Dana" took several specimens of Sarsia in the Kattegat and the Sound, height of the bell 2—8 mm. Between Copenhagen and Möen, on the 19th April, Sarsia was found only once, at St. 2954 in the Bay of Köge; where an advance of the bottom water from the Sound must recently have taken place across the Saltholm ledge (see General Section Chap. I).

The medusa was lacking at Stevns and in the Bay of Præstö, but was found south of Möen and at all stations throughout the western Baltic and in the Great Belt. In the Baltic, it was very common in the lower water layers, but decreased greatly in numbers towards the north, through the Great Belt. Practically all the specimens found in the Baltic were small, height from 1 to 4 or 5 mm; only a few measured 6—7 mm (several representative samples were examined). In the Great Belt, specimens up to 9 mm were found, but here also the small ones were far more numerous. There was thus at this time (20—25 April) a large local stock of blue Sarsia in the western Baltic.

In Samsö Bay, Sarsia was numerous in the lower water layers; only a few, however, were found in the southern, eastern, and northern Kattegat, and as we move farther north, the occurrence of the medusa is more and more restricted to the upper water layers. Throughout the whole of this range, from Samsö (St. 2978) to Bohuslän (St. 2992), I noticed, even while on board, a remarkable fact which was subsequently confirmed by measurement of the specimens taken, *viz.* that those from the lower water layers were predominantly small (1—7 mm, mostly under 5 mm), whereas those from the upper water layers were almost exclusively specimens of good size (6—10 mm). This is doubtless due to the peculiar hydrographical conditions prevailing in the Kattegat at the time, which I shall discuss later on at greater length. The bottom water in the deeper portions of the Kattegat consisted of Atlantic water of high salinity (nearly 35‰); there was no reason to suppose beforehand that this water should carry a medusa such as blue Sarsia down into the Kattegat from the north; the few Sarsia found in this water were doubtless all hatched in the immediate vicinity of the places where they were taken. The surface water had been unusually fresh for some little time past, but was now of almost normal salinity (abt. 18—22 ‰); it was Baltic water moving northward, and the comparatively large Sarsia found in that water had doubtless all covered some considerable distance from places farther south; the complete absence of small specimens from the upper water layers shows that the Sarsia hatched in deep water had not made any ascent from the salt bottom water to the fresher upper layers.

A single blue Sarsia was found as far west as Tannis Bay (St. 2996, 30 April), but none were taken beyond here.

When the vessel returned to the Kattegat about the middle of May, blue Sarsia were again met with everywhere, in rather small numbers as a rule. In the eastern channel, where the bank water of the Skagerrak was now thrusting its way forward between the Atlantic bottom water and the Baltic surface water, Sarsia was found chiefly in the last-named water; in Læsö Channel and Aalborg Bay it occurred at all depths. No quite small specimens were now found, but several of 4—6 mm and some of considerable size, 10—12 mm; north of Anholt (St. 3050) many particularly large ones were taken, up to 13 mm, i. e. fully as large as the brown Sarsia of the North Sea, but with the magnificent colouring of the blue form.

About the 1. June, when the "Dana" had put to sea again after a stay of 10 days in Copenhagen, Sarsia was still fairly common in the southern Kattegat and Belts; it seemed, however, to have disappeared from the western Baltic. The size of specimens varied from 4 to 9 mm in the material brought home, but it should be noted that only a few specimens, selected at haphazard, were preserved from this part of the cruise, during which I was not on board myself. — Finally, Sarsia was taken at a few localities in the Baltic proper, as far east as Long. 14° 49′ (St. 3103), N. of Bornholm.

Since the greater portion of the large stock of Sarsia medusæ in our inner waters are indigenous, it is remarkable that the Hydroid should so rarely have been found there, though it must of necessity be fairly common. Judging from my own observations of the hydroid in the Little Belt in 1915, the explanation of this apparently remarkable rarity is a very natural one, *viz.* that the hydroid colonies die off in the spring, after having liberated their medusæ, while the young colonies produced from the ova of the medusæ evidently remain in an inconspicuous state throughout the summer, and are thus easily overlooked. If the colonies only exist in a well-developed state during the months of winter and early spring, it is not unnatural that they should be but rarely found, as the collection of such organisms as hydroids, at any rate in our waters, is practically restricted to the summer months. This explanation is confirmed by one or two observations on the part of other writers. Hartlaub ("Altern einer Kolonie von Syncoryne") states that he kept a colony of "*Syncoryne decipiens*" alive in an aquarium at Helgoland for four years; he writes (p. 93): "Sie starb in den Sommermonaten scheinbar völlig ab, schlug aber jeden Winter mit erneuter Kraft aus". So also McLean Fraser writes (1914, p. 103) with reference to *Syncoryne mirabilis* from Vancouver, on the west coast of North America, that in the spring, when the medusæ have been liberated, "the hydroid dies off and nothing is seen of it later in the year."

Brown Sarsia.

Material.

1903. "Thor" St. 44, 4 miles S. of Blaavandshuk, 15 April, 11 m, 3 spec., height 5, 7, 9 mm.
1913. Ringköbing Fjord, E. of Ballehage, 4 May, 1 spec.
1923. "Dana" St. 2998, N. W. of Bulbjerg, 30 April, depth 23 m, Ytr.[1] near bottom, few spec., height 5—12 mm.
St. 2999, W. of Bragerne, 1 May, 15 m, Ytr. 25 m wire, 1 spec., 10 mm.
St. 3001, W. of Vorupör, 2 May, 24 m, Ytr. near bottom, few spec., 8—12 mm.
St. 3003, W. of Bovbjerg, 2 May, 24 m, Rtr. 20 m wire, a few spec.; Ytr. near bottom, 41 spec., 5—12 mm.
St. 3004. W. of Sönder Lyngvig, 2 May, 26 m, Rtr. 30 m wire, some few spec. Ytr. near bottom, in great numbers, 7—15 mm.
St. 3012. 32 miles W. of Bovbjerg, 7 May, 31 m, Ytr. near bottom, 2 spec., 8—10 mm.

The earlier material is, as will be seen, very scanty indeed; I should add that on one occasion, a single specimen of a Sarsia "tubulosa" was taken at Horns Rev Lightship (3 April 1911). The great numbers of brown Sarsia off the west coast of Jutland in 1923 (see Chart 3) may safely be said to be an unusual phenomenon. It would therefore be interesting if we could ascertain the cause.

A glance at the chart (p. 29) at once shows that the distribution was in itself remarkable. At St. 2997, in the middle of the Jammer Bay, where there was a bank water fauna rich in number of species as of specimens, the brown Sarsia was altogether lacking; a few specimens were met with in Vigsö Bay, and from there onwards, the numbers increased southward along the west coast of Jutland as far as the northern edge of Horns Rev, where the species was extremely numerous. South of the reef it was completely absent. When the "Dana", after a couple of day's stay at Esbjerg, again moved northward, I expected to find the brown Sarsia again at the off-shore stations; but it was not there; only at St. 3012 were two specimens taken. The medusa was thus keeping close inshore, by far the greater part in the lower water layers, and there was a huge accumulation of them just north of Horns Rev. This, in connection with the complete absence of the species south of the reef shows, in the first place, that no recent movement of the water can have taken place from north to south, while the distribution of certain other medusæ (red *Sarsia*, *Bougainvillia britannica* etc.) shows on the other hand that there was no current flowing from the south across the reef. The chart shows a branch of the reef running out from the western end of Horns Rev (see the 20 m line); between this branch and the shore there must have been a sheltered corner, and it was here the brown Sarsia had gathered in such abundance. Had now all this host of Sarsia been carried direct to the spot from distant waters, or were they hatched on the shores of western Jutland, as the offspring of a stock introduced the year before? — I would here at once point out that the distribution of various other species suggests that there really was, in 1922, a considerable importation of northern medusæ into the waters

[1] Ytr. = Young-fish trawl. Rtr. = Ringtrawl.

of the west Jutland coastal banks, where their offspring were found in the spring of 1923; these species, however, were not found together with the brown Sarsia, but on the contrary, in just those tracts where it was missing, to wit, south of Horns Rev and at the outer (off-shore) stations; there is thus nothing in this to suggest a corresponding origin for the brown Sarsia. — The great majority of the Sarsia were very large; there were, however, a few of medium size (down to 5 mm) but none altogether small. The size of the specimens does not disprove the theory that the whole stock was imported, but indicates that such importation must have taken place quite recently if at all; on the other hand, the lack of small specimens is no complete proof of such introduction, though from what I know of the occurrence of the species off the west coast of Norway, in a native population we should expect to find young specimens at this time of year. It must be pointed out that specimens of 5—7 mm were found only at the northernmost stations; at St. 3004, where the great mass of specimens was found, none were under 7 mm. This might suggest at any rate a movement towards the south. Even though the size of the specimens does not afford any direct proof either for or against, I consider nevertheless that the distribution of the stock argues decisively against its being of local origin. To judge from the occurrence of the species off the coast of Norway, where it has been thoroughly studied by DAMAS, the large individuals constituting the bulk of the material from western Jutland should be abt. $1^1/_2$—2 months old, and the medusæ would thus, if hatched off the west coast of Jutland, have been kept to the area in question for the whole of that period; it is inconceivable, however, that such a numerous stock should have so remained within such a restricted area; and this, moreover, on a coast exposed to strong and variable winds, with tidal currents of considerable strength. A large home-bred stock would certainly have been scattered in a comparatively short time, extending over a considerable space. The same would, of course, take place ultimately in the case of an imported stock. I therefore conclude that the stock in question, at the time when we found it, had quite recently arrived on the spot, almost in a lump as it were, and had not yet had time to disperse. There is not the slightest likelihood that it should have come from the open waters of the North Sea; it is undoubtedly of Norwegian origin; the Sarsia is a well-marked coastal form on the west coast of Norway.

As to the route followed, we can form a very reasonable guess from the salinity of the water at the "Dana" stations. The temperature on the other hand is of but slight importance at this time of year, being very uniform throughout the whole of the North Sea (see charts for May in Bull. Resumé de l'Hydrogr. 1909). Round Hanstholm, the salinity at the bottom (30 April—1 May) was 33.6—33.8 ‰; at the outer stations between the Jutland Bank and Horns Rev (St. 3009—3012, 6—7 May) it was fairly high, abt. 34‰. The bottom water at the two stations where Sarsia was common, on the other hand (St. 3003 and 3004, 2 May) showed a comparatively low salinity, 32.9 and 32.7 ‰. The same low salinity was recorded at the two inner stations south of Horns Rev, but, as already mentioned, the dis-

tribution of medusæ shows that no interchange of water had taken place across the reef at that time. A very striking phenomenon was encountered at the mouth of the Skagerrak on the 7 May (St. 3014 and 3015). The extremely low surface salinity (28.5 and 29.9 ‰) might conceivably be due to outflowing Baltic water; this, however, would not suffice to explain the fact that there was an unusually low salinity (abt. 32.5 ‰) right down to the bottom; at St. 3014 (depth 135 m) the salinity at 100 m was still only 32.7‰, *i. e.* precisely as at St. 3004 north of Horns Rev, where the Sarsia were so numerous. Farther east in the Skagerrak again, a similar low salinity was noted at the outer stations. The water here was undoubtedly of Baltic origin; it had not, however, come directly through the Kattegat, but had spread out from the southern shores of Norway. At some time or other, shortly before the 1st of May, a mass of water from the west coast of Norway must have taken part in this movement, and was carried, possibly by the strong north-westerly and northerly breezes that prevailed on the 23—24 April, eastward round the Jutland Bank and down to the west coast of Jutland, where it pushed on southward in a narrow fringe along the coast, taking with it a great mass of Sarsia; north of Horns Rev, this mass of water came to a stop, forming an eddy perhaps, and here it was that the main bulk of the Sarsia assembled, a smaller number being left behind in more northerly waters. The phenomenon must, as already mentioned, have been of very brief duration. It seems to me that this is the only possible explanation of the remarkable features of distribution observed.

We can, then, state that the brown *Sarsia tubulosa*, which belongs properly to the coastal waters of the west coast of Norway, occasionally visits the western shores of Jutland. To judge from what has been observed up to now, such visits are only occasional, and as a rule only few specimens appear, but in certain cases there may be an influx en masse, as in the spring of 1923.

Red Sarsia.

I have not been able to discover any older material of the "red Sarsia" mentioned above; all that I know of is that from the spring cruise of the "Dana" in 1923, when I found the medusa, which is very conspicuous in the living state, at several places in the North Sea and in the western parts of the Skagerrak.

Material.

1923. Off the west coast of Jutland and in the south-western part of the Skagerrak, "Dana" St. 2998—3022, 30 April—9 May (Table XII and Chart 3).

The chart distinctly shows that the distribution of the red Sarsia differed altogether from that of the brown Sarsia at the same time. South of Horns Rev, the red Sarsia was fairly common (St. 3007), and specimens of all sizes from $2^1/_2$ to 12 mm were found here. It was thus evidently indigenous in this area. Since it was lacking at the same time north of the reef, the occurrence here of this medusa,

in conjunction with others, especially *Bougainvillia britannica*, proves that there had not recently been any movement of water across the reef from south to north, at any rate as regards the lower water layers, the only ones in which the red Sarsia was found. — On the grounds about Hanstholm also, the red Sarsia must have been in its own territory, as the few specimens found in Vigsö Bay were small, 3—5 mm. A solitary specimen was taken off the northern part of the west coast of Jutland (St. 3012, S. of the Jutland Bank).

Whether the red Sarsia is normally indigenous in these waters we cannot say; if identical with "*Sarsia densa*", its normal habitat should be in the neighbourhood of Helgoland. Its occurrence in the spring of 1923 distinctly showed that the hydroid must, during the previous winter, have been growing in the waters south of Horns Rev and on the banks at the south-western entrance to the Skagerrak. In the last-mentioned water, only small specimens of the medusa were found; it would seem then, as if they had not been liberated here before the end of April, whereas south of Horns Rev, the liberation began considerably earlier but was continued at any rate up to the 1 of May or thereabouts (see St. 3007).

Purena gemmifera (Forbes).

Chart 4.

Sarsia gemmifera Forbes 1848.

Codonium gemmiferum Haeckel 1879.

Hydroid unknown.

Purena gemmifera rarely attains a height of more than 5 mm, its reproduction takes place by gemmation, the buds being produced from the long manubrium, and the great majority of specimens found in the plankton are gemmiferous, so that the later, mature stage is presumably of brief duration.

The area of distribution ranges from the Mediteranean to the west coast of Norway and the Danish Belt Sea. — Hartlaub has taken it at Roscoff and Concarneau off the coast of France in June; in British coastal waters it is not very numerous as a rule; it is found at Plymouth and in Valencia Harbour from June to September; has been taken in the Firth of Clyde from end of July to early October. Fowler's investigations in the Faeroe Channel record it from July and August; Crawford notes it from St. Andrews Bay 16 August. Finally, it has been found at the Shetland Islands (Forbes). — Up to now, the only finds recorded from the west coast of Norway are in the neighbourhood of Bergen, where it appears in July or August and may remain until October. It may possibly exist farther north, but there are no observations from there for the months in question. — From the point of view of our Danish waters, *Purena gemmifera* must be regarded as a southerly form.

The first mention of *Purena gemmifera* from the waters round Denmark is by Johansen & Levinsen (1903, p. 276, *Dipurena ophiogaster*); it was taken in Læsö Channel on the 27 July 1898 "in enormous quantities", and at Schultz's Grund

from early August to mid October 1899 and in August 1900. The only record from the Skagerrak up to date is that given by BROCH (1905, p. 4): Söndeled Fjord on the coast of Norway, September 1904. — HARTLAUB (1907, p. 59) mentions it from the Little Belt and the Bay of Kiel in August.

Material.

1891. Fænö Sound, 23 Sept., 3 spec. (Posselt).
1910. Hellebæk, 25 July, surface, 7 spec. (Kramp).
Schultz's Grund Lightship, 1 Aug.—1 Sept., 10—0 and 25—0 m (Table VII).
1911. Schultz's Grund, 4 July—15 August, few in number, mostly in the lower water layers (Table VIII).
"Thor". — 4 and 7 July: round Læsö and Anholt; 8—11 July: Samsö Bay; 16 July: E. of Samsö; 17 July: North of Sealand and in The Sound (Table X).
1912. Anholt Knob, 15 July—15 Sept., sometimes in quite large numbers (Table VI).
Schultz's Grund, 9, 16, and 23 July, rare (Table VIII).
1913. Anholt Knob, 15 July, 5 Aug., and 1 Oct., rare (Table VI).
Schultz's Grund, 19 Aug. and 14 Oct.—18 Novr., at all depths, few in numbers (Table VIII).
Between Gniben and Hasenöre 9 July, motor boat from the "Thor", St. 2089 and 2091, 1 spec. each.
1916. Nyborg Fjord, in the plankton, 28 Oct., 22 spec.

Purena gemmifera lives in the middle part of the Kattegat, Samsö Bay, and the Sound, but seems only exceptionally to penetrate into the Belts (see Chart 4); evidently, then, it requires a certain minimum of salinity. As regards the first occurrence of the medusæ at the lightships of Anholt Knob and Schultz's Grund, we see from the tables that it took place at the same time in each of the years 1911, 1912, and 1913, and simultaneously at both localities; *viz.* in the first half of July. (No collections were made at Schultz's Grund in July 1913, but the medusa was found at two places closely adjacent on the 9th July). There is, on the other hand, a great difference between the three years in regard to frequency of the species; and despite careful analysis of the material available, it has proved impossible to discover any relationship between these differences and the hydrographical conditions. Possibly the variations in the frequency of the medusa may be due to peculiarities in the development of the previous hydroid generation; but since we do not know the hydroid, or even where it lives, we cannot say anything positive as to this. As regards the time when the medusa disappears from the plankton, I would point out that in 1911, it disappeared from Schultz's Grund as early as 15 August, whereas in 1913, after an absence of two month (from 19 Aug.), it reappeared on the 14th of October, and remained for over a month, until 18 Novr. It is quite possible that the early disappearance in 1911 may have some connection with the high temperature of the water that summer, which may have accelerated the development of the individuals, bringing the stock at an earlier period to the stage where gemmation ceases. In 1913, the temperature at all depths was lower on the whole.

As *Purena* is practically lacking off the west coast of Jutland and in the Ska-

gerrak, and appears in the Kattegat at about the same time in all parts, there can be no doubt but that it is indigenous here, and not imported from the Skagerrak. Despite its lively reproduction by gemmation, it is never found in great numbers in our waters; its (unknown) hydroid is therefore probably rare. Both the horizontal and the vertical distribution of the medusa suggest that the hydroid lives in the deeper parts of the Kattegat. It sends out a number of medusæ in July; the number is further gradually increased by gemmation; for three or four months the stock is carried this way and that by the currents, until the time when gemmation ceases and maturity sets in, when the number of the medusæ is suddenly reduced.

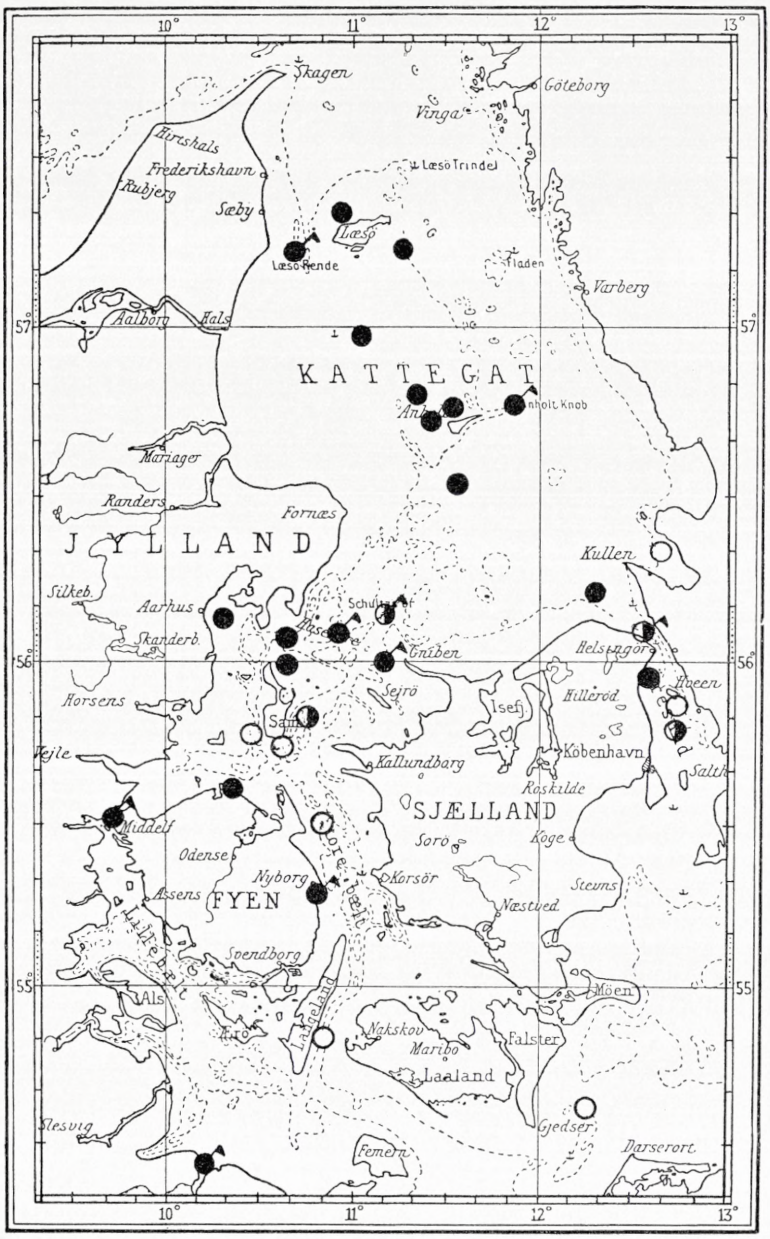

Chart 4. ● *Purena gemmifera*, finds during the cruise of the "Thor" 1911; ◢ other finds. — ○ finds of *Euphysa tentaculata*. ◑ finds of both species.

Eucodonium brownei
Hartlaub.

Hydroid unknown.

This remarkable little gemmiferous medusa was first described by Browne (1896, p. 473, Pl. XVI, fig. 2) under the name of *Dipurena sp.*, from two specimens taken at Plymouth, 10 Sept. 1895. Hartlaub (1907, p. 71) elevated it to the rank of a new genus and species, *Eucodonium brownei*. — Neppi & Stiasny (1913, p. 14) have

since found the species at Trieste in October, and give a new brief description and illustration.

One specimen of this species was taken at Schultz's Grund on the 20 March 1901.

Euphysa aurata Forbes.

Chart. 5.

Hydroid: *Corymorpha nana* Alder.

Geographical distribution. — The Hydroid of this little medusa has hitherto only been recorded from three places; E. coast of England (Northumberland), Plymouth, and in deep water near the Tanafjord in the northernmost part of Norway.

The Medusa is found off the shores of northern Europe from the English Channel to the Murman coast; its distribution within this range is mainly of a northerly character, the species being scarce in the southern British waters (most southerly find recorded, Scilly Isles), but numerous off the coast of Scotland and very common also on the west coast of Norway, in the fjords from Bergen to Aalesund. It has been taken several times on the Murman coast; I have also seen a specimen from Disko Bay, on the west coast of Greenland (for details, see KRAMP 1926 a). — From Helgoland, the species has not been recorded with certainty.

As we shall presently see, the occurrence of the medusa in Danish waters is restricted to the summer and autumn months; it is remarkable therefore, that in other waters, off the coasts of Britain and Norway, it should be taken at nearly all seasons of the year, right from early spring to late in the autumn.

Works dealing with *Euphysa aurata* in the waters round Denmark. First mentioned by MÖBIUS (1884, p. 65) from Kiel, and strangely enough, in April, a remarkable contradiction to all other records. AURIVILLIUS (1898a, pp. 266, 276, 282, 310, 360) has found *E. aurata* several times in the fjords of Bohuslän in July, August, and September, generally in small numbers. — ASLAUG SVERDRUP (1921) states that it appears annually in the Christiania Fjord, but as a rule in small numbers — JOHANSEN & LEVINSEN (1903) record it from the Skagerrak (north of the Skaw) in July and August, from the Kattegat (Læsö Channel, Anholt Knob, and Schultz's Grund) in August and 1 Novr., from the Great Belt (Knudshoved) in September and 1 November. The writers add (p. 276) "This late occurrence in our southern waters may perhaps indicate that the medusa is carried southward by the currents from the Skagerrak." We shall later proceed to consider how far recent observations tend in the same direction. — Finally, HARTLAUB mentions (1907, p. 81) the medusa from Stollergrund and Kiel in the western Baltic in August, September, and October (common in October 1895).

Material.

As regards older material, apart from that mentioned by Johansen & Levinsen, there are only a few specimens from Frederikshavn 15 July 1898 and 24 July 1899; and from Sprogö, in the Great Belt, 27 Sept. 1898.

Recent Material.

1909. Spodsbjerg, Langeland, 5, 7, and 16 June, lower water layers, 4 specimens in all.
Little Belt, near Middelfart, 16 July, 7 spec. (Kramp).
1910. Hellebæk, 25 July, surface, 11 spec. (Kramp).
Schultz's Grund, 1 Aug.—14 Sept., common throughout the whole of this period, especially numerous about middle of August, by far the greater part in the lower water layers (Table VII).
North coast of Sealand, and Humlebæk in the Sound, end Oct.
1911. Horns Rev, 21 Aug. and 18 Sept., rare (Table V).
Anholt Knob, 1 July—16 Oct., fairly common in August (Table VI).
Schultz's Grund, 11 July—12 Decr., not common, most in August, very rare in the upper water layers (Table VIII).
Cruise of the "Thor". — A single station (1552) in the North Sea, not in the Skagerrak; fairly common in the northern Kattegat 28 June—4 July; a very few specimens at Anholt and in Samsö Bay 7—16 July; lacking in Aalborg Bay and in the Belt Sea (Table X).
1912. Horns Rev, 15 July (Table V).
Anholt Knob. 1 Jan.; 15 July—1 Oct., in all hauls, few spec. (Table VI).
Schultz's Grund, 25 June—15 Oct., rare except on 17 Sept. (no samples from Aug. and first half Sept.); almost exclusively from lower water layers (Table VIII).
1913. Horns Rev, 7 July—18 Aug., in nearly all the hauls, but rare; also 29 Sept. (Table V).
Anholt Knob, 15 July—1 Oct., in all hauls, rare except on 15 Aug. (Table VI).
Schultz's Grund (investigations commenced 19 Aug.), 19 Aug.—2 Sept., fairly common; 25 Sept.—21 Oct., and 2 Decr., rare (Table VIII).
Between Gniben and Hasenöre, 9 July, 10 spec.
1915. Middelfart Sound, 23 July and 18 Sept., common (Table XI).
1919. 2 miles S. of the Skaw, 5 Novr., surface, 1 spec. (Kramp).

Euphysa aurata was observed every summer from 1911—1913 at the Horns Rev Lightship, but it is only under certain circumstances that it is found here.

The hydrographical conditions in the North Sea during the summer of 1911 were marked first and foremost by the unusual difference between surface and bottom temperature in May, June, July, and August. I shall later on, in the General Section, go further into this. A mixture of Atlantic water and the cold "northern bank water" was then pushing southward along the west coast of Jutland, forming a barrier against the warmer water of the Jutland Current. The greatest difference in temperature recorded on the cruise of the "Thor" in the North Sea was at St. 1552 (see Station Chart, Chart 20). The surface temperature here was 12°9, bottom temperature 7°1, difference 5°8. At this station, and nowhere else, several specimens of *Euphysa aurata* were found together with *Lizzia blondina* and *Bougainvillia britannica*, which were also found at several other stations near at hand, undoubtedly brought down from the north. On the 21 Aug., when 7 specimens of *Euphysa* were taken at Horns Rev, the difference in temperature between surface and bottom was 6°6, which is rather unique in this locality. Everything thus suggests that the specimens of *E. aurata* taken off the west coast of Jutland in 1911 were brought down from the northern part of the North Sea and were not natives of the Jutland Current.

In the summer of 1912, the north-going current at Horns Rev was fairly strong,

and the temperature was practically uniform throughout all water layers all the year round, with the exception of July! on the 15th of July, when *Euphysa* was found, the difference of temperature between surface and bottom was 17°7 ÷ 12°1 = 5°6. This, however, is due rather to a sudden and marked increase of the surface temperature than to a fall in the bottom temperature; some fall, however, there was, especially noticeable at 20 m' depth. In July then, there was, beneath the warmer water of the Jutland Current, a distinct colder under-layer, which must have been brought down from the north.

In 1913, *Euphysa aurata* was commoner than in any of the other years at Horns Rev; true, it was never met with save in very small numbers, but occurred in nearly all hauls from 7 July to 18 Aug., and again on the 29 Sept. From April right on till October the north- and south-going currents held each other in check; the Jutland Current was held back by a movement of water from the north, and it is undoubtedly this water which brought *E. aurata* to Horns Rev (see General Section).

From the above then, we may say that this species only appears in small numbers at Horns Rev, and then only during the months of July, August, and September, when there is an inflow of water from the north.

With regard to the occurrence of *Euphysa aurata* in our other waters, I would first briefly state as follows: From the Skagerrak, no other finds are known beyond those noted in the literature (*vide supra*). — In the Kattegat, it appears every year at Anholt Knob and Schultz's Grund. It has also been taken at several other places in the Kattegat (see Chart 5); also in the Sound and in the Belts, and, according to Hartlaub, in the Bay of Kiel.

The suggestion of Johansen & Levinsen noted above, that the Kattegat receives its stock of this medusa from the Kattegat will soon be found to be incorrect. In 1911, the species appeared at Anholt Knob and Schultz's Grund with only 10 days between (1 to 11 July) and at about the same time it was found on the cruise of the "Thor" at several places between the Skaw and the north coast of Fyen; many of the specimens were very small. In 1912, small specimens were found at Schultz's Grund long before the first appearance of the species at Anholt Knob, and in 1913, I found it at the entrance to Samsö Bay on the 9 July, some days before it appeared at Anholt Knob. There can therefore be no doubt but that the species is indigenous in the Kattegat. The regular occurrence at Anholt Knob, in conjunction with the distribution in July 1911 suggests that the hydroid lives in the deeper parts of the Kattegat, the medusa being carried thence with the in-going undercurrent down into the Belts, while local currents may also bring it in to the coasts. It is not certain that it is constantly indigenous in Samsö Bay; it certainly was so in 1915, when I found it in considerable numbers in Middelfart Sound on the 23rd of July with a south going current; in July 1911 it was not found in the Belts. Its endogenetic range is doubtless variable, as the occurrence of a few individual specimens in the Langelandsbelt as early as 5, 7, and 16 June 1909 (Kramp 1915)

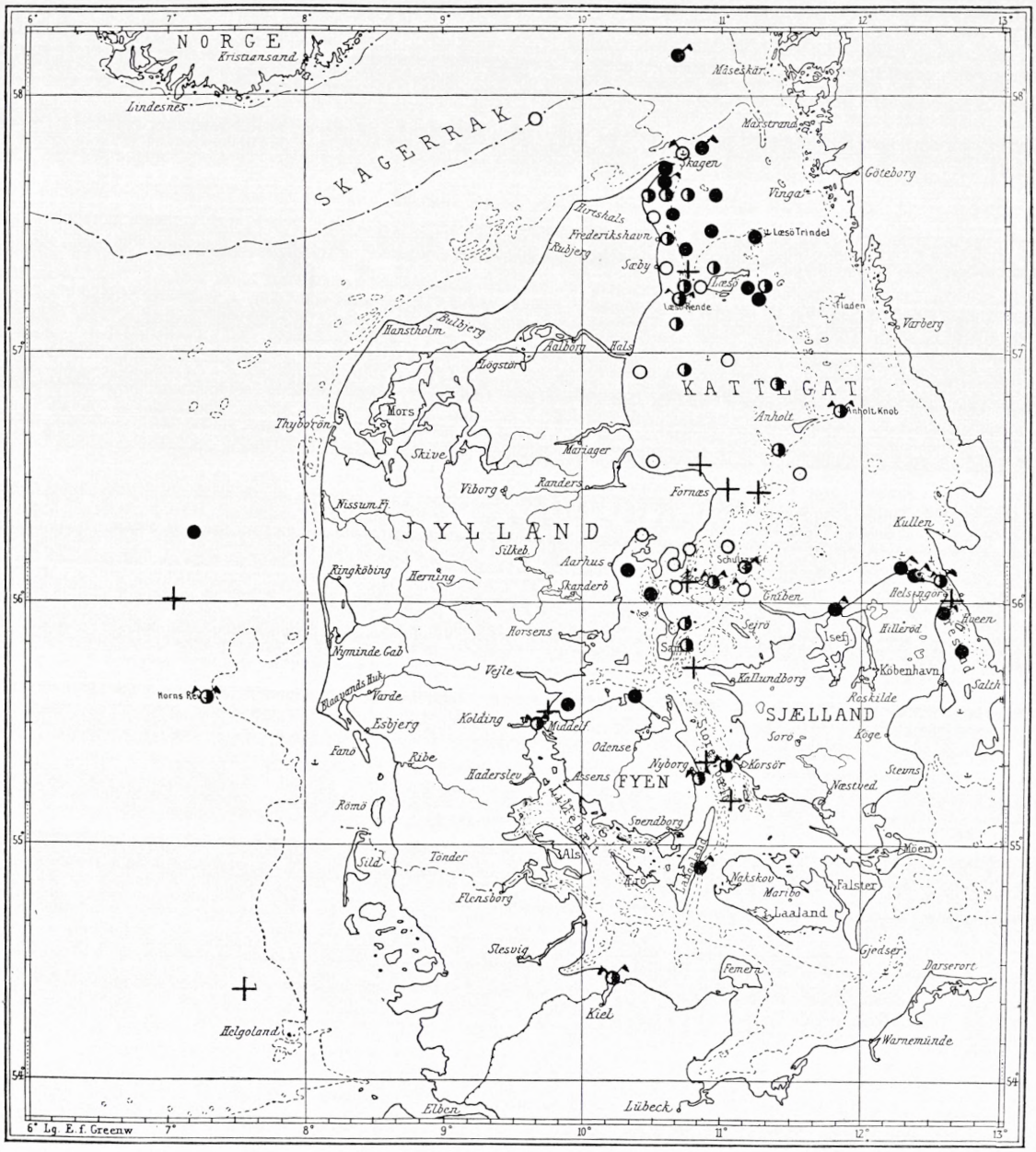

Chart 5. ● *Euphysa aurata*, "Thor" 1911, ◢ other finds.
○ *Steenstrupia nutans*, "Thor" 1911, ◠ other finds.
◑ Finds of both species of medusæ.
+ Finds of the hydroid *Corymorpha nutans*.

can only mean that the species was indigenous that year in the Great Belt, which, according to all other observations, is not normal.

The hydroid begins to liberate its medusæ in June, the process continuing throughout the summer; the main occurrence is in August, and, as a rule, the medusa disappears in October or November, but isolated specimens may occasionally be found as late as December, or even at the New Year (Anholt Knob 1 Jan. 1912). It is possible that some of these late-comers may originate from the Skagerak, but as the medusa does not properly belong to the Jutland Current, and is relatively rare off the coast of Bohuslän (Aurivillius), appearing in the fjords there at the same time as in the Kattegat, any importation from the northward must doubtless be but very slight. — The interesting occurrence at Schultz's Grund in August—September 1910 will be further referred to in the General Section.

Euphysa tentaculata Linko.

Chart 4.

Hydroid unknown.

At several localities in the southern Kattegat and the Belt Sea there has been found a small medusa which in most respects resembles *Euphysa aurata*, but differs from this especially in having 3 well-developed tentacles, the one opposite the rudimentary tentacle bulb being somewhat longer than the other two. The height of the bell may amount to 6 mm, *i. e.* somewhat more than that of *E. aurata*. The medusa agrees exactly with the description of *Euphysa tentaculata* Linko from the Barents Sea (Linko 1904). A further account of the morphology of this medusa and its position in regard to classification will be found elsewhere (Kramp 1926 a).

Material.

1911. "Thor" St. 1657, E. of Samsö, 16 July, 24—0 m, 1 spec., height 1½ mm.
"Thor" St. 1665, S. of Hveen, 17 July, 22—0 m, 4 spec., height 1½—3 mm (Table X).
1912. Schultz's Grund Lightship, 2 July, 26—0 m, 5 spec., ½—2½ mm.
do. 16 July, 26—0 m, 1 spec., height 2 mm (Table VIII).
1923. Cruise of the "Dana" (Chart 4 and Table XII).
19 May—5 June, Stat. 3054—3082, height 2½—4 mm.

Euphysa tentaculata has thus been found: in the Sound and in the vicinity of the northern entrance to that water, in the south-western Kattegat and Samsö Bay, in the Great Belt and the Langelandsbelt, and finally, at a single locality in the Baltic a little east of Gedser. The size of the specimens shows that the species is indigenous throughout the whole of this area; the specimen from Gedser was only 2 mm high, and cannot have come very far; it is possible however, that it may have been hatched in the western Baltic and carried in through Kadetrenden, in the northern part of which it was found. The species is evidently not common, the number of specimens found being but small. — The time of occurrence extends from mid May to mid July, and presumably somewhat later, young specimens having been found as late as mid July.

Steenstrupia nutans (M. Sars).

Chart 5.

Syn. *Steenstrupia rubra* + *flaveola*, Forbes 1848.
— *galanthus*, Haeckel 1879.
Hydroid: *Corymorpha nutans* M. Sars (1835).

Geographical distribution.

The medusa *Steenstrupia nutans* is known from various places in the Mediterranean. If *St. gracilis* Brooks is identical with *St. nutans*, then the species also lives on the east coast of North America, S. of Virginia; Bigelow (1915 p. 316—317) describes the American medusa as a neritic warm-water form.

On the shores of northern Europe, *Steenstrupia nutans* appears as a neritic, temperate-boreal species; both hydroid and medusa are known from the North of France almost as far as Lofoten on the west coast of Norway, and the southern Icelandic waters. The species is common both in the northern and in the southern part of its area of distribution, but the occurence of the medusa falls much earlier in the year in the south than in the north. It appears on the southern shores of Britain in March or April, in the Scottish waters in May, in Norwegian and Icelandic waters in July. It is recorded from Helgoland from early June to mid August, but is never numerous (Hartlaub 1907, p. 77).

Waters round Denmark.

The Hydroid: For localities of finds see chart. The hydroid is found on sandy bottom, but never in very shallow water (7—28 m). The bottom may have a certain admixture of ooze but consists more often of coarse sand. Great numbers have often been taken within a narrowly restricted area, but the occurrence of the hydroid is highly irregular. It was taken, for instance, en masse in Middelfart Sound in July 1900 by Th. Mortensen, but in 1907, when the Biological Course had its headquarters at Middelfart it was looked for in vain; in 1909, I found several specimens at about the same spot where Dr. Mortensen had found his; I took careful bearings of the locality, and in 1912, Dr. Mortensen made another find, but in 1915, when I made repeated investigations in these waters, I did not succeed in finding any; the Biological Course of 1916 was equally unsuccessful. — Three specimens from the Sound, taken on an excursion with the Danish Natural History Society on the 29 August 1920 were much larger than any other specimens I have seen, the majority of which were taken in June and July. This, in conjunction with Hartlaub's find of small specimens (10—15 mm) at Helgoland on the 12 May (Hartlaub 1894) leads me to believe that the hydroid is an annual.

Works dealing with *Steenstrupia nutans* in waters round Denmark. — First mentioned by Schultze 1875, p. 136, *Corymorpha nutans:* Great Belt between Sprogö and Korsör, 22 July, 1872, surface — Further: Aurivillius 1898, p. 178,

St. galanthus: Gullmarfjord, 19 Aug. 1895, surface. — Aslaug Sverdrup 1921, Kristianiafjord, a single specimen at Dröbak, 9 July 1915. — Johs. Petersen 1893, p. 32, Fænö Sound. — Hartlaub 1907, p. 77, Kiel 4 Sept. 1866. — Johansen & Levinsen 1903, *St. galanthus* + *Hybocodon nutans;* rare at Skagens Rev (in August) common especially at Læsö Channel and Anholt Knob, but also at Schultz's Grund and Knudshoved from the beginning of June to end September, found as late as 2 Oct. These writers come to the conclusion that "its main occurrence in the Kattegat and the Belt Sea is not due to any immigration from without" (p. 276). — As will be seen, the medusa has not hitherto been found off the Danish coast of the North Sea, and the few records from the Skagerrak seem to suggest that it is rare here, though well known in the Kattegat and the Belt Sea.

Material.

As regards older material, apart from that noted by Johansen & Levinsen (1903) there are only 6 specimens from Anholt Knob 15 May 1899.

Recent Material (Summary).

1910. Hellebæk, 27 July, surface, Kramp.
Schultz's Grund, some spec. early Aug., numbers decreasing until 25 Aug., a couple of specimens 12 Sept.; almost exclusively from lower water layers (Table VII).

1911. Anholt Knob, 1 Aug. (Table VI).
Schultz's Grund, 18 July—29 Aug., rare (Table VIII).
Cruise of the "Thor": Not in the North Sea. — St. 1576, mid. Skagerrak, 27 June. — At most stations in the northern Kattegat and Aalborg Bay 28 June—4 July, common in parts. — In rather small numbers at most stations 1616—1629, from Læsö to the inner part of Aarhus Bay, 7—10 July; not, however, west of Samsö, nor in the Belts or western Baltic; found again east of Samsö 16 July (Table X).

1912. Anholt Knob, 1 July and 1 Aug. (Table VI).
Schultz's Grund, 21 May, 25 June, 16 and 23 July, singly (no samples from August and first half September) (Table VIII).

1913. Horns Rev, in nearly all hauls 12 May—14 July, fairly common (Table V).
Anholt Knob, 15 Aug. (Table VI).
Between Gniben and Hasenöre, 9 July.

That the species is indigenous in Danish waters is evident from the fact that the hydroid is met with at several places in the Kattegat and the Belts, as well as in the Sound. But, as with the hydroid, which may be found in great numbers at a given locality in one year, and sought for in vain there the next, so also the pelagic material shows that the medusa is extremely erratic in its occurrence. — At Horns Rev, the medusa was only found in 1913, but it was a considerable stock that appeared on that occasion, and unquestionably of local origin, some of the specimens being quite small. The specimen of Steenstrupia taken at St. 1576, midway out in the Skagerrak, on the 27. July 1911, must presumably have been carried thither by the remarkably widespread Baltic surface water (see General

Section). The species was altogether lacking at all stations in the Jammer Bay 5—6 July. — In the Kattegat, the remarkable scarcity of the medusa at Anholt Knob is first observed; as the hydroid keeps to sandy bottom, it is natural that it should be rare in the eastern Kattegat, where the bottom consists mainly of clay; and it is evidently only exceptionally that it is carried by the currents past Anholt Knob. This, in conjunction with its evident rarity in the Skagerrak, suggests that there is practically no importation into the Kattegat from without. There can be no doubt but that the hydroid was, in 1911 (cruise of the "Thor"), living both in the northern Kattegat and on the plateau between Læsö and Anholt. In the southern and south-western Kattegat, the occurrence of the medusa in summer is evidently a regular phenomenon. That the species can occur in the Belt Sea, and even in the western part of the Baltic, we know partly from extant works, partly from the various finds of the hydroid, but the cruise of the "Thor" in 1911 showed that it can, in some years, be altogether lacking in the Belt Sea. It will be noticed also that in 1915, when I sought in vain for the hydroid at its well-known haunts in the Little Belt, the medusa was similarly lacking in the plankton of the Belt.

The duration of the medusa's occurrence evidently does not as a rule exceed two months or a little over; it may, exceptionally, appear in May, as a rule not until June or July, and disappears in August or September. The life of the medusa is probably short — some few weeks only — and it is hardly likely that it is ever transported for any great distance. — *Steenstrupia nutans* is a typical example of a medusa indigenous in the Kattegat. The occurrence of the medusa in the different years is doubtless only to a slight extent directly dependent on the prevailing hydrographical conditions, but is determined by the distribution of the hydroid generation at the time.

Hybocodon prolifer A. Agassiz.

Chart 6.

Hydroid: *Hybocodon prolifer* A. Agassiz.

For the presumed identity of the American *Hybocodon prolifer* Agassiz, the Icelandic *Auliscus pulcher* Sæmundsson and the *Hybocodon* of northern Europe, see Kramp 1926 a.

The *Hybocodon* hydroid is of the Tubularia type, producing a large number of medusæ. The medusa propagates very actively by gemmation (from the tentacle bulb), and for the first few months of its appearance among the plankton, only this asexual reproduction takes place, so that the stock is very greatly increased; a few hydroids can thus give origin to great numbers of medusæ. At a certain time, the development of the genital organs begins, and very shortly after, nearly all the medusæ have passed from the gemmiferous to the mature stage. We do not know whether the first medusæ, produced directly from the hydroid, ever attain sexual maturity, or whether this is reserved for the later generations.

Geographical distribution.

The Hydroid is known from North America and Iceland; E. T. Browne informs me, in a letter, that he found fertile specimens at Plymouth in March 1914, on a sponge *Desmacidon fruticosus*.

The Medusa occurs on the coast of North America within a comparatively restricted area (Woods Hole to Massachusetts Bay) from March or May to August. Also found on the Pacific coast (Vancouver and Dutch Harbour).

In European waters, *Hybocodon* appears as a northern-boreal species, ranging from North France to Malangsbanken in northern Norway and the north coast of Iceland; it does not penetrate into the Arctic proper, but seems to be commoner in the northern than in the southern parts of its area of distribution. Seasonally, there is but little difference, though it would seem to arrive somewhat later in Icelandic waters than off the coasts of Britain and in the North Sea area. It is met with here in early spring, sometimes even in midwinter, culminates in April—May and generally disappears in June, but may exceptionally be met with in August. The most interesting feature from our point of view is its occurrence in Norwegian waters; it is not found in the oceanic water off the west coast of Norway, and consequently, cannot be imported by the Gulf Stream; everything seems to suggest that the hydroid lives in the immediate vicinity of the coast, perhaps in the fjords; in any case, the medusa is common in the coastal waters in early spring, and can be carried along by the coastal currents.

Works dealing with *Hybocodon prolifer* in the waters round Denmark. First mentioned by Aurivillius (1898, *Amphicodon fritillaria*), from Måseskär, 22 March 1897. Johansen & Levinsen (1903) rightly consider Haeckel's three species *Amphicodon globosus* Hckl., *A. amphipleurus* Hckl., and *A. fritillaria* (Stp.) as one, adopting the last of these three names; they mention it (Table p. 290—291) only from Læsö Channel and Schultz's Grund in April and May; in the list on p. 274 it is noted as indigenous in the Skagerrak and Kattegat. — It is recorded from the south coast of Norway by Broch (1905, p. 4, *Amphicodon fritillaria*) from Sandnæsfjord 16 May 1904, and by Aslaug Sverdrup (1921, p. 16) from the Christiania Fjord in November. — The only record from the Baltic is that given by Hartlaub (1907, p. 100) who mentions it from Femern, Bay of Neustadt, and Als 2 May, and from Stoller Grund (outside the Bay of Kiel) 2 Feb.

Material.

Of older material, the Zoological Museum has only that dealt with by Johansen & Levinsen; some of this however, is not included in their work (1903) *viz.* specimens from Frederikshavn 25 March—5 April, and May 1898, also 17 from the same locality 24 July 1899, and finally one specimen from Skagens Rev 4 April 1900.

Recent Material (Summary).

1909. Spodsbjerg, Langeland, 10 April—9 June, great numbers in May, by far the most part in the lower water layers; gemmiferous until 4 May, mature specimens from 19 April.
Cruise of the "Karen" 20—28 April; lacking at Baltic stations, very numerous in Great Belt and N. of Samsö, fewer in northern Kattegat.
1910. Schultz's Grund, a few spec. in lower water layers 1—9 Aug. (Table VII).
1911. Anholt Knob, 1 Feb.—15 July; very numerous in April and May (Table VI).
Schultz's Grund, numerous 14 May, decreasing until 18 July (Table VIII).
"Havörnen" 11—16 May, at nearly all stations from the Skaw to Spodsbjerg, Langeland, but not in the Baltic; generally numerous (Table IX).
Cruise of the "Thor", at some few stat. Aalborg Bay 30 June; St. 1624 NE of Hjelm 8 July; St. 1632 near Aarhus 10 July; St. 1661 off Nakkehoved 17 July; always in small numbers (Table X).
1912. Anholt Knob, 15 April (Table VI).
Schultz's Grund, 2 Jan.—9 April, single specimens (Table VIII).
1913. Anholt Knob, 1 March—15 May, very numerous (Table VI).
1914. Anholt Knob, 15 March (Table VI).
Schultz's Grund, 17 Feb.—31 March, numerous last half of March (Table VIII).
Skagerrak, 4 April, in all hauls at the two stations nearest the coast of Norway, but lacking at the two stations farther south (see General Section Chapt. I).
1915. Middelfart Sound, 11 March—21 May, very numerous 4 May; 18 Decr. 2 spec.
Nyborg, Great Belt, well of Biological Station, 28 March, 8 April, 16 and 17 May.
1916. Middelfart Sound, 18 Jan.
Nyborg, 10 April.
1920. E. of Slipshavn, Great Belt, 13 April, intermediate haul over 20 m water, 3—400 specimens, all gemmiferous (Biol. Stat.).
1921. Same place, 13 April very numerous (Biol. Stat.).
1923. Cruise of the "Dana". — 1—2 April, singly in eastern Kattegat and the Sound (St. 2939—2941). — 17—26 April, SE Kattegat, Sound, Bay of Köge, western Baltic (but not S. of Fyen), Great Belt, Samsö Bay, E. Kattegat as far as Læsö (St. 2944—2985). — 13—19 May, Aalborg Bay and off Hellebæk (St. 3036—3038 and 3050—3054). — 29 May—5 June, singly in southern Kattegat and Belt Sea (St. 3059, 3065, 3074, and 3082) (Table XII and Chart 6).

This species, though found off Helgoland, has never been met with off the west coast of Jutland, and never near the Danish coast in the Skagerrak. It is found however, everywhere throughout the Kattegat and the Belts. Hartlaub (1907 p. 100) and the records from the "Dana" show that it can also appear in the western Baltic, but its occurrence here is evidently only occasional, for in the material from the cruise of the "Karen" in 1909 and "Havörnen" in 1911, the species is lacking at the Baltic stations, though numerous at the same time in the Kattegat and the Great Belt. On the other hand, it seems as if it could at times be carried quite a considerable distance into the Baltic proper. In the records from the cruise of the "Thor" in the spring of 1908, 28 April—8 May, we find frequent mention of "*Steenstrupia*", sometimes in great numbers; and a "Steenstrupia" which appears, and that in great numbers, about the 1st of May can hardly be anything but Hybocodon. We see then, that this medusa has penetrated into the Baltic proper nearly as far

as Bornholm. Apart from some stations in the Kattegat, "Steenstrupia" is noted in the Journal in question as very numerous at nearly all stations from Als to a point 9 miles WSW of Hammeren, Bornholm (55° 12′ N., 14° 32′ E., St. 1221, 6 May 1908); it was not found at stations east of here (cf. *Sarsia tubulosa*, same cruise). It should be noted however, that Hybocodon was found only in the deep hauls near the bottom (for details, see Table XIII). It was in all probability a somewhat unique occurrence, naturally explained by the unusually high salinity of the bottom water at the time and place in question. That Hybocodon can be indigenous in the western Baltic or in the southern part of the Little Belt is evident from my collections in Middelfart Sound, 1915—1916; in May it came from the north, but in March and December 1915 and January 1916 it was only found when the current was flowing northward, never with a south-going current.

The origin of the numerous Hybocodon medusæ in the Kattegat and Belt Sea is difficult to explain, as the position is evidently complicated, differing greatly from one year to another. It is a positive fact that there exists an indigenous stock in these waters, but there is much to suggest that some importation of medusæ also takes place, as a rule with the undercurrent from the Skagerrak; these individuals are gemmiferous and propagate actively, increasing in numbers as they approach the southern Kattegat and Belt Sea, where they mingle with the native population. The medusæ can be extraordinarily numerous; about the middle of May 1909, for instance, an average of something approaching 1000 specimens per sq. metre of surface was found in the Langelandsbelt. They keep almost exclusively to the lower water layers.

In those parts of our waters where the species is indigenous, the medusa appears in the plankton in midwinter, sometimes as early as December, but as a rule in January or February. For a long time reproduction takes place only by gemmation, the stock being thus constantly increased; on several occasions I have observed that the process terminates rather suddenly in the latter half of April, giving place to sexual reproduction; this goes on for about a month, after which the number of specimens shows a marked decrease. As a rule, the main bulk of the stock will have disappeared about the 1st of June, but a few stragglers can occasionally be found, especially in the inshore waters, right on into July, or even August (1910); on the other hand, the species may dissapear far earlier, as in 1912; the variation is doubtless in some way connected with the proportion between the native population and the imported.

In 1912, there was only a slight inflow of North Sea water into the Kattegat (see General Section Chap. I), and no importation of Hybocodon took place; the stock in the Kattegat was small, especially at Anholt Knob, where the species only appeared on one day, the 15 April; at Schultz's Grund it was found as early as the New Year, and several times during the following months, but it only remained in the plankton until 9 April. In 1914, there was a very large native stock in the

vicinity of Schultz's Grund, where the species appeared in increasing numbers from 17 Feb. At Anholt Knob, only a few specimens were found abt. 15 March. (Whether any importation took place later in the year, we do not know). In both these years, then, the native stock was very small in the eastern channel of the Kattegat near Anholt Knob. — A very different state of affairs was noted in 1911 and 1913, when the Kattegat received a considerable inflow of North Sea water (see General Section Chap. I). In 1911, Hybocodon was particularly numerous in the Kattegat; the first specimen was taken at Anholt Knob on the 1 Feb., the numbers of medusæ increasing thenceforward until mid May, when the maximum was reached, followed by a sudden and very marked decrease; isolated specimens were, however, taken in June and July. At Schultz's Grund it was common as late as the 23 May; the numbers decreased rapidly after that date, but specimens were, however, taken in June and July. At Schultz's Grund it was common as late as the 23 May; the numbers decreased rapidly after that date, but specimens were still to be found on the 18th of July. It is very interesting to note that the culmination of the stock at Anholt Knob does not occur until more than a fortnight after the almost complete cessation of gemmation (on the 1 May only one among the numerous specimens was found to be gemmiferous); this shows that there must have been an importation from elsewhere; and the hydrographical observations indicate that the marked increase in the numbers of medusæ from March to May coincide with a distinct rise in the salinity of the lower water layers, where the medusæ were undoubtedly to be found, thus showing that the importation must have taken place from the north. (Precisely the same thing was noted in the Langelandsbelt in 1909). As regards the horizontal distribution of the medusæ in 1911, we have valuable information. The cruise of "Havörnen", 11—16 May, took place just at the time when Hybocodon culminated at the two lightship stations; and the medusa was also found at all stations in the Kattegat, Samsö Bay, and Langelandsbelt; numerous everywhere west of Læsö and Anholt and in Samsö Bay; it was scarce, however, at the two stations east of Læsö; importation through the eastern channel must therefore presumably have been at an end throughout this range, while the last portion of the great mass in question had not yet passed Anholt Knob. That part of the imported stock which came down into Læsö Channel, was checked by the Aalborg Plateau, and accumulated outside the mouth of the Limfjord (St. 1511). On the cruise of the "Thor" in June and July, a few isolated specimens were found here and there in the Kattegat, *viz.* in Aalborg Bay, Samsö Bay, and north of Sealand. The occurrence of the medusæ at Anholt Knob suggests that the importation covered a considerable period of time, from the middle of March to some way on in May. In contrast to this, we have the occurrence at Anholt Knob in 1913; the inflowing surface current and the relatively high salinity in the upper water layers during March and April show that there was no likelihood af any importation from the southward; the whole of the stock observed must undoubtedly have come from the north, and the brief occurrence en

masse, sudden appearance and disappearance (see Table VI) and the abruptness with which gemmation ceased and maturity set in (in the latter half of April), all suggest that the entire imported stock must have entered the Kattegat at an early date, propagating rapidly there, while further importation was checked (see General Section). As the medusæ were not found at Anholt Knob until 1 March, it is evident that in this year also there was no native stock of any importance in that area.

The distribution of Hybocodon in 1923 is extremely interesting, and deserves further consideration (see Chart 6).

On the spring cruise of the "Dana" in 1923, Hybocodon was found in great numbers in our waters under circumstances which show that it must have been exclusively a native population; no importation from without took place in this year. — About the middle of April, the medusa was common in the south-eastern Kattegat. It was altogether lacking throughout the range from Stevns to Gedser, but at St. 2954 in the Bay of Köge it was very numerous, having been brought in from the Sound by an advance of bottom water from there across the threshold at Saltholm (see General Section). Out of 586 specimens examined from this locality, 6 % were found to be mature, all males. — The medusa was lacking in the waters south of Fyen, but a few specimens were met with in the lower water layers along the range from the southern extremity of Langeland to Kadetrenden, presumably on their way from the Great Belt to the Baltic. — Proceeding northward through the Great Belt, the medusæ were found to be far more numerous, E. of Samsö and SE of Hjelm (St. 2978 and 2979) extremely so. The gemmiferous specimens at St. 2976—2978 amounted to abt. 80 %, at St. 2979 only 50 %. From here the numbers of specimens decreased very rapidly towards the north and east. At the Great Middelgrund (St. 2982) the species was still met with in the lower water layers, but in the eastern channel between Anholt and Læsö, it was altogether lacking in the salt bottom water, which, as the high salinity (abt. 34.8 ‰) and the composition of the fauna showed, was of Atlantic origin. A few isolated individuals were found here in the surface water, where the salinity was comparatively low (18.5—22.4 ‰); these were evidently from the stock in the southern Kattegat. In the northern Kattegat, Hybocodon was not found at all, and in those parts of the Skagerrak and North Sea investigated it was similarly lacking. In Aalborg Bay there must evidently have been a considerable local stock, for about the middle of May the medusa was found here in quite considerable numbers, for the most part mature specimens.

As mentioned elsewhere, there was, in the spring of 1923, a great inflow of Atlantic water from the Skagerrak to the deeper portions of the Kattegat, the usual northern bank water being thrust aside, and not allowed to pass from the Skagerrak into the Kattegat (see General Section). There can be no doubt but that in the spring of 1923, the Kattegat held a remarkably numerous native stock af Hybocodon, for the most part concentrated in three areas: Aalborg Bay, northern entrance to the Sound, and Samsö Bay. In the middle of May, when the "Dana"

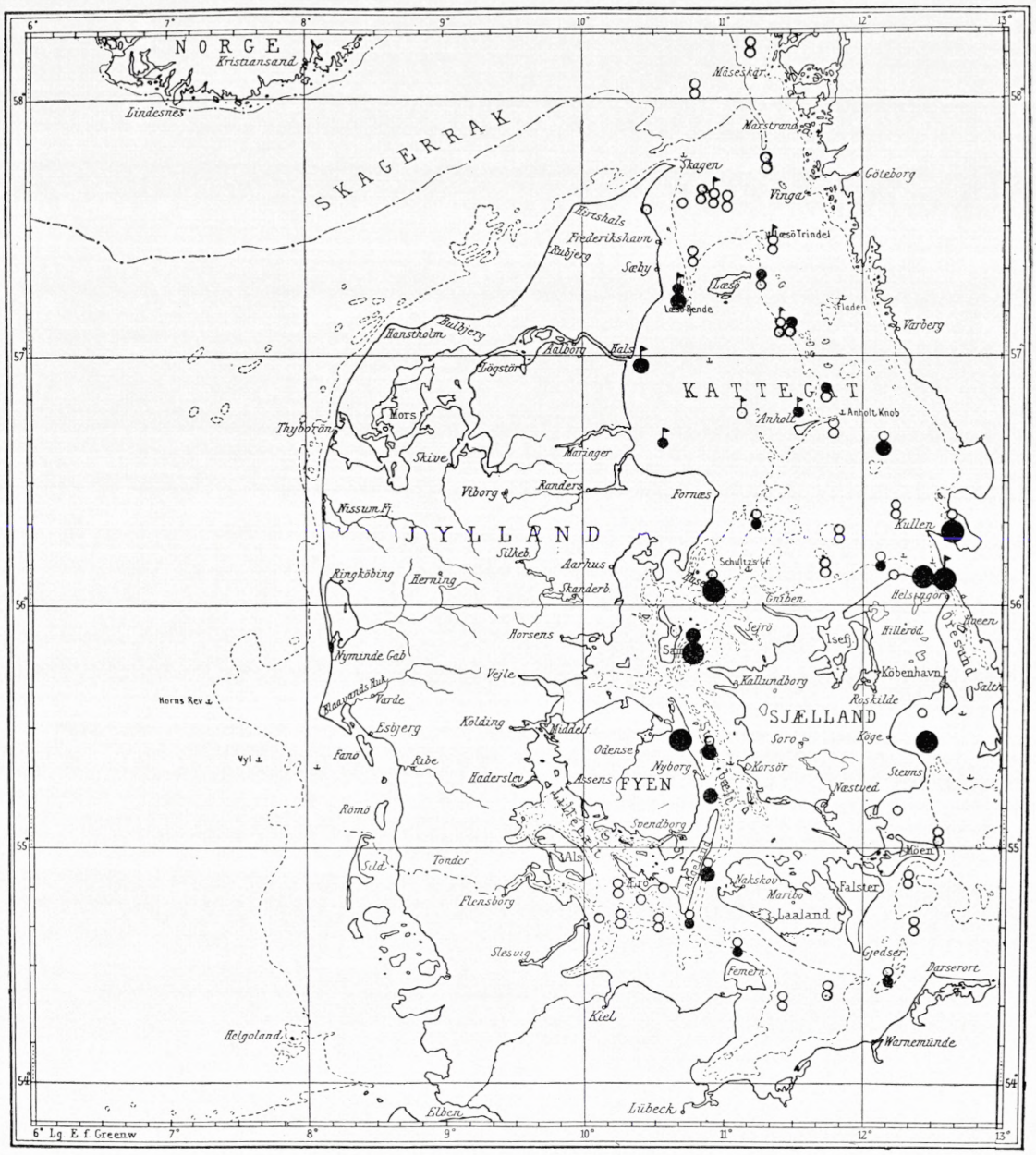

Chart 6. *Hybocodon prolifer.* Occurrence on the cruise of the "Dana" 17 April—19 May 1923. All pelagic stations within the periods noted below are marked on the chart. Two circles, one on top of the other, denote hauls made in upper and lower strata. Blank circles indicate that the medusa was not taken in the hauls so marked. The three different sizes of filled circles represent the frequency of the species.

o = Stat. 2944—2993, 17—29 April.

♂ = — 3036—3054, 13—19 May.

was on the way back to Copenhagen, Hybocodon was lacking in the eastern Kattegat, but still common in the northern part of the Sound (St. 3054); and when, after a stay of some 10 days in Copenhagen, the vessel once more put to sea, at the end of May, the stock had everywhere almost entirely disappeared. A few isolated specimens were taken at Hjelm and in the Great Belt, while a number had found their way from Samsö Bay via the Little Belt to the north coast of Als (St. 3074). A small remainder was likewise found east of Falster during the first few days of June. A few of these stragglers were still gemmiferous.

The occurrence of Hybocodon in 1923 gives an idea of the development of the native stock, its distribution and movements, undisturbed by any importations. A point of particular importance is the almost complete absence of the species in the waters round Anholt Knob, both in April, when the medusa was numerous in the southern Kattegat, and in May, when the species in ordinary years culminates at Anholt Knob. This is a striking confirmation of the fact that the great numbers of Hybocodon found at Anholt Knob Lightship in 1911 and 1913 in April and first half of May really came from the north, and not from the southern Kattegat. Introduction from the south during the two mentioned years was only possible with the surface current, and this possibility was at least equally great in 1923, when there was, in April, a thin but horizontally extensive layer of Baltic water at the surface, the remarkably low salinity of which, especially at the time just before the "Dana" collections were made, suggests a marked outward movement. In May, the Baltic current was very strong; nevertheless, this current carried with it practically no Hybocodon, though the native stock of the southern Kattegat was a large one; indeed, remarkably so.

Summary.

It will be seen from the above that the medusa of *Hybocodon prolifer* is a pronounced seasonal organism in the plankton of the Danish waters, and that we may, inside the Skaw, find both a local and an imported stock, the relative sizes of these being highly variable.

The native stock is particularly common in Aalborg Bay and the south-western Kattegat, with Samsö Bay, but is also met with in the Belts and at times in the western Baltic. It appears in mid winter. It keeps for by far the greater part to the lower water layers, and has therefore but little chance of being carried northward with the out-going currents. And in accordance with this, we also find that the medusa was, practically speaking, absent throughout the area round Anholt Knob during the two years (1912 and 1923) when no importation from the Skagerrak took place. On the other hand, parts of the native stock can be carried further on towards the Baltic with the in-going undercurrent.

The great masses of Hybocodon which as a rule fill the current areas of the Kattegat in spring, with a maximum in April—May, and evidently keep mainly to the salt, inflowing bottom water, doubtless belong for the greater part to a stock

imported from the north into the Kattegat, where they propagate rapidly by gemmation and mix with the native population, which likewise keeps chiefly to the lower water layers and is thus led to accompany the imported stock on their further progress towards the Baltic, where they are killed off, sooner or later, by the fresher water. It is of course impossible to say how many specimens in any given instance belong to the local stock and how many to the imported. It is also difficult to determine the time when the importation begins, as we have to reckon with the presence of native specimens. The material from the lightship at Anholt Knob suggests that the imported stock arrives there about the beginning or middle of March. Part of the imported stock goes westward round Læsö into Aalborg Bay, where it either stagnates or is carried hither and thither by the local currents; another portion moves eastward round Læsö through the eastern channel of the Kattegat down into the Belts. It increases steadily in numbers, owing to gemmation, and this is the reason why it can culminate, numerically, almost simultaneously at places far apart. Gemmation ceases for the most part rather suddenly in the latter half of April; the time does not appear to depend very much on the temperature of the water. Sexual propagation goes on for about a month, after which the number of specimens rapidly decreases; a few stragglers may occasionally be found, especially in the inshore waters, right on into July or even August, but sometimes the species disappears entirely from the plankton in May or even as early as about the middle of April (as in 1912).

As regards the very important question: whence and by what route the imported Hybocodon are introduced into our inner waters, it is difficult to answer this, as the horizontal distribution of the species in adjacent waters, especially the Skagerrak, is so little known. The medusa has never been found off the west coast of Jutland, and does not seem to occur on the Danish coast of the Skagerrak (cf. "Havörnen" 1914 and "Dana" 1923). It is found however, on the south coast of Norway, and is common throughout the coastal waters of the west coast of Norway, but not in the oceanic water farther out (Kramp & Damas 1925). It appears to be rare in the Christiania Fjord. Aslaug Sverdrup (1921) records it only from November (precise data are unfortunately not given). It seems likewise to be rare on the coast of Bohuslän (Aurivillius 1898). It is not mentioned in Théel's list of the plankton forms at Kristineberg. — Hybocodon is imported into the Kattegat with the in-going salt undercurrent, which, in the spring, consists mainly of northern bank water, *i. e.* the coastal water off the west coast of Norway at the mouth of the Norwegian Channel. This does not imply that the medusæ, even if carried into the Kattegat with the northern bank water, have always kept to this water and came with it right from the Norwegian Sea; they might very well have been picked up by the bank water on the way, from adjacent water masses of different origin. The Danish coast of the Skagerrak seems to be out of the question as a source of origin, and the suggestion that the stock should come from the eastern

part of the Skagerrak, off Bohuslän, is contradicted not only by the evident scarcity of the species in this area, but also by its occurrence in the Kattegat in 1912, when no importation took place; the current conditions at that time were such that there was nothing to prevent importation from the eastern Skagerrak, if there had been any stock of Hybocodon there, whereas importation from the North Sea was out of the question (see General Section). The point above noted, that the imported stock does not seem to arrive at Anholt Knob until March, abt. two months after the first appearance of the native stock in the Kattegat, suggests that the imported stock has had to cover some considerable distance before reaching the Kattegat, so that as far as time is concerned, there is no reason why they should not have come from the south coast of Norway or the southern part of the west coast of Norway, where the bank water comes from and where the medusæ are known for certain to occur. I cannot but consider this the most likely supposition; it is impossible, however, to say anything definite until we know the distribution of the medusæ in the Skagerrak and Kattegat at the time when the importation takes place. — For the rest, it is highly probable, that the imported stock does not come from exactly the same locality every year. The species is, not only in our waters, but also elsewhere, e. g. in British waters, known to be very erratic in its behaviour and the occurrence of the medusa depends not only on the prevalent current conditions, but also on the distribution of the hydroid generation at the time.

Fam. *Cladonemidæ.*

Cladonema radiatum Dujardin.

Hydroid: *Cladonema radiatum* Dujardin.

Geographical distribution. — Widely distributed in the Mediterranean. At Trieste, the hydroid is common on *Ulva* in summer and far on into the winter, rarer in the spring; the detachment of medusæ has been observed from July to December. The medusa itself has been found to attain full growth and maturity in the course of four weeks (aquarium observations) (Graeffe 1884, p. 353).

The species has also been found at several places on the north coast of France, at Ostend, on the south coast of England, in the Bristol Channel, and near Valencia Harbour in Ireland. It is not recorded from the North Sea.

Off the coasts of France and Britain, the medusa appears in spring and summer. — E. W. H. Holdsworth has observed its remarkable propagation in August—September (Hincks 1868, p. 65—67). Other interesting observations are noted by Browne (1900, p. 701—702), who like Hincks, points out that the tentacle branches provided with suckers are not used for purposes of locomotion, but only for holding fast to an object. In northern Europe, the hydroid has only been observed in aquaria; the medusa, however, has frequently been met with in a state of nature.

Cladonema radiatum is common in the Gullmarfjord on the Swedish coast of the Skagerrak. SEGERSTEDT (1889, p. 8) saw it first in aquaria in the summer of 1885; two years later he found the medusa in open water, some swimming at the surface, others attached to the algæ near the shore. It has also been taken at the same place in September 1896, among *Zostera* (AURIVILLIUS 1898a, p. 276).

Occurrence in Denmark. — The only known find up to date in Danish waters is from Nyköbing in the Limfjord, where TH. MORTENSEN found the medusa in great numbers among the Zostera on the 7 July 1895 (MORTENSEN 1897); the hydroid was not found. Since then, the medusa has often been observed in the same locality. During a stay at Nyköbing in June 1920, I found numerous specimens of the medusa in the luxuriant growth of *Zostera*, but despite a thorough search, I did not succeed in finding the hydroid there. On the 17th June 1920, however, in a plankton sample from the southern part of Sallingsund, I found a single hydranth with two almost fully developed medusæ attached, both making powerful swimming movements.

As far as the aquarium observations of the above-noted English writers enable us to judge of the natural conditions, it would seem that the life-cycle of the species in north-european waters is as follows: The medusæ propagate in late summer and autumn; from the ova, there is produced a hydroid generation which hibernates in a sterile state, and in the spring sends out a new generation of medusæ. Possibly the hydroid then dies off; we have no certain knowledge on this point, but this would explain its never having been found hitherto in a natural state in northern Europe. Biological stations are, as we know, generally but little occupied during the winter, and we cannot expect that so inconspicuous an organism as this hydroid should be found unless specially sought for. It is hardly likely, by the way, that it should keep to the Zostera leaves, as these do not live long enough for the hydroid, which survives the whole winter. There are thus two open questions in the biology of Cladonema: where is the hydroid to be found, and how long does it live?

The common view that the *Cladonema* medusa keeps its tentacles in an upright position is not altogether correct. It is only when disturbed that the medusa elevates the branches armed with nematocysts like a protective netting round the body; when the organism has been at rest for some little time, the tentacles are extended out horizontally on every side, and only the extreme ends of the branches with the clusters of nematocysts are lifted a little, so as to be free of the substratum.

I have thought over the question, why the Limfjord should be the only one of our Zostera-bearing waters where this medusa is found. The reason is, perhaps, that the species requires a certain minimum of salinity in conjunction with protection against strong wave action. On the shores of the North Sea there is, practically speaking, no Zostera or other close vegetation; the northern Kattegat has, it is true, an abundant vegetation, but the waves are rather violent, and there are no quiet

spots with rich vegetation in the Kattegat until we get far to the south or up into the fjords, where the salinity is considerably less than in the western parts of the Limfjord.

Another possible reason is that the species has not the capacity for moving far in different directions. The medusa is undoubtedly somewhat stationary in its habit, clinging to its Zostera leaves and loth to be carried away by the currents. The only means whereby the area of distribution could be increased would then be by transport, either of the medusæ or of the hydroid colonies, on drifting weed. We may well imagine the species to have been introduced into the Limfjord in this manner; but no weed drifts from the North Sea into the Kattegat. Certainly, the medusa or hydroid might, with a continuous westerly current, be carried from the Limfjord to the Kattegat, but they would in such case have to pass through all the eastern part of the Limfjord, where the salinity is low; lower, indeed, than in the adjacent portion of the Kattegat; we thus again encounter the salinity as an obstacle.

Finally, there is the possibility that the species actually does exist in other parts of our waters, but has been overlooked; This I consider hardly probable; in the first place, I have myself made considerable explorations along our Zostera-bearing coasts; and of late years, Dr. JOH. PETERSEN has taken a great interest in the fauna of the Zostera region; this lively little medusa, conspicuous by its red colour, could scarcely have escaped his notice.

Fam. *Margelidæ.*

Bougainvillia principis (Steenstrup).

Hydroid unknown.

Geographical distribution. — *Bougainvillia principis* is a northern-boreal, neritic medusa. Its principal area of distribution lies off the coasts of Iceland and northern Norway, where it is common from May to September; it penetrates into the Barents Sea but not up into the higher arctic regions. From the northern part of the west coast of Norway its frequency decreases as we move southward; it is still indigenous near Bergen and off the coast of Scotland, and may occasionally be met with as far south as SW Ireland and Helgoland. In the southern part of its area of distribution, its occurrence falls somewhat, though not much, earlier in the year than in the more northerly waters (cf. the case of the more arctic *B. supercilliaris*, where the difference in time of occurrence between north and south is far more pronounced).

Danish waters. — *Bougainvillia principis* is recorded by BROCH (1905, p. 6) as having been taken in Sandnæsfjord, on the Norwegian coast of the Skagerrak, in July 1904. — In the Museum at Bergen there are 13 large and medium sized specimens taken off the west coast of Jutland at 56° 55′ N., 7° 58′ E., 1 Aug. 1906 ("Michael Sars" St. 329). I saw these specimens myself during my stay with Prof. DAMAS at Liége in 1920.

Bougainvillia superciliaris L. Agassiz.

Hydroid of the same name, Hartlaub 1911.

Geographical distribution. — *Bougainvillia superciliaris* is an even more northerly form than the foregoing; in contrast to *B. principis*, it has an area of distribution extending to the western parts of the Atlantic area. It is extremely numerous in summer off the west coast of Greenland, and its area ranges from Davis Strait as far south as the influence of the Labrador Current extends.

It is common at Spitsbergen (June—July) and in the eastern part of the Barents Sea, as also on the Murman coast and in the white Sea. It does not appear to be common in Icelandic waters; has only been found in the fjords of the north-west coast, from May to July. Its distribution in a southerly direction through the eastern Atlantic area is essentially different from that of the foregoing species: *B. principis* is common off the coasts of Norway and Scotland, *B. superciliaris* very rare in both areas (occasionally met with in March and April). It is regularly found, however, off Helgoland and in the Danish waters.

Hartlaub has made the interesting observation that this very northerly species is indigenous in the eastern part of the North Sea; he describes (1911, p. 174—176) the small, inconspicuous hydroid, which was found on stones with calcareous algæ at Mandal, *i. e.* at the entrance to the Skagerrak, and young specimens of the medusa are met with every year at Helgoland. The period for occurrence of the medusa here is from February to April, rarely also in May or June. It has been taken off the coast of Holland in March and April.

Of works dealing with *Bougainvilia superciliaris* in the Danish waters, we can only cite Hartlaub 1911 (p. 173) where a specimen is recorded from Femern 1905; Johansen & Levinsen (1903) determined the specimens noted below as "*Margelis ramosa*".

Material.

1898. 23 miles N. of the Skaw, 9 July, a large spec., diam. 6 mm.
1899. Knudshoved, Great Belt, 19 April, a young spec.
1900. Læsö Channel, 19 Feb., a young spec.; 2 and 17 April, 2 and 15 May, medium and large.
1902. Little Belt, 5 April, 3 spec., rather small, 3—4 mm.
1906. 3 miles WNW. of Kærgaarde beacon, 9 April, "Thor" St 802, 1 medium sized spec. (5 mm), with planula larvæ (Table XIII).
1912. Horns Rev Lightship, 15 April, 1 spec., 3 mm; 22 April, 2 young spec., $1^1/_2$—2 mm (Table V).
1913. Ringköbing Fjord, 8 March, three places in the Nyminde Channel, depth abt. $2^1/_2$ m, 1 spec. at each, in horizontal hauls.
1915. Middelfart Sound, 11 March, at the surface, 1 spec.; with 20 m line 3 spec.; 14 March 1 spec., surface. All young specimens.
1923. "Dana" St. 2997, N. of Svinklöv, near bottom, 15 m, 30 April; St. 3074, N. of Als, in the Little Belt, near bottom, 28 m, 2 June; 1 spec. each Stn., abt. 5 mm diam. (Table XII).

Adding to the above the specimen recorded by Hartlaub from Femern in February 1905, it will be seen that *B. superciliaris* can occur in all parts of our

waters, even in the western Baltic; further, that both young and full grown specimens have been found; and finally, that its occurrence in the main falls at the same time in all parts, with no discernible phase dislocation, and simultaneously with the occurrence of the medusa at Helgoland, where it is undoubtedly indigenous. The Danish material certainly suggests that the species is also indigenous in our inner waters, at any rate in the Kattegat. It is, however, evidently rare. The full grown medusa is a comparatively large organism (8—9 mm broad and high) which might well escape the implements used for vertical hauls; this alone, however, is not sufficient to explain its being so rarely found; *B. britannica*, which is at least as large, was taken in several vertical hauls in 1911. *B. superciliaris* is a distinctly northern species, and our waters lie near the southern limit of its distribution. In accordance with this, we find that the occurrence of the medusa in our waters comes in early spring, Febr.—April; and in April, after propagation, the medusæ disappear. Only twice has the species been taken later in the year, *viz.* 1 large specimen in July 1898 in the Skagerrak and one in the Little Belt on the 2 June 1923.

Bougainvillia superciliaris is evidently euryhaline; the medusa can live, and doubtless also propagate, both in our inner waters and on the open coasts of the ocean; the medusa is also stenothermic with a low optimum; in our waters, which are near its southern limit of occurrence, it disappears before the hot season sets in.

Bougainvillia britannica Forbes.

Chart 7.

Hydroid: *Bougainvillia flavida* Hartlaub.

This species has a rather small area of distribution. It is found off the coasts of Britain from the Channel (where it is very common) to the Shetlands, and in the North Sea from Holland about as far as Bergen in Norway. Its season of occurrence is, in the Channel, April—June, Ireland and Scotland June—August; at Helgoland it is found, often in great numbers, from May to June, isolated specimens as late as August. As regards the Danish waters it must be designated rather as a southerly form.

Records from Danish waters. The species is mentioned by Johansen & Levinsen (1903) under three different names, *Margelis principis*, *ramosa*, and *flavida* (*vide supra*, bibliography); Hartlaub has examined and determined these specimens, but omits to mention them in the Nordisches Plankton.

Material.

1898. Skagerrak, 11 June, 3 large spec., diam. 7—8 mm (Joh. & Lev., det. M. principis); 23 miles N. of the Skaw, 9 July, 12 spec., 5—7 mm (det. ramosa).
1899. Læsö Channel, 15 July, 1 rather small spec., 3 mm (det. M. flavida).
1900. Skagens Rev, 4 June, 1 small spec., 2 mm (det. M. flavida).
1911. "Havörnen", Stat. 1517, S. of Læsö Trindel, 13 May, 28—0 m, 1 young spec., 2 mm (Table IX).

Cruise of the "Thor", for precise localities see Table X and Chart 7: North Sea, 18—2 June, St. 1542—1564, diam. 3½—8 mm. — Skagerrak, 26—27 June, St. 1574—1577, diam. 3—7 mm. — Kattegat, Aalbæk Bay, 29 June, St. 1584, diam. 2 mm; Aalborg Bay, 1 July, St. 1592, diam. 5 mm.

1923. Cruise of the "Dana" (Table XII).

30 April—2 May, Jammer Bay and Vigsö Bay, and near west coast of Jutland as fas as Bovbjerg (St. 2997—3003), few in numbers, small and medium sized specimens, diam. 1½—5 mm.

5—9 May, at nearly all outer stations in the North Sea and Skagerrak (St. 3006—3023); numerous S. of Horns Rev, otherwise rather scarce; all sizes, diam. 2—8 mm.

15—19 May, north of the Skaw (St. 4042) and at St. 3040, 3047 and 3048 in the Kattegat, diam. 4—8 mm; St. 3054 off Hellebæk, 2 small spec., diam. 2—4 mm.

29 May—1 June, at most of the stations from St. 3058—3068, S. of Anholt, Samsö Bay and Great Belt as far as east coast of Langeland, large spec., diam. 6—8 mm.

Inside the Skaw, *Bougainvillia britannica* appears to be a rare visitor. In the Skagerrak and the North Sea it was common in 1911 and 1923, but it is a question whether this is normal, or whether particular circumstances were responsible in those two years; this we shall discuss further later on. In 1898, 1899, and 1900, the medusa was taken in the Skagerrak and northern Kattegat. It never appears in the lightship collections; and this cannot be due solely to its avoiding the nets as it was taken in several vertical hauls on the cruise of the "Thor" in 1911.

The species was fairly common in June 1911 throughout a rather large area (see Chart 7), not, however, including any of the lightship stations. The occurrence of the medusa at Helgoland suggests, not that it is indigenous there, but that it is carried thither by the Jutland Current, which, however, evidently cannot carry it further on to Horns Rev. When found on the west coast of Jutland, it must be presumed to be either indigenous there, or imported from the north; as a rule, there is no south-going current off the west coast of Jutland (save for local currents); in June 1911, however, the cold northern bank water, mixed with Atlantic water, was very widely distributed in a southerly direction, and spread out as a substratum below the warmer surface water right down towards Horns Rev. It is doubtless this water from the north which brought down the specimens taken in 1911 at several places off the coast of Jutland; and this is confirmed by the fact that a remarkably large number of specimens were taken with the young-fish trawl a little above the bottom (see General Section). We do not know at what depth they were taken in the Skagerrak. No quite tiny specimens were found, but a number were fairly young, which suggests that the hydroid was living near the mouth of the Skagerrak, probably, indeed, even some way up in the Skagerrak itself, to judge from the finds of rather young specimens at Læsö Trindel 13 May (St. 1517) and in Aalbæk Bay 29 June (St. 1584). In this year the medusa was carried right down to Aalborg Bay (St. 1592) where a rather large specimen was taken on the 1 July.

Extremely interesting is the occurrence in 1923 (see Chart 7). — In April, the species was lacking altogether in the Belt Sea, the Kattegat, and eastern Skagerrak.

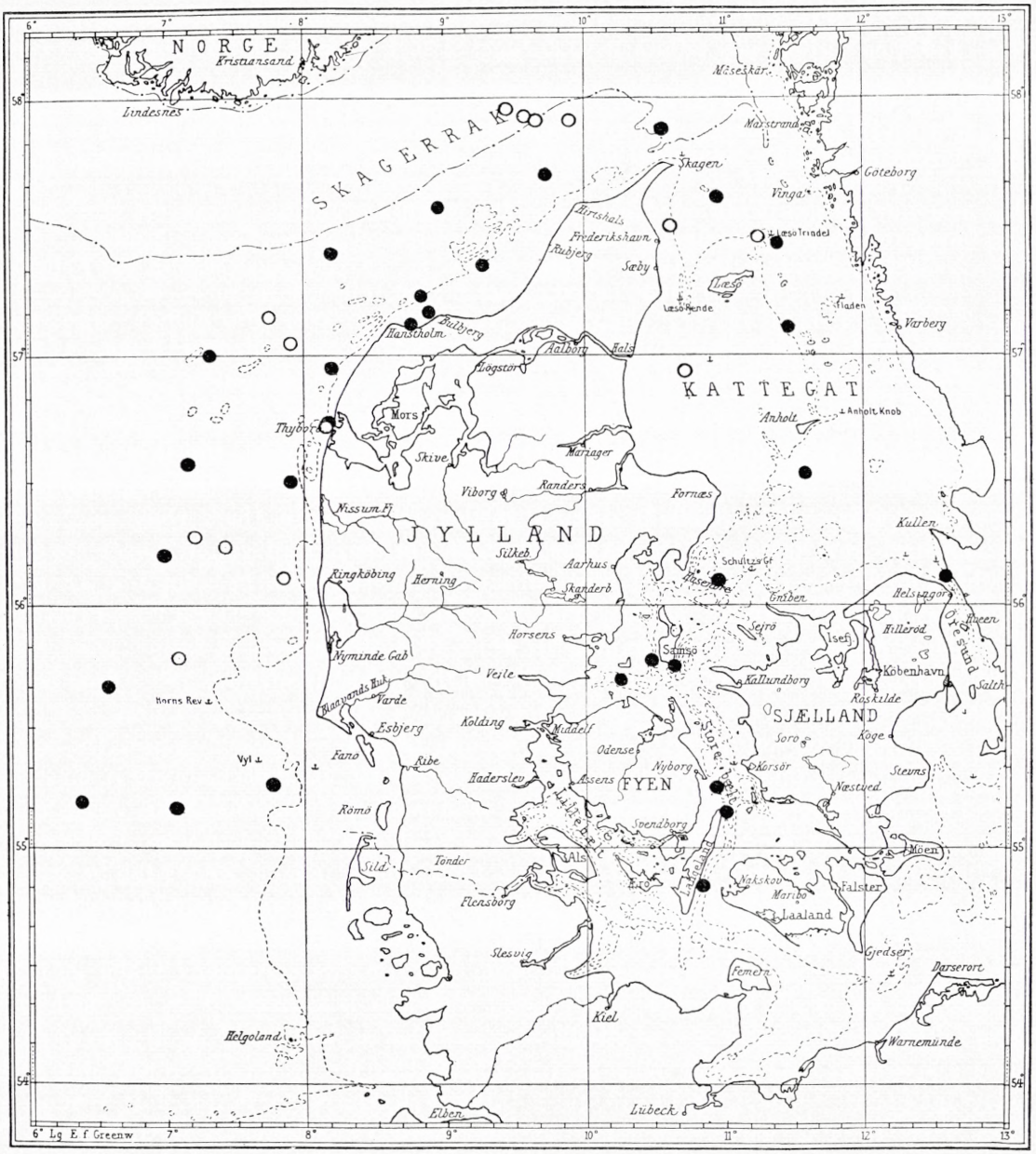

Chart. 7. *Bougainvillia britannica.* ○ = Occurrence in 1911; ● = Occurrence in 1923.

It was found, however, in rather small numbers, in all hauls in the displaced bank water in Jammer Bay and Vigsö Bay about 1 May, and was carried by the same water down along the west coast of Jutland as far as Bovbjerg. The largest specimens in this area were 4—5 mm diam., but most were much smaller, down to

1½ mm. There can thus be no doubt but that this stock was indigenous on the banks round Hanstholm. South of Horns Rev, the medusæ were numerous; both south and west of the reef, a number of small specimens were found, as well as some large ones. The small ones were 2—3 mm in diameter; evidently then, the hydroid was living in these waters in the spring of 1923 and must have been extremely common. — Having in mind the experience of previous years (never taken at Horns Rev Lightship; distribution in 1911) this cannot be regarded as a normal occurrence. We shall later see that other species also exhibit a peculiarity of occurrence off the west coast of Jutland in 1923, and the question will therefore be discussed as a whole in the General Section.

At the beginning of May, the great mass of Atlantic water which filled the channels of the Kattegat, began to fall back, and the North Sea bank water,[1] which had been thrust aside in the outer part of the Skagerrak, moved in towards the Kattegat, taking with it *B. britannica*. The species was found at this time at all stations in the Skagerrak to north of the Skaw (St. 3042), and at Herthas Flak (St. 3040) a specimen of 5 mm was taken on the 15 May. Two days later, several specimens (4—8 mm) had made their way down into the eastern channel of the Kattegat at Læsö Trindel and Groves Flak (St. 3047 and 3048), the species thereby reaching the southern limit of hitherto known distribution in the Kattegat. But it was to continue its way far beyond this limit! From the 20 May to 1 June it was taken at nearly all stations from a little south of Anholt (St. 3058) up into Samsö Bay and through the Great Belt right down to the southern part of Langelandsbelt (St. 3068), all mature specimens, 6—8 mm diam. *Bougainvillia britannica* here acted as an excellent current indicator (see General Section Chap. I). I have no doubt but that this stock of Bougainvillia really came from the Skagerrak; it has certainly no connection with the specimens taken at Hellebæk, near the northern entrance to the Sound, on the 19 May. This find was a very remarkable one, the specimens being small, 2—4 mm diam. There must have been a small local stock of *B. britannica* in or a little north of the Sound.

Summary.

The medusa *Bougainvillia britannica* appears in the Danish waters from April or May to June or July; it lives presumably for about 2 months, but we know nothing certain as to this. The hydroid lives, normally, near the mouth of the Skagerrak, and the medusæ can be carried thence some distance by the currents. The species, however, both hydroid and medusa, would seem to be very erratic in occurrence. It is probably highly susceptible both to temperature and salinity, and relatively slight local alterations in the hydrographical conditions can accelerate or retard the development of hydroid or medusæ, causing considerable aberrations from the normal occurrence and distribution of the species.

Bougainvillia ramosa van Beneden.

Chart 8.

Hydroid of the same name.

This species has frequently been confused with *B. britannica* (see KRAMP 1926a).

Geographical distribution. — *B. ramosa* is a southerly species. — The Hydroid is found in the Mediterranean, off the Atlantic coasts of Europe, round the British Isles, in the Christiania Fjord, and in the Danish waters as far as the Belt Sea. It is further recorded from several places in the Pacific: Japan, New Britain, and Amboina.

The Medusa has been found in the northern part of the Bay of Biscay, at Valencia Harbour in Ireland in August—Novr., off Plymouth in September; in the south-eastern part of the North Sea (Borkum Reef, Helgoland, Amrum Bank) it is common in Aug.—Novr., and isolated specimens have been found at Helgoland right on to the end of December (HARTLAUB 1911, p. 185). The only authentic find of the medusa *B. ramosa* on the west coast of Norway is that of a dwarf variety, found in the enclosed basin Nordaasvand near Bergen in October 1908 (KRAMP & DAMAS 1925). — The medusa has further been found at Rhode Island on the east coast of North America in July—October (MAYER 1900, *B. gibbsi*; MAYER 1910, p. 169, *B. autumnalis*) and finally, it is recorded as taken by the "Valvidia" expedition off the west coast of South Africa.

Works dealing with *B. ramosa* in Danish waters. AURIVILLIUS (1898a) is the first to mention this species from waters inside Hanstholm-Lindesnes; he calls it *Lizusa octociliata*, but also notes "*Margelis ramosa*" (p. 290); possibly this also belongs to the *ramosa* species; it was only taken in the Gullmarfjord on the coast of Bohuslän, where it was found in August, September, and October during the years 1895—97; the specimens were invariably taken near the surface. — In JOHANSEN & LEVINSEN (1903) as already mentioned, the name "*Margelis ramosa*" conceals two other species of *Bougainvillia*, but not *ramosa* van Beneden. — According to BROCH (1905, p. 6) the medusa was taken in the Christiania Fjord in July 1904, and this is probably correct.

There is a very remarkable statement in HARTLAUB (1911, p. 185) to the effect that *B. ramosa* was taken on the 1 March 1903 in the Skagerrak, 57° 41′ N., 11° 23′ E., 50—0 m; Hartlaub does not cite his authority; it is to be presumed that he has himself seen and classified the specimens, and the determination of species is therefore probably correct; but I do not venture to assume that the date is so.

Distribution of the Hydroid in waters round Denmark. According to HARTLAUB (1900, p. 92) *B. ramosa* has been found at several places in the eastern part of the North Sea at 18—47 m' depth; fertile colonies in August and September; according to JÄDERHOLM (1909, pp. 46 and 47) it is common off the coast of Bohuslän, especially in the Gullmarfjord, at 50—100 m. For other finds, see Chart 8. On the cruise of the "Dana" in September—October 1922, the species was found

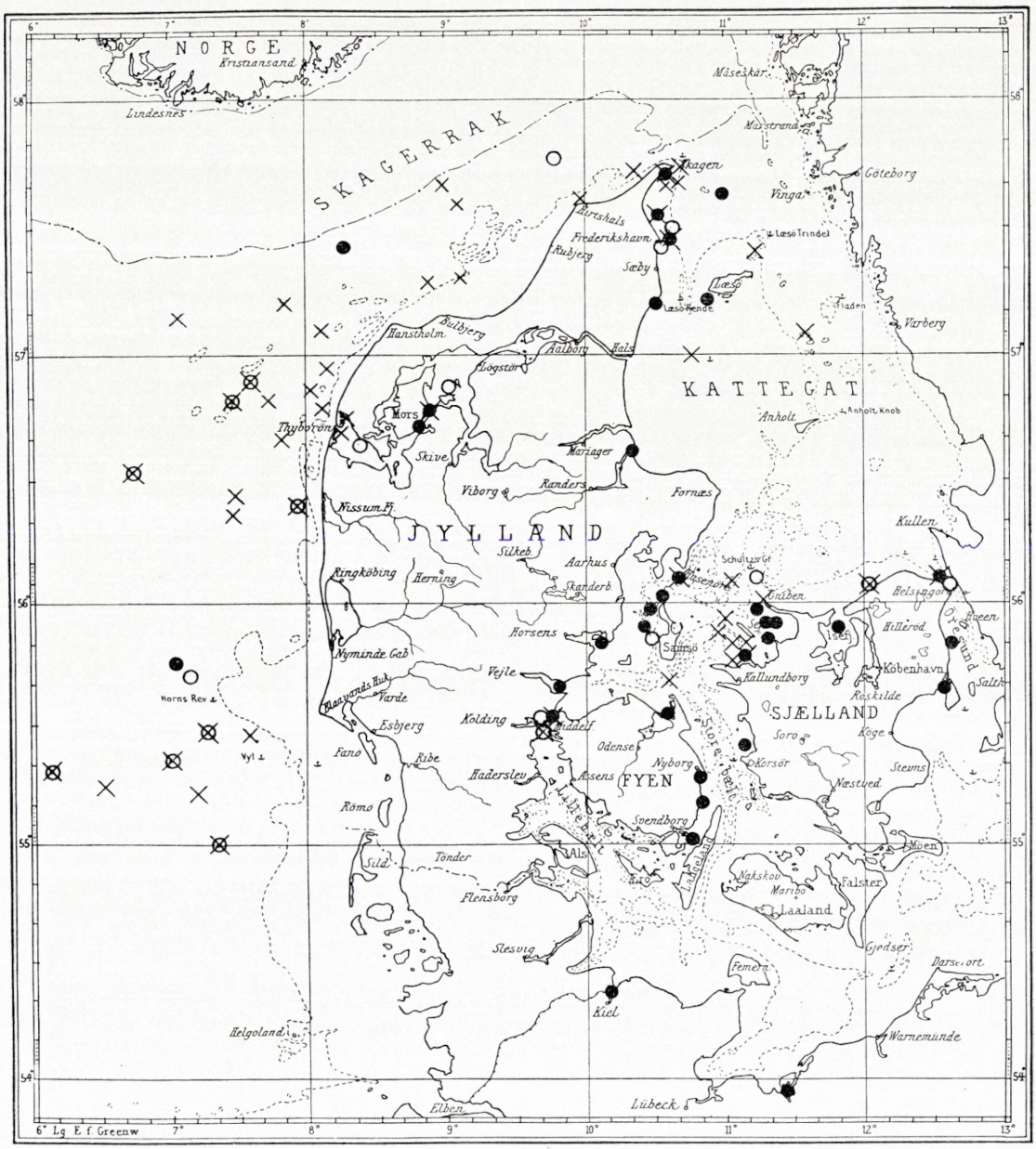

Chart 8. Finds of the hydroids: ○ *Bougainvillia ramosa*; ● *Hydractinia carnea*; × *Campanularia johnstoni*.

at several places in the North Sea between 24 and 44 m; on the Jutland Reef it was found on *Desmarestia*; also on hydroids, *Flustra*, *Corystes*, etc. In the Kattegat, it appears to keep to the immediate vicinity of the coast, and is found here mainly

on *Laminaria*; its distribution in towards the Baltic stops at the northern entrances of the Belts and the Sound.

Material.

1909. Middelfart Sound, 16 July, 1 young spec. (Kramp).
1910. Hellebæk, 25 July, surface, 1 spec. (Kramp).
Schultz's Grund, several times between 6 Aug. and 14 Sept., when the work of collection ceased, 10—0 and 25—0 m, always in small numbers, except 13 Sept. Mature specimens were found both in August and September (Table VII).
1911. Schultz's Grund, 8 Aug., 12 Sept., and 17 Oct., 26—0 m (Table VIII).
"Thor", three localities near land in Samsö Bay, 11—12 July, St. 1638, 1639, and 1642, few specimens, all young (Table X).
1912. Horns Rev, 23 and 30 Sept., 30—0 m, few spec. (Table V).
Anholt Knob 2 and 15 Sept., 1 Oct., few spec. (Table VI).
1913. Horns Rev, 6 Oct. (Table V).
1915. Middelfart Sound, 23 July, surface, 8 spec.; 18 Sept., surface, 61 spec., mostly mature; abt. 26 m line, 47 spec., mostly mature (Kramp).
1918. 2 miles S. of Skaw Harbour, 5 Novr., surface, 1 mature male (Kramp).

The horizontal distribution of the medusa coincides with that of the hydroid. The medusa begins to appear in July, is most common in August and September, and may be found even at the beginning of November. All the specimens taken in July are young; in August—October both young and mature specimens may be found. The medusæ must therefore detach themselves any time from July to October, but the process is at its height in August—September. The life of the medusa is presumably but short; in the immediate vicinity of places where the hydroid is common, the medusæ may be taken in great numbers (as at Middelfart); elsewhere, it is rare, because its brief span of life does not allow of transport to any great distance.

My investigations in the Little Belt in 1915 give a good view of the life history of the species in that water. The hydroid is very common in the neighbourhood of Middelfart, and is found here almost exclusively on *Liminaria digitata*. In September we find both old colonies with great numbers of gonophores at all stages of development, and also young colonies consisting of far-extending stolons, not yet forming dense accumulations; from these, young stems with a single hydranth or a few such, are produced. — We have some observations as to the growth of such Bougainvillia colonies from Plymouth (Browne 1907) from which in appears that the growth proceeds very rapidly, long stolons being formed, which ramify and develop a host of stems. According to Orton (1914) a Bougainvillia colony can develop medusæ at an age of some 6 weeks; this I can confirm, as I found, in some few cases, a few young gonophores on the young colonies from September; there is thus the possibility of two generations of medusæ developing in the course of the same autumn. In November—December, the colonies lose their hydranths. The root net which consists of long stolons, together with a close reticulation, contains living tissue, and the same applies in some degree to the stems, whereas most of the branches are empty. In January and March, the hydranths are altogether lacking,

and most of the branches broken off, so that we have, on the root net, which is generally closely reticulate, a number of short, slightly ramified stems; the stolons are completely filled with living tissue, the stems partly so.

In May, new life begins to appear in the colonies. New hydranths and lateral branches are developed from the old brown stems, while the stolons produce a number of young stems, still with only a few hydranths and altogether colourless perisarc. In July, the colonies are dense and highly ramified, but not very high; they now bear numerous gonophores.

The old fertile colonies found in September have large and powerful stems; from the old, close-packet root net new long stolons are put forth, bearing small new stems, the hydranths occasionally having a couple of quite young gonophores. Simultaneously, then, with the detachment of a numerous host of medusæ, the vegetative growth proceeds very intensively.

The hydroid's preference for *Laminaria* may perhaps serve to explain the remarkable distribution of the species in the waters this side the Skaw. In the Little Belt, where there is, it is true, a strong current, but no wave action to speak of, the older portion of the laminaria leaves can live on, albeit torn and ragged, till well on in the autumn; a Bougainvillia hydroid attaching itself in the autumn to the same year's growth of the laminaria has thus, in the Little Belt, the chance of living to the age of about a year. It is otherwise on the shores of the Kattegat in northern Jutland. Here, as soon as we move out beyond a few meter's depth, we find soft bottom, where the laminaria cannot grow; in shallower water, there are, it is true, laminaria in abundance, but the action of the waves is here so violent that last year's leaves are washed away already in the spring, or at any rate, so early in the year that a Bougainvillia colony which had attached itself there the previous autumn would perish before it could develop its medusæ; the chances of existence of the species in these waters are thus greatly reduced. I have, it is true, found *B. ramosa* on Laminaria at Frederikshavn, but only in the harbour itself; the species has never been taken on algæ in the neighbourhood outside the harbour; only once on crabs (WINTHER 1880).

Lizzia blondina Forbes.

Chart 9.

Syn: *Lizzia claparedei* Haeckel.
Dysmorphosa minima Haeckel.

Hydroid unknown.

Geographical distribution.

Apart from the Mediterranean, this charming little gemmiferous medusa lives also on the shores of northern Europe, its principal area of occurrence here being in British waters; up to now, the southernmost find recorded in northern Europe is from the north coast of France; it is still common round the Shetlands. Along

the west coast of Norway it is not known from farther north than Bergen. It has also been found at the Færoes, and on one occasion at Cape Nord, in north-west Iceland. Throughout the entire north-european area, the medusa is a pronounced summer form; it is met with in the Channel from May to September, and in Scottish waters from June to October. It does not appear at Helgoland until July; is not uncommon there in July and August, and may be met with as late as November. In all probability, it is not indigenous at the Færoes, or in Icelandic waters, or off the west coast of Norway. — *Lizzia blondina* must be described as a southern-boreal species; from the point of view of our Danish waters, rather a southerly form. — As the stock lives for some months in the plankton and propagates rapidly by gemmation, it can be very numerous and be carried far and wide with the currents.

There is no mention of *Lizzia blondina* from Danish waters in extant literature, save for a doubtful record from Kiel (MÖBIUS 1884, p. 5).

Occurrence in Danish waters.

Material.

1910. Schultz's Grund, 1 Aug.—13 Sept., 25—0 m (Table VII).
Off Hellebæk, 25 July, surface, 1 spec. (Kramp).
Off Gilbjerg Hoved, 26 Oct., 15—0 m, 1 spec., "Thor" St. 1492 (Table XIII).
1911. Horns Rev, 27 June, 30—0 m, 2 spec., gemmiferous (Table V).
Anholt Knob, 15 July (Table VI).
Schultz's Grund, 11 July—17 Oct., in all water layers (Table VIII).
Cruise of the "Thor" (Table X):
19—20 June, several places in the North Sea, St. 1552—1564.
28 June, Aalbæk Bay, St. 1578 and 1580.
5 July, Jammer Bay, St. 1606 and 1611.
4—17 July, several places in the Kattegat, from Læsö to Samsö and Nakkehoved; the Sound; not, however, in the Belts or western Baltic.
Motor boat from the "Thor", 3—5 Aug., at all stations on the west coast of Jutland between Blaavandshuk and Hanstholm, St. 1679—1697; 10 August, at the Skaw, St. 1725, otherwise not taken in the Skagerrak (see Chart 9).
1912. Anholt Knob, 15 July—1 Decr. (Table VI).
Schultz's Grund, 9—23 July and 17 Sept.—5 Novr., at all depths (Table VIII).
1913. Anholt Knob, 15 July—1 Oct. (Table VI).
Schultz's Grund, 19 Aug.—9 Decr., at all depths (Table VIII).
Between Gniben and Hasenöre, 9 July, motor boat from the "Thor", St. 2089 and 2091.
1915. Middelfart Sound: 23 July, surface, 5 spec.; 18 Sept. surface, 3 spec., 26 m line, 14 spec. (Kramp).
1916. Nyborg Fjord, 28 Aug., 2 spec. (Biol. Stat.).
1920. Off Glyngöre, in the Limfjord, 19 July, surface, 1 spec. (Kramp).

From this it will be seen that *Lizzia blondina* has been found in all parts of our waters as far as the Belts and the Sound. Whether it penetrates farther south is uncertain, as the plankton material available from the Baltic was collected at a time of year prior to that when the species can be expected to appear in our inner waters.

It is further apparent that Lizzia is an organism of marked seasonal occurrence, appearing in our waters every summer and disappearing completely in the autumn until the following summer. Its first appearance in the Kattegat invariably takes place abt. 2 months later than in British waters. Since it generally occurs simultaneously at Anholt Knob and Schultz's Grund, it seems likely that there is an indigenous stock in the Kattegat, but possibly also there may be some importation from the Skagerrak.

In order to answer the question of the origin of the summer population of Lizzia in the Kattegat, we will first concider the distribution of the medusa in 1911, as noted on the cruise of the "Thor" in June—July (see Chart 9). The occurrence in the North Sea and Skagerrak will be further dealt with later on. From 28 June—7 July, the medusa was found in Aalbæk Bay, north and east of Læsö, in small numbers between Læsö and Anholt, and in abundance at St. 1623 S. of Anholt (depth 30 m); it was lacking, however, in Aalborg Bay. It was also lacking at the numerous stations in the south-western Kattegat and Samsö Bay 8—12 July, which certainly suggests that it was not indigenous here, and had not yet reached these waters. (It was also lacking in the Belts and western Baltic). At Schultz's Grund lightship, the first specimen was noted on the 11 July, and when the "Thor" returned to the waters E. of Samsö on the 16 July, Lizzia had arrived there and was taken at two stations (1657 and 1659). The species was taken at Schultz's Grund lightship almost every week until 17 Oct., but always in small numbers, and chiefly in the intermediate and lower water layers.

It will be seen from the foregoing that Lizzia was generally distributed throughout the Kattegat in July 1911; it is therefore remarkable that in this of all years it should be so rare at the Anholt Knob lightship, where it was only taken once, on the 15 July. It will be shown in the General Section that the undercurrent of bank water in the Kattegat was for the most part moving strongly towards the west (cf. occurrence of Lizzia NW. of Anholt) and avoided Anholt Knob; it must, however, evidently have passed the site of the lightship on the 15th of July; for on that one day, the bottom water showed a high salinity and low temperature. It is rather interesting to compare the different hydrographical data from Anholt Knob with the observations at the above-mentioned St. 1623 S. of Anholt, where Lizzia was taken in great numbers on the 7th of July:

	Anholt Knob Lightship			Stat. 1623	
	Depth m	Mean for July 1911	15 July	7 July	Depth m
Temp. C.°	0	16.0	17.0	15.2	0
	28	10.4	8.6	8.5	30
Sal. ‰	0	18.7	17.5	16.1	0
	28	32.5	33.4	33.9	30

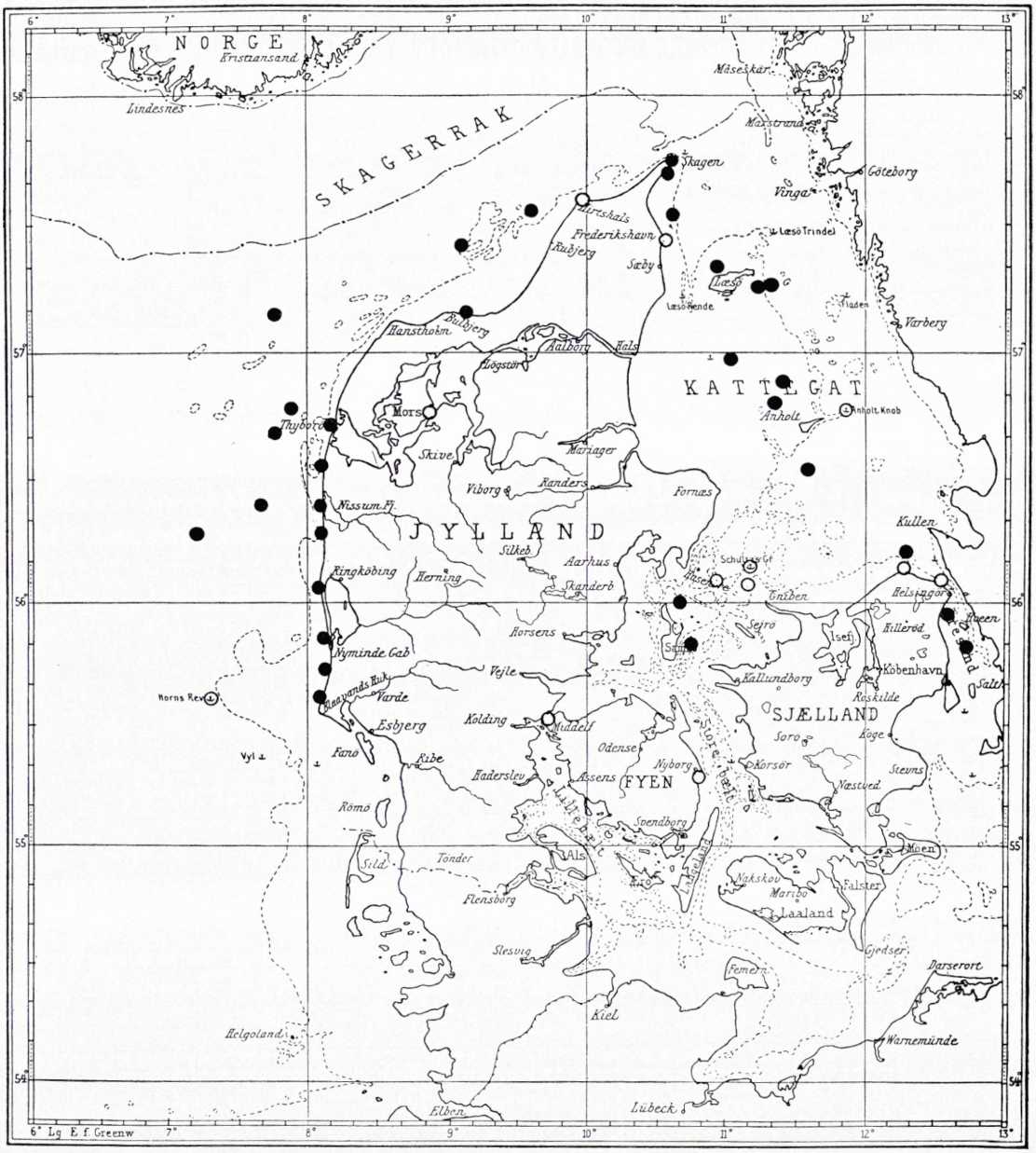

Chart 9. *Lizzia blondina*. ● "Thor" and motor boat from the "Thor" 1911; ○ other finds.

On the day when Lizzia was taken at Anholt Knob, the hydrographical conditions in the lower waters layers were thus practically the same as at St. 1623, but differed considerably from the average for the month.

From the facts noted in 1911 it then appears: that *Lizzia blondina* was, at any rate during that year, not indigenous in the south-western Kattegat, but arrived there in the middle of July, brought by the current flowing from the Skagerrak down over the Plateau south of Læsö and round the west of Anholt; *i. e.* with the bank water, not with the Baltic water which was circulating in the eastern Kattegat (see General Section). Whether this stock was of the same origin as that met with off the west coast of northern Jutland, or came from somewhere nearer at hand, e. g. the eastern Skagerrak or northern Kattegat, is another question.

In 1912, Lizzia appeared at Anholt Knob in great numbers on the 15 July, and was found thenceforward, in fairly considerable numbers for the most part, in all hauls up to 1 Decr. Its abundance on the very first day of its appearance suggests, to my mind, that the organisms belonged to an imported stock, which had had time to increase its numbers considerably by gemmation before reaching the spot. The salinity in the lower water layers was approximately normal in July, rather high for the rest of the period. In all probability, Lizzia was brought to Anholt Knob by the under-current, but hardly from the North Sea, as everything suggests that there was, in 1912, but very slight interchange of water between the North Sea and the Kattegat; the medusa cannot have come farther than from the eastern Skagerrak, and may possibly have been indigenous in the eastern channel of the Kattegat. A point in favour of this latter theory is the occurrence at Schultz's Grund, where Lizzia appeared even earlier than at Anholt Knob, *viz.* on the 9 July. It is highly unlikely, that the stock at Schultz's Grund should have been imported by a current from the north, flowing past Anholt Knob and on in the usual direction; the non-existence of any such regular inflowing undercurrent in the summer of 1912 would seem to be proved by the fact that the hydrographical conditions at the two lightships were altogether different. Nevertheless it is hardly likely that the stock was indigenous in the immediate vicinity of Schultz's Grund; the medusa was fairly common from the first day, mainly in the intermediate and lower water layers, and the inflowing current was strong (except in September). — Probably, there was, in 1912, a native stock of *Lizzia blondina* in the eastern channel of the Kattegat, both the northern and the southern parts; the currents in the lower water layers have then transported the organisms from there to both Anholt Knob and Schultz's Grund in the first half of July.

In 1913, Lizzia was taken at Anholt Knob in great numbers on the 15 July, while at the same time, an increase of salinity was noted in the lower water layers; smaller numbers were taken up to 1 Oct. This was unquestionably a stock imported from the north.

At Schultz's Grund, the occurrence of Lizzia in 1913 falls into two distinct periods. From the lightship itself we have, unfortunately, only material from 19 Aug.

to the end of the year, but on the 9th of July, a considerable number were taken at two places near at hand, between Gniben and Hasenöre. At Schultz's Grund Lightship a few Lizzia were found on the 19 and 26 August. The medusa was thus present in this part of the Kattegat as early as the beginning of July, simultaneously with, or even before, its occurrence at Anholt Knob; there must, then, undoubtedly have been an indigenous stock in the southern Kattegat. The distribution in July—August, however, hardly extended very far in towards the Belts, as the species was altogether lacking at Schultz's Grund throughout the whole of September, when the supply of water proceeded mainly from the Belts; this outflowing water contained no Lizzia. In October—November on the other hand, there was an unusually strong inward current at Schultz's Grund, embracing all depths, and this current at once brought a considerable quantity of Lizzia with it; from the 30 Sept. to 25 Novr. the species was found in every single haul, often in great numbers, and, as it would seem, with almost equal frequency in upper and intermediate water layers. The hauls from 16—0 m brought up as a rule about the same number of specimens as those from bottom to surface, so that the medusa was probably scarce in the lowest depths, but kept mainly in the neighbourhood of the boundary layer. This stock must, shortly before, have been living in the deeper parts of the southern Kattegat; presumably also, parts of the large stock which passed Anholt Knob in July coming from the north, must ultimately have reached Schultz's Grund, where the medusa was found in the lower water layers as late as December. — We find, then, again in 1913, that *Lizzia blondina* was indigenous in the deeper parts of the eastern Kattegat, both north and south, but not in Samsö Bay.

In 1915, I found *Lizzia blondina* in Middelfart Sound as early as the 23 July, so there must presumably, in this year also, have been a native stock of Lizzia in the southern Kattegat; and the unusually strong current in July must have carried part of this stock down into Samsö Bay, whence it was subsequently transported to the Little Belt, whenever the current was flowing inward (found 23 July and 18 Sept.).

The daily collections at Schultz's Grund lightship from 1 Aug.—14 Sept. 1910, in which Lizzia was taken almost every day throughout the period, and quite as frequently in the upper as in the lower water layers, are interesting chiefly from the fact that there was no discernible connection between the numbers of medusæ and the hydrographical conditions at the time; the species must have been fairly evenly distributed throughout the whole of the southern Kattegat, so that it would be taken at Schultz's Grund whichever way the current happened to be; it was found off the north coast of Sealand as late as 26 Oct. (St. 1492, see Table XIII).

From the foregoing, then, it appears that Lizzia is indigenous in the deeper parts of the Kattegat, but not, or only exceptionally, in Samsö Bay, doubtless, also, not in Aalborg Bay. It probably comes to Anholt Knob as a rule from the northern part of the eastern channel of the Kattegat, possibly also to some extent from the

Skagerrak; to Schultz's Grund from the southern deeps of the Kattegat. Now and again it is carried down into the Belts, but how far we cannot say. — Though keeping for the most part to the lower water layers or the boundary layer, Lizzia has occasionally been taken in remarkably great numbers in the upper water layers (Schultz's Grund), particularly when the surface water was flowing inwards.

Occurrence in the North Sea and Skagerrak. — The only time Lizzia has been taken at Horns Rev was on the 27 June 1911. From 17—21 June the same year, the "Thor" was searching the ground off the western coast of Jutland roughly as far as Long. 7° 00′ E., and a series of stations was taken from Lodbjerg approximately in the direction of Lindesnes in Norway. Lizzia was taken, always in small numbers, on the 19 and 20 June, at St. 1552, 1554, 1558, 1560, and 1564. These stations lie at very different distances from the coast (up to 30 miles) with depths between 16 and 53 m. As the species was not taken at any of the 17 southerly stations (17—19 June), and did not appear until 27 June at Horns Rev, which lies 44 miles S. of St. 1552, we must take it that the stock was brought down by a current from the north, this including also those specimens found at Horns Rev on the 27 June. — *Lizzia blondina* is undoubtedly indigenous near the mouth of the Skagerrak, where it lives in the northern bank water. In 1911, this cold bank water spread out, mixed with atlantic water, as an underlayer down along the west coast of Jutland, reaching in course of time as far as Horns Rev, and carrying with it *Lizzia* (also *Bougainvillia britannica*, q. v.). As the northern bank water does not ordinarily penetrate so far to the south, it seems likely that the same applies to Lizzia. We can hardly state it as a certainty, as there is no plankton material available from the area in question for the summer months in other years; it is nevertheless a fact that during the period covered by the regular plankton collections from Horns Rev lightship, 1911 is the only year in which Lizzia was found there.

We cannot disregard the possibility that Lizzia may, later in the year, be brought to the west coast of Jutland with the Jutland Current; it is found, as we know, at Helgoland in July and August, but seems, ordinarily at any rate, not to reach so far as Horns Rev. The specimens taken in early August 1911 close inshore off the west coast of Jutland from Blaavandshuk to somewhere near Hanstholm are undoubtedly remains of the same stock which arrived on the west coast in June from the north.

The eastern distribution in the Skagerrak is very little known; the species was taken by the "Thor" at two places in Jammer Bay 5 July 1911 (see chart), and on the cruise of the motor boat in August of the same year, it was found at Bulbjerg and the Skaw; it is doubtless indigenous on the Jutland side of the Skagerrak (I found it frequently in Hirtshals harbour in the summer of 1925).

Remarks on the gemmation. — Both at Anholt Knob and Schultz's Grund, Lizzia appeared each year at the same time, a little before the middle of July; there is, however, great difference in the length of time it remains in the plankton

in the different years. At Anholt Knob, in 1912, it was found up to 1 Decr., whereas in 1913 it disappeared as early as the 1 Oct. In the autumn of 1913, the temperature at all depths was on the average, higher than in 1912. At Schultz's Grund, in 1911, it disappeared on the 17 Oct., but in 1912 remained at least until 5 Novr.; in 1913 until 9 Decr. The temperature in September and October 1911 was considerably higher at all depths than in the corresponding months of 1912 and 1913. It would seem then, as if Lizzia disappears earlier when the water is warm than when it is cold. The higher temperature presumably accelerates the development of the individuals, and thus also gemmation, which is very natural and agrees with many other observations as to the influence of temperature on the development of marine organisms; the most interesting point is, that the more rapid development of the individuals leads to the earlier disappearance of the stock. That means that the number of medusa generations which can be produced by gemmation in a single season is limited; it must not be supposed that the process goes on as long as the water is warm enough; it ceases as soon as the physiological limit of numbers is reached; and this, from the observations noted above, seems to be earlier as the water is warmer. The point is one of some physiological importance, and it would therefore be desirable to test the accuracy of the observation by investigation of other and more extensive material.

It is very interesting to note that we find, almost throughout the whole period, both gemmiferous and mature specimens (see KRAMP 1926 a, p. 55).

Podocoryne carnea M. Sars.

Chart 8.

Podocoryne carnea M. Sars 1846.
Dysmorphosa carnea Haeckel 1879.

Hydroid: *Hydractinia carnea* M. Sars.

Podocoryne carnea M. Sars 1846.
Hydractinia — — 1851.
Podocoryne inermis Allman 1876.

I agree with HJ. BROCH that the hydroid genus *Podocoryne* Sars 1846 cannot properly be distinguished from *Hydractinia* van Beneden 1841, the only difference being the degree of development in the sexual generation. *Podocoryne* must therefore be deleted from our classification as a generic term for hydroids. The medusa, on the other hand, should continue to bear the name of *Podocoryne carnea* Sars.

Geographical distribution.

The Hydroid has been found off the atlantic coast of Cape Colony, at several places in the Mediterranean, off the atlantic and channel coasts of France, and at many places round the British Isles. It has not been taken at Helgoland. It is met with

all along the coast of Norway from the Christiania Fjord as far as the North Cape, and extends in these waters out to water of 150—200 fathoms' depths, whereas otherwise, it keeps almost exclusively to the littoral waters. — The hydroid has been found off all the coasts of Iceland, including the cold east coast; the most northerly find recorded is from King's Bay on the western side of Spitzbergen. — A solitary find is noted from Greenland, Godthaab, 23 m. Finally, the hydroid is very common off the southern shores of New England, in the Bay of Narragansett and Buzzard's Bay; it is not found north or south of here (MAYER 1910, p. 138).

The Medusa. Turning to the free-swimming medusa, we find that it is remarkably rare in most localities, even where the hydroid is quite common; there are, however, one or two localities where the medusa is stated as being very numerous. This is connected with an interesting variation in the development of the medusa.

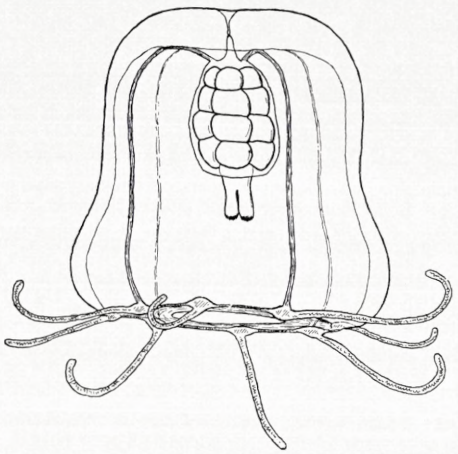

Fig. 1. *Podoryne carnea* Sars. Newly hatched. Middelfart Sound 16 July 1909, pelagic. Diam. 0.86 mm. Drawn from life by the author.

CHR. LOVÉN (1857) observed that the medusæ of this species had, on liberation from the hydroid, the gonads already filled with ripe sexual products; the same observation has been made on several occasions, and this is doubtless the rule in the north-european area; at any rate, no specimens of this medusa have ever been taken in north-european waters with more than 8 marginal tentacles. The accompanying figure is drawn from a live specimen hatched at Middelfart in 1909; that the individual in question is newly hatched is evident from the apical canal and from the "navel", which has only just begun to close; it will be noticed that the gonads are full of large, mature ova. There can be no doubt but that the medusa of this type has only a very short life as a free pelagic organism; at the moment of liberation, it is already prepared to exude the sexual products, after which it perishes. This explains why the medusa in question in so rarely found in the plankton.

It is not, however, the same everywhere. In most parts of the Mediterranean, the medusa behaves in a similar manner to that noted in northern Europe; at Trieste, however, it has a longer span of pelagic life, and may develop as many as 16 tentacles (GRAEFFE 1884, p. 347). Off the east coast of North America, the development proceeds even farther; according to MAYER (1910, p. 138) the medusa attains a height of 3.5 mm, and may then have as many as 32 tentacles.

Distribution and seasonal occurrence of the medusa. — In the Mediterranean, the medusa appears mainly in the winter and spring; off the east coast of North America in late summer. — Off the coast of France the medusa has never been taken, but BILLARD (1905, p. 500) found the hydroid with medusa buds on

the 5 August. At the British Isles, the liberation of medusæ takes place probably at nearly all seasons of the year. — In the vicinity of Bergen, SARS found the hydroid with medusa buds both in August and in March—April; the medusa has been taken pelagically near Bergen in August—September (BROCH 1905, p. 5). It has never been taken pelagically in Iceland, Spitzbergen or Greenland waters.

Occurrence in waters round Denmark.

Literature. — First observed by CHR. LOVÉN (1857, pp. 305—313) who found the hydroid with medusæ in the Bohuslän skærgaard (the belt of rocky islets off the coast) in July—August. — The hydroid has since been found in many places, and is mentioned by various writers; in several works by MÖBIUS for instance. ALLMANN (1876, p. 255) has described a new hydroid, *Podocoryne inermis*, from the Sound and Middelfart Sound; this form is, however, now regarded as identical with *Hydractinia carnea* Sars. It may perhaps be described as a non-spinous variety, as it lacks the small smooth spines found on the stolonial net of the typical form; the stolonial net of *inermis* is altogether less developed. The lack of spines is possibly nothing more than an indication that the species does not, in relatively enclosed waters like ours, attain such a high degree of development as off the coasts of Great Britain and Norway. (All the Danish specimens belong to the *inermis* variety, which had not hitherto been observed elsewhere.) — The species is noted by WINTHER (1880) under the name of *Podocoryne inermis*, and similarly by LEVINSEN (1893) from a number of localities, all in the Belt Sea (with Samsö Bay).

The medusa is only noted as having been taken pelagically in two places, *viz.* Bay of Kiel (MÖBIUS 1873b, p. 101, *Dysmorphosa fulgurans*) where the medusa is said to develop from spring to autumn; and Gullmarfjord in Bohuslän, where it has been taken once in June and July, several times in August (AURIVILLIUS 1896 and 1898a, *Dysmorphosa carnea* and *Dysmorphosa sp.*). JOHANSEN & LEVINSEN (1903) make no mention of this species, and HARTLAUB has no new finds to add from Danish waters. — The medusa is thus not mentioned in the literature as taken pelagically in the Danish area proper.

Material.

The Medusa. — There are in the Zoological Museum at Copenhagen two Danish specimens, taken pelagically at the following localities:

Off Gilbjerghoved, north coast of Sealand, 26 Oct. 1910, "Thor" St. 1492.
Middelfart Sound, 1 July 1915, surface (Kramp).

Of the Hydroid, the Zoological Museum possesses a considerable material, which, in conjunction with the literature, gives a good view of the distribution of the species in our waters. All finds known up to date are noted on Chart 8 (p. 63). It will be noticed that the species is altogether lacking on the Danish side of the Skagerrak (it has been taken in the Christiania Fjord and in Gullmarfjord), and

that it is very rare off the west coast of Jutland, where it has only been taken once or twice in deep water. It is likewise rare throughout the greater part of the Kattegat, where it lives for the most part as a littoral form; it goes down into the Sound, and into fjords such as the Issefjord in Sealand and Odensefjord in Fyen. Its principal area of occurrence is in Samsö Bay, where it is extremely common, and has been taken at depths from 5—24 m (WINTHER 1880, LEVINSEN 1893). Through the Little Belt and the Great Belt it passes into the western Baltic, to Kiel (MÖBIUS 1873b, p. 101) and Wismar (BRAUN 1888, p. 14). It is quite evident that the hydroid lives mainly in shallow and sheltered waters, which is doubtless correlated with its manner of growth; the colony forms a network or plating over some firm substratum; in most places it seems to prefer shells occupied by Paguræ. In the Danish waters, however, it has been found almost exclusively attached to living *Nassa reticulata*, rarely on living *Nassa pygmæa*, and only twice on a Nassa shell containing a Pagura; finally, BRAUN (1888) has found it in the Bay of Wismar on *Littorina rudis* and *Neritina fluviatilis*.

We now find that there is a very close agreement between *Hydractinia carnea* and *Nassa reticulata* as regards their distribution in Danish waters. Braun's interesting find of *H. carnea* on *Littorina rudis* and *Neritina fluviatilis* in the inner part of the Bay of Wismar, where *Nassa* is not found, shows, however, that the hydroid can stand a lower degree of salinity than the species whose shell it selects as its favourite site of occupation.

The few finds of the pelagic medusa afford no satisfactory idea as to its occurrence in Danish waters; investigation of the hydroid colony, on the other hand, gives a good view of the life cycle of the species in our area. The hydroid hibernates, but in the course of the winter, the polyps die off, and it is thus properly only the stolons which survive the winter; from these, new polyps begin to form in the spring, and continue for some part of the summer, so that the number of individuals in the colony is gradually increased; the ones first developed are sterile feeding polyps, but fertile individuals are very soon produced, from May or June, and the liberation of medusæ proceeds then uninterruptedly until well on in the autumn, being at its height in July—August; even as late as the beginning of November, fertile colonies may still be met with; most are, however, sterile by then. The free medusæ have, on liberation, already fully developed gonads with ripe or nearly ripe sexual products; their pelagic life is brief, and the Planula larvæ emerging from the ova soon attach themselves to shells of live Nassa and form the nucleus of new colonies; the sterile colonies found in August—November are such newly formed colonies, with a fine, scanty stolonial net and small polyps set far apart; the earliest formed colonies have time to develop medusa buds, and presumably also free medusæ before the next winter sets in; there is thus a possibility for the development of two generations in the same year.

Podocoryne areolata Alder.

Syn. *Cytaeandra areolata* Haeckel 1879.
Lymnorea borealis Mayer 1910.
Limnorea norvegica Broch 1905.

Hydroid: *Hydractinia areolata* Alder 1857.

The medusa is somewhat larger than that of the previous species (4—5 mm high) and is otherwise to be distinguished from it by its dichotomically branched oral tentacles and the larger number of marginal tentacles. — The species is known from British waters, the Shetlands, northern part of the North Sea, Christiania Fjord, and west coast of Norway as far as Molde and the Romsdal Bank (63° 10′ N.); finally also from Helgoland. — The medusa occurs at nearly all seasons of the year (see HARTLAUB, 1911, p. 219, and KRAMP & DAMAS, 1925, p. 268). It has been taken in the Christiania Fjord in June (DAMAS).

In the Danish waters, only a single specimen of this charming little medusa has been found: a specimen 3 mm high from the "Dana" St. 3012, in the North Sea S. of the Jutland Bank, 7 May 1923, near bottom at 31 m' depth.

Rathkea octopunctata (M. Sars).

Chart 10.

Syn. *Cytæis octopunctata* M. Sars 1835.
Oceania blumenbachii Rathke 1835.
Lizzia octopunctata Forbes 1848.
— *grata* A. Agassiz 1865.
Margellium octopunctatum Haeckel 1879.
Rathkea octopunctata — —
Rathkea blumenbachii Hartlaub 1911.

Hydroid unknown.

My reasons for retaining the specific designation of *octopunctata* for this well-known little medusa are set forth at length in my paper on the Anthomedusæ of the "Ingolf" Expedition, 1926 a.

Geographical distribution.

This medusa is known from the Black Sea and Mediterranean, but seems to be rare in those waters; also from the Bermudas (found in May and June), east coast of North America north of Newport (February to June; off Newfoundland until July), west coast of Greenland (July and August) and from the Pacific (Dutch Harbour in May; Japan in winter).

In north-european waters, *Rathkea octopunctata* is an extremely common form, ranging from the north of France to Iceland and Novaya Zemlya. — The occurrence of the medusæ falls somewhat later in the northern than in the southern parts of its area of distribution in northern Europe. Off the coasts of England and

Ireland, and in the southern parts of the North Sea, it appears in January or February, propagates at first by gemmation, attains maturity in April—May and disappears in May or June; in Scottish waters, it has medusa buds as late as June, and is common right on into July. Off the north coast of Iceland, mature specimens are found in June, but in the colder waters of the east coast, it is still gemmiferous in August. The records of occurrence in the Barents Sea and off Novaya Zemlya are from July and August. Off the west coast of Norway it is taken as a rule from March to June or July; it is numerous in the fjords, but may also be met with out at sea.

As regards north-european waters, *Rathkea octopunctata* must be considered as an artic-boreal form. In the boreal region, it is a spring form, but isolated specimens may occasionally be met with at other seasons (September, October, November); these are, however, rare exceptions.

Works dealing with *Rathkea octopunctata* in waters round Denmark.

First mentioned by JOHANSEN & LEVINSEN (1903); the species is mentioned in the text p. 279 where it is stated that the data available suggest that it is indigenous in our inner waters. In the table p. 290—291, it is noted as found at Thyborön, and from Skagens Rev to the Great Belt between February and June.

BROCH (1905, p. 6) notes the medusa from the fjords at Risör on the Norwegian side of the Skagerrak in March and April 1904. According to SVERDRUP (1921) a few specimens were taken in the Christianiafjord on the 30 April 1916.

HARTLAUB (1911, p. 232) adds the following new localities: Frederikshavn 24 July; Limfjord 1 May 1895, in great numbers; Hellebæk; between Als and Aarö; Stollergrund in May.

The international plankton lists up to May 1908 contain no mention of Rathkea from the Danish waters with the exception of two stations off the Swedish coast of the Skagerrak in February 1903 (see KRAMP, 1913a, p. 524, and chart Pl. XCV). — In the Bulletin Planktonique for 1908—1911, it is noted from Anholt Knob 15 May and 15 July 1911; I do not know who is responsible for determination of the specimens, but the one from July I should consider very doubtful.

Summary of Material.

1895. Limfjord, 1 May, 27 spec., most with well-developed gonads, only 3 gemmiferous (Th. Mortensen).

1909. Off Fornæs (56° 22′ N., 11° 08′ E.), 4 April, depth 18 m, Ytr. 16 m buoy rope, 5 spec. "Thor" St. 1233.

Off Spodsbjerg, Langeland, 10 April—9 June, very numerous abt. mid May, rare in the upper water layers (see KRAMP 1915). Pelagic stations of the cutter "Karen" in the Great Belt and Kattegat 22—28 April, often in great numbers in the deeper water layers (see KRAMP 1915).

1911. Horns Rev, 28 March and 17 April, 1 gemmiferous specimen on each occasion (Table V). Anholt Knob, in all hauls 16 Feb.—15 May, frequent in April (all gemmiferous), and May (all mature); also one spec. 15 Decr. (Table VI).

Schultz's Grund, 14 May—4 July, frequent in May (all mature) rarer later, only in the intermediate and lower water layers; 7 and 12 Decr. 2 gemmiferous spec. (Table VIII).
"Havörnen" 11—16 May, all stations between the Skaw and Spodsbjerg, Langeland, but not in the Baltic; rare in the upper water layers (Table IX).
Cruise of the "Thor", in June—July: Bay of Aalborg 30 June, St. 1587—1591; S. of Hasenöre 8 July, St. 1628; Bay of Aarhus 10 July, St. 1632; The Sound, 17 July, St. 1665 (Table X).

1912. Horns Rev, 22 and 29 April, 6 May; gemmation ceased about end April (Table V).
Anholt Knob, 2 Feb.—15 May; gemmation ceased abt. 1 May (Table VI).
Schultz's Grund, 2 and 23 Jan., 14 March—28 May, very scarce, only in the lower water layers; mature in May (Table VIII).

1913. Horns Rev, 14, 21, and 28 April, all gemmiferous (Table V).
Anholt Knob, 1 March—1 June, in all hauls, very numerous in May; gemmation ceased early May (Table VI).
Ringköbing Fjord; Nyminde Channel 9, 21 and 25 Feb. single specimens; Nyminde Channel 8 March, in thousands; Nyminde Channel 21 April, in hundreds, abt. 30 % mature; Ballehage, Havrvig Huk, and Stavning Pynt 4 May, in thousands, abt. 50 % mature.

1914. Horns Rev, 30 March (Table V).
Anholt Knob, 15 March and 1 April (Table VI).
Schultz's Grund, 17 Feb.—31 March, very rare in upper water layers, numerous in lower water layers last half of March (Table VIII).
Skagerrak 4 April "Havörnen": at the two stations nearest the coast of Norway; St. I, 75—35 m, 20—0 m and 5—0 m; St. II 40—0 m (see General Section, Chapter I).

1915. Middelfart Sound: 15 Jan., 3 Feb., 11, 14, and 25 March, 4 and 21 May, 18 Decr. — Scarce as a rule, but in great numbers 4 May (nearly all mature), and fairly common 18 Decr.
Nyborg, in the well of the Biological Station 8 and 14 April, 16 and 17 May.

1916. Middelfart Sound 18 Jan., 2 specimens.
Nyborg 10 April.

1920. Limfjord; off Örodde 17 March; S. of Lögstör 13 April, mostly mature (R. Spärck).
Great Belt E. of Slipshavn 13 April, in great numbers, 60 % gemmiferous (Biol. Station).

1921. Nyborg, well of the Biological Station, 8 and 9 April, 24 and 20 % gemmiferous; SE. of Slipshavn 19 April, in great numbers, 1 % gemmiferous (Biol. Station).

1923. Cruise of the "Dana": 1—2 April, single specimens in eastern Kattegat St. 2939. — 17—26 April, south-eastern Kattegat (St. 2944 and 2946), Bay of Köge (St. 2954), Femern Belt (St. 2963), between Ærö and Langeland (St. 2969), Great Belt, Bay of Samsö, and southern Kattegat (St. 2974—2982), scarce everywhere. — 30 April—9 May, Skagerrak and North Sea (St. 2997—3023). — 13—19 May, Kattegat (St. 3036, 3038, 3050, and 3054) (Table XII).

Rathkea octopunctata has been found in all our waters as far as the western Baltic. It is a seasonal form, but in our inner waters, its "season" is of considerable duration, covering sometimes two-thirds of the year; in August—November the species is nowhere to be found. — Though the medusa is common at Helgoland (according to HARTLAUB) it seems to be rather scarce on the whole along the Danish portion of the west coast of Jutland, and to disappear completely some time in May. In the Limfjord, it has been taken right up in the eastern part of Livö Bredning. It is found in all parts of the Kattegat, not only those where there are constant currents, but also in fjords and bays and shallow waters such as the Bay

of Aalborg, Bay of Samsö etc. In the Kattegat and the Belts it appears in mid winter, sometimes as early as December, and may still be met with in June, or even July; it has always a pronounced maximum in April—May, and may then appear in enormous numbers. In the Langelandsbelt, 13 May 1909, abt. 3000 specimens per sq. m. of surface were noted, and in Middelfart Sound on the 4 May 1915, I found close on 2000 per cubic metre of water. Where any data as to vertical distribution are available, the medusa is always noted as far more common in the lower than in the upper water layers. — As regards its limit of distribution towards the Baltic, I do not feel sure of my ground here. Its coming in through the Sound ("Dana" 1923) must certainly be quite an exceptional occurrence. I have found it in the northern waters of the Little Belt both in December and January, with a strong north-going current; in December, indeed, in considerable numbers; this seems to me to prove that the species can be indigenous in this water. HARTLAUB records the medusa from the southern part of the Belt (between Als and Aarö) and from Stollergrund outside the Bay of Kiel. It was lacking, however, at "Havörnen"s three stations south of Fyen and Laaland 17 May 1911, though taken a few days before in the Great Belt and Langelandsbelt. On the cruise of the cutter "Karen" in 1909, Rathkea was lacking at the two stations S. of Langelandsbelt 20 April; it had by then been present for some time at Spodsbjerg, though in small numbers, and was not common there till some days later. On the 22 April it was found in great numbers at Nyborg. It is possible that its absence from the Baltic on the 20 April 1909 and 17 May 1911 may in both instances be due to the fact that the stock from the north had not yet arrived; on the other hand, the variation in number of specimens at Spodsbjerg in 1909 exhibits a very distinct correlation with direction and force of the current, and with the salinity of the water, showing that Rathkea was lacking or scarce in the Baltic water, but numerous as soon as any strong inflow of salt water took place from the north. This certainly suggests that the great hosts carried by the current down through the Great Belt and Langelandsbelt must for the greater part have perished as soon as they entered the Baltic; after abt. 1 May 1909, no gemmiferous specimens were found. And this is highly remarkable, as the species did not attain its maximum frequency at Spodsbjerg until about a fortnight later, which proves that the stock must have been brought down from the north, from the Kattegat (cf. also distribution in April 1923).

In the Kattegat, Rathkea behaves in a very similar manner to *Hybocodon prolifer* (p. 52); there is both an indigenous stock and a stock imported from the Skagerrak, the distribution and relative numbers of the two varying considerably from one year to another.

In 1912, when no importation took place (cf. *Hybocodon* and General Section), there was a very small indigenous stock of *Rathkea* both at Anholt Knob and at Schultz's Grund; at both these localities it appeared in December 1911 and remained until past the middle of May 1912. — In 1914, the medusa did not appear at Anholt Knob until the 15 March; if there was any indigenous stock in the vicinity

it must therefore have been very small. At Schultz's Grund on the other hand, there was a very large native stock, appearing in rapidly increasing numbers from the 15 Feb. The influence of salinity on the medusæ was very distinctly apparent in March of that year; between 17 and 31 March, the surface salinity dropped from 20.1 to 13.8 ‰, whereas at the bottom, the salinity remained practically unchanged; on the 17 March, Rathkea kept mainly to the vicinity of the boundary layer (the greatest number was taken in the haul 16—0 m); on the 24 March, the salinity of the intermediate layers was appreciably lower, and on that date, more Rathkea were taken in the haul 26—0 m than in the one from 16—0 m; on the 31 March, the salinity not only at 10 and 15, but also at 20 m' depth was lower than on the other days, which evidently forced the medusæ still lower down, for the haul from 16—0 m yielded only a few specimens, whereas the haul from bottom to surface showed the species as very numerous there. — In 1911, there was a considerable importation of Rathkea from the Skagerrak into the Kattegat. At Anholt Knob, the medusa was scarce in February and March (presumably indigenous) but common in April and May; gemmation ceased in the latter half of April, but even as late as the 15 May, the number of specimens was as great as on 15 April; there must therefore have been a continual supply of new arrivals, and these can only have come from the north. At Schultz's Grund, where it was common on the 14 May, when the work of collection commenced, it remained until 4 July. On the cruise of "Havörnen" 11—16 May, Rathkea was found in the lower water layers at all stations between the Skaw and the Langelandsbelt; scarce everywhere in the eastern channel of the Kattegat, but common in the north-western Kattegat and in the Bay of Samsö. Its occurrence was thus in the main just like that of Hybocodon, with an indigenous and an imported stock; now, about the middle of May, the importation had ceased, and the medusa had become comparatively rare in the current areas of the Kattegat, but in the coastal areas, and in the Belt Sea, part of the stock still lived on, busy with sexual propagation. On the cruise of the "Thor", the last remains of that year's stock were found, partly in the Bay of Aalborg 30 June, partly south of Djursland 8—10 July. It is very interesting to note that on the 17 July, in the Sound (St. 1665) quite a good number of specimens were taken (21), two-thirds of these being still gemmiferous, and undoubtedly the offspring of a stock carried into the Sound long before, their development there, owing to the low temperature (5°7 at bottom) proceeding more slowly than in the other waters (cf. *Sarsia tubulosa*). — In 1913 also, the Kattegat doubtless received a considerable, though brief, importation of Rathkea, as of Hybocodon; this is indicated by the rather rapid increase from small beginnings in March, the sudden transition from gemmiferous to mature stage in the first half of May (1 May all gemmiferous, 15 May all mature), and the rapid decline in the latter half of May. One peculiar feature must, however, be noted in this connection; to wit, the remarkable scarcity of Rathkea on the 15 April; the salinity of the lower water layers was then very slight, far below the mean salinity for the month; the medusæ may, perhaps, have

been very common a couple of days earlier or later. — So far, then, the investigations up to 1914 show that the native stock of Rathkea is small in the neighbourhood of Anholt Knob, but may be large in the south-western Kattegat, and that a stock is sometimes imported from the north, this having appeared, in 1911 and 1913, at Anholt Knob in March.

As regards occurrence in waters outside the Skaw I will here only state as follows: At Horns Rev, the species has only been taken in small numbers and over very short periods in each year. On the other hand, the medusa seems to have found conditions favourable in Ringköbing Fjord in 1913, when the old outlet of the fjord at Nymindegab was closed, while salt water flowed in abundantly through the new channel at Hvide Sande; the occurrence of small numbers of medusæ in the closed Nyminde channel as early as 9 Feb. shows that the hydroid must have been living, if not in the fjord itself, at any rate in the North Sea very near its mouth. The numerous medusæ found in the Nyminde channel on the 8 March (abt. 900 per sq. m surface at $2^1/_2$ m depth, or about 360 per cubic metre) and in the middle of the fjord on the 4 May, must doubtless have been produced in the fjord itself, by gemmation, as the offspring of the small stock found in February; immigration en masse from without is unlikely, as the species, judging from the samples taken at Horns Rev Lightship, appears to be scarce on the west coast of Jutland, and remarkably so in 1913. — Finally, there are the plankton collections from "Havörnen" early April 1914, in the Skagerrak, along the line Oxö—Hanstholm, where Rathkea was found at the two most northerly stations nearest the coast of Norway, but was lacking at the two southern stations (see General Section).

The distribution of *Rathkea octopunctata* in the spring of 1923 is extremely interesting (see Chart 10, p. 83). It falls into two completely distinct areas, as the stock from the Skagerrak did not penetrate down into the Kattegat.

The stock in the Kattegat. — There was a not very large indigenous stock in the southern and western Kattegat. The investigations of the "Dana" in the south-eastern Kattegat in mid April yielded only a few specimens. I was not present on board myself; Rathkea was doubtless present in several of the samples, but was overlooked; this little medusa is hardly discernible in a sample containing many different plankton organisms unless one is particularly looking for it, and a piece of white paper is placed under the dish containing the sample, in order to render the dark marginal bulbs visible.

A few specimens were found in the Bay of Köge on the 19 April (see General Section). Out of six specimens taken, 4 were gemmiferous, 2 mature.

The medusa was lacking throughout in the Baltic east of Femern, and west of Langeland it was only found at a single locality (St. 2969); a few specimens had been brought down from the Great Belt into the Femern Belt. On the 24—26 April, Rathkea was taken in all hauls from the lower water layers (never at the surface) along the range from the Langelandsbelt through the Great Belt to the Great Middelgrund in the Kattegat. It was altogether lacking, however, in the eastern Kattegat

north of Anholt, and throughout the whole of the northern Kattegat; also in those parts of the eastern Skagerrak investigated at the latter end of April. In the Bay of Samsö and immediate vicinity, the number of specimens was quite considerable, but decreased both towards the north and towards the south. There can be no doubt but that there was, in the southern Kattegat, an indigenous stock of Rathkea which kept to the lower water layers and was carried with these down through the Great Belt. It is equally evident that no importation took place from the Skagerrak.

It is interesting to compare the percentages of gemmiferous and mature specimens at the different localities:

	Stat.	Date	No. examined	% gemmiferous	Average temperature
Femern Belt	2963	21. IV.	18	72	3.8
Great Belt	2974—2977	24. IV.	114	26	4.7
Bay of Samsö	2978—2979	25. IV.	113	24	5.1
S. Kattegat	2980—2982	25—26. IV.	10	0	6.1

We are evidently at the close of the gemmiferous period, and the great difference in the number of gemmiferous specimens from St. 2963 to the stations in the Great Belt is probably due in some degree to the interval of time, 3 days. Naturally, there are also a number of accidental variations, some of the stations yielding but a small amount of material. On the whole, however, the figures show a distinct correlation with the temperature in the lower water layers, where the medusæ were taken.

As mentioned elsewhere, the deeper portions of the Kattegat were, in April, almost entirely filled with a very salt water mass of Atlantic origin, the bank water being kept out and thrust down into the south-western part of the Skagerrak; here, Rathkea was found in considerable numbers, but in the middle of May, when the bank water began to make its way into the Kattegat, the Skagerrak stock of Rathkea was well on the decline, and did not manage to penetrate into the Kattegat. There can be no doubt but that all the Rathkea taken inside the Skaw in the spring of 1923 were of local origin. This also applies to the few specimens found in Læsö Channel and Bay of Aalborg about the middle of May; all were mature, being the last remains of the native stock. On the cruise in the southern Kattegat about 1 June, no Rathkea were found.

We have here, then, as in the case of Hybocodon, a favourable opportunity of considering a stock indigenous to our waters undisturbed by any importation from without. And we find that there was a not very numerous native stock in the following areas, keeping throughout to the lower water layers: Bay of Aalborg, southern Kattegat, Bay of Samsö, and perhaps part of the Great Belt. A number of individuals were carried by the in-going undercurrent either through the Sound to the Bay of Köge, or through the Great Belt to the Femern Belt. None, however, were carried to the neighbourhood of Anholt Knob, which confirm the supposition

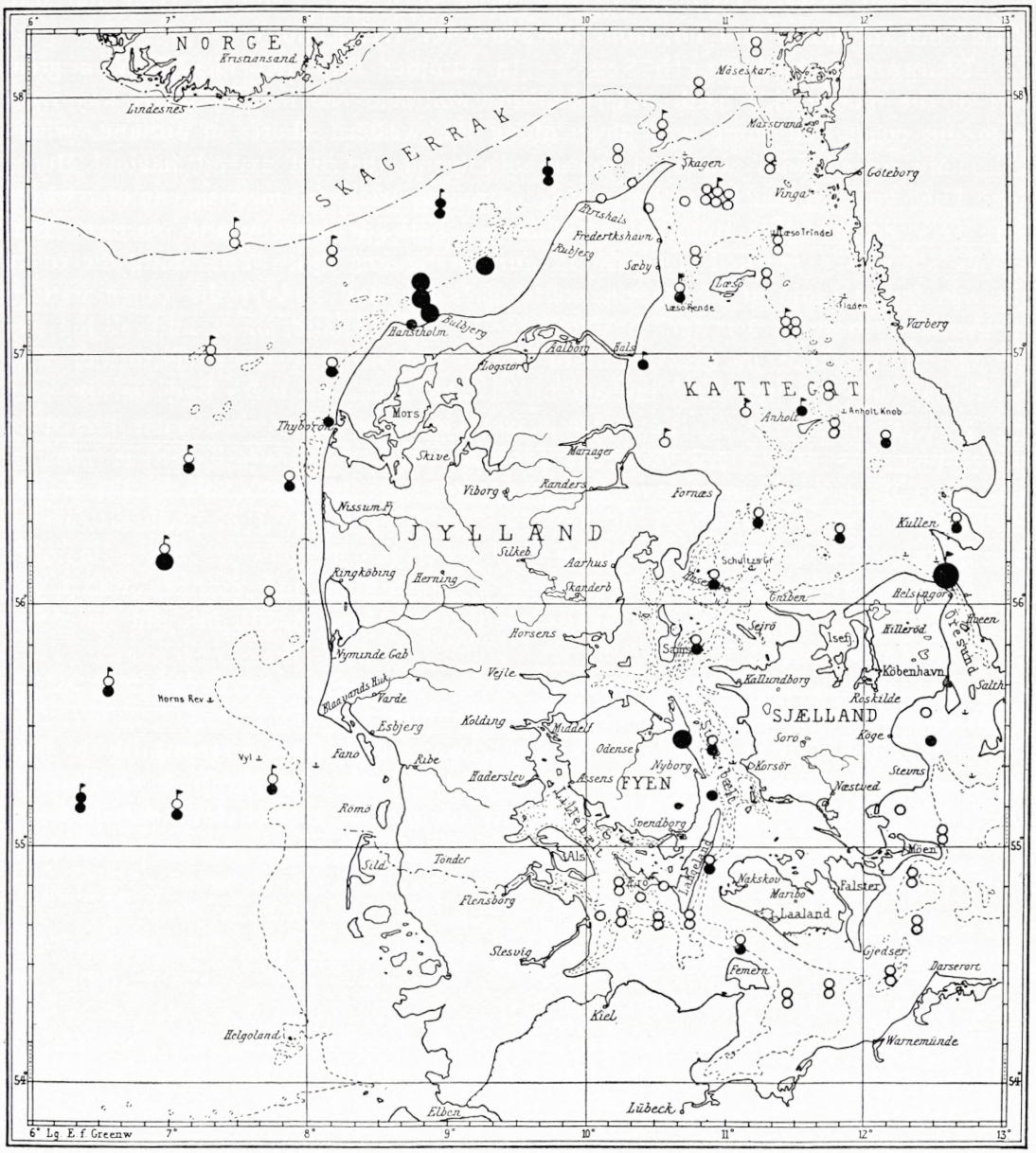

Chart 10. *Rathkea octopunctata*. Occurrence on the cruise of the "Dana" 17 April—19 May 1923. All pelagic stations within this period are marked on the chart. Two circles, one on top of the other, denote hauls made in upper and lower water layers. Blank circles indicate that the medusa was not taken in the hauls so marked; the three different sizes of filled circles represent the frequency of the species.

o = St. 2944—3004, 17 April—2 May.

♂ = - 3006—3054, 5—19 May.

that the great masses taken in normal years at Anholt Knob in April and May come from the north and not from the south (cf. Hybocodon).

Skagerrak and North Sea. — In Jammer Bay and Vigsö Bay, a great part of the Skagerrak's bank water (salinity abt. 33.8 ‰) had made its way right in to the coast and some way down along the western shores of Jutland, where it became mixed with water of lower salinity; it did not extend beyond Horns Rev. The water round Hanstholm was extremely rich in medusæ, among which were very considerable numbers of Rathkea, both at bottom and surface. This species showed a marked decrease in numbers going southward along the coast, but was found again at all stations south of Horns Rev and at the outer stations off the west coast. It was lacking, however, at the Jutland Bank and at the two stations midway out in the mouth of the Skagerrak. The stock south and west of Horns Rev was probably indigenous to that area, as there had hardly been any great displacement of the water masses here for some time past. The stock in Jammer Bay and Vigsö Bay was probably in part native, but it is possible that some importation may have taken place from the northern side of the mouth of the Skagerrak. There was at any rate an accumulation of medusæ east of Hanstholm. — Towards the middle of May, when the bank water began to move inwards towards the Kattegat, the medusæ went with it, and Rathkea was found at the two outer stations in the Skagerrak (St. 3022 and 3023), but did not penetrate into the Kattegat.

The temperature in the parts of the Skagerrak and the North Sea with which we are here concerned did not vary greatly, and the variations were fairly irregular. The development of the medusæ likewise shows no distinct susceptibility to fluctuations of temperature. There was, however, in the course of the time occupied by the investigations, a marked decrease in the number of gemmiferous specimens:

Station	Date	No. examined	% gemmiferous	Average temperature
2997—3003	30. IV—2. V	102	77	5.5
3006—3012	5. V—7. V	54	46	5.2
(3022—3023	9. V	8	37	5.9[1])

These figures are very interesting when we compare them with those for the Kattegat and the Belt Sea, where, as we have seen (p. 82), the number of gemmiferous individuals was far smaller (*i. e.* the stock much farther advanced in development) though the temperature on the whole was lower. It had already occurred to me that the native stock of the Kattegat developed earlier and more rapidly than the imported; and here, where we have them separately (the "importation" stock in this case not being imported), the feature in question is very distinctly apparent. In

[1] Material insufficient.

1912, we had a similar state of things, insofar as the importation did not take place, and both at Anholt Knob and Schultz's Grund we find Rathkea culminating earlier than usual. In 1909, 1911, and 1913, when the importation was of considerable extent, Rathkea remained in the Kattegat plankton right on into June or July; in 1912 it disappeared, just as in 1923, before the end of May.

Summary.

Rathkea octopunctata is indigenous in the North Sea, the Skagerrak, and certain parts of the Kattegat, especially in the Bay of Aalborg and the Bay of Samsö and in the southern Kattegat; in the eastern channel of the Kattegat on the other hand, it appears to be very rare as an indigenous form (cf. Anholt Knob and distribution in 1923). Occasionally there may also be a native stock in the Belts and the western Baltic, but this is probably not always the case. In our inner waters, the medusæ of the indigenous stock begin to make their appearance in the plankton in the middle of winter. For the first few months, the medusæ propagate exclusively by gemmation; as long as this is actively in progress, the specimens have as a rule four medusa buds at the same time, but towards the close of the gemmiferous period, we find as a rule only one or two buds on each individual. Gemmation, which gives rise to a marked increase in the numbers of the stock, ceases for the most part about the end of April, and the individuals then remaining pass over into the mature stage, the stock now suffering a rapid decrease in numbers. In years when the Kattegat receives no importation of Rathkea from the Skagerrak, the whole of the native stock disappears before the end of May (as in 1912 and 1913). As a rule, however, there is some importation of Rathkea into the Kattegat from the Skagerrak; the individuals thus imported propagate actively by gemmation, the current at the same time carrying them farther in, and the new arrivals, with their offspring, mingle with the native stock. The time at which this importation begins cannot be stated precisely; judging from the facts observed at Anholt Knob, where the native stock appears to be small, it seems likely that the imported stock appears here in March; it is, however, impossible to say what is the rate of its further progress southward. Both the imported and the native stock keep almost exclusively to the lower water layers, and are borne along by the undercurrent. Sometimes the entire importation takes place in a very short time, as in 1913; at others, it may extend over a longer period. We have interesting data from the Great Belt as to the progress of gemmiparous propagation in different years. True, the material was not collected at exactly the same spot or on exactly the same date every year. Nevertheless, comparison of the percentage of gemmiferous Rathkea and the mean temperature for April at 20 m at Schultz's Grund gives, if not an exact, at any rate useful view of the manner in which development depends on the temperature of the water.

Year	Locality	Date	% gemmiferous	Temperature
1909	Slipshavn	22. IV	22	4° 8
1920	—	13. IV	60	3° 6
1921	—	19. IV	1	5° 5
1923	Great Belt	24. IV	26	4° 9

From this, and other examples above noted (The Sound 1911, Kattegat and Great Belt 1923) there seems to be no doubt but that the temperature of the water affects the progress of gemmation (and to a higher degree in the case of Rathkea than of Hybocodon) so that it proceeds more actively and ceases earlier at higher temperatures. This, among other factors, renders the duration of gemmiparous propagation, and thus the length of time for which the stock is present, subject to some variation from place to place. This applies not least to the imported stock, which, after passing in through the mouth of the Kattegat, is distributed among several different parts of our inner waters; the species very soon disappears from the eastern channel of the Kattegat, but can remain for some time, even on into July, in different bays and enclosed waters, where it is carried hither and thither by the currents. — With regard to the occurrence and development of the medusa in the North Sea, we know very little indeed; the material from Horns Rev lightship, and also the investigations of 1923, suggest that the occurrence of the North Sea stock falls somewhat later than that of the stock in the Kattegat.

As in the case of Hybocodon, so also here, I am in doubt as to the source and route of the stock imported into the Kattegat; the occurrence of the two species inside the Skaw is, however, uniform in all essentials, and it is therefore highly probable that they come from the same region, *i. e.* presumably from the southern coasts of Norway. On the other hand, since Rathkea is known to be indigenous in the vicinity of Hanstholm, it is very possible that importation into the Kattegat may take place along the Danish coasts of the Skagerrak. The question cannot be definitively settled until we have investigated the horizontal and vertical distribution of the medusa in the Skagerrak throughout the first months of the year.

Fam. *Tiaridæ.*

Tiaranna rotunda (Quoy & Gaimard).

Hydroid unknown.

Recent descriptions of this medusa have been given by Maas (1910, p. 8) and by me (Kramp 1920, p. 6, Pl. I, figs. 2—4). In 1913, Hartlaub (1913, p. 266) described a young specimen of this species from the northern part of the North Sea; otherwise, it has, until quite recently, only been known from the immediate vicinity of the Straits of Gibraltar. It has since been found, however, that the medusa Hartlaub described in his "Anhang" to "Nordisches Plankton" (p. 411), under the name of *Rotundula brochii* n. gen., n. sp., from the Trondhjem Fjord, is in reality a speci-

men of *Tiaranna rotunda*. The species has since been found again in Trondhjem Fjord, and DAMAS found it in considerable numbers in deep water in the Hjörundfjord, farther south along the west coast of Norway (KRAMP & DAMAS 1925, p. 275). It is therefore not so remarkable that it should live in the deeps of the Skagerrak, but it was not found there until 1922, when I took it on the cruise of the "Dana" in the autumn at the two following localities:

St. 2895, 46 miles N. by W. of Hirtshals, 58° 13′ N., 9° 34′ E., 11—12 Oct. 1922. Depth 650 m, bottom temperature 5°10, salinity 35.14 ‰. Ytr. with chain, at bottom (1200 m wire). — 14 specimens.

St. 2896, 33 miles N. by W. of Hirtshals, 58° 06′ N., 9° 35′ E., 12 Oct. 1922. Depth 450 m, bottom temp. 5°28, salinity 35.14 ‰. Ottertrawl. — 1 spec.

As will be seen, the medusa was found in quite considerable numbers at the deeper of the two stations. When the young fish trawl was hauled up from 650 m' depth at this station, it contained a mass of soft black mud. It was on careful examination of this that the 14 specimens were found. Several of them were rather small, and it is likely that there were others which were overlooked. A haul made at the same station with the young fish trawl without chain, and with 1000 m wire (at abt. 500 m' depth below surface) proved negative as far as Tiaranna was concerned. The temperature of the water at 450 m was 5°42, salinity 35.08 ‰. The specimen from St. 2896 was rather large, and was taken in the ottertrawl; the mere fact of a Tiaranna being taken with this wide-meshed net suggests that the medusa must have been fairly common in this locality as well. — We see, then, that *Tiaranna rotunda* occurs in not inconsiderable numbers in the deepest parts of the Skagerrak, where it keeps close to the bottom in the atlantic water. As to its time of propagation and growth in our waters it is of course impossible to say anything from the material in question.

Halitholus cirratus Hartlaub.

Chart 11.

Syn. *Tiara pileata* autt. partim.

Hydroid: *Perigonimus cirratus* Hartlaub.

Geographical distribution.

HARTLAUB has described this species in the "Nordisches Plankton" (1913); he notes it from several places at Spitzbergen, both on the eastern and on the western side of the islands, where it has been found in June, July, and August. Also from the Barents Sea and the Murman Coast, where it appears to be rare. — After renewed investigation of the material from the "Tjalfe" Expedition, I can add two localities from SW. Greenland, in July (KRAMP 1926 a). As the species has now also been found off the north coast of Alaska (BIGELOW 1920, p. 7), its distribution is evidently arctic-circumpolar.

Apart from these arctic regions, *Halitholus cirratus* is also found in the Baltic and the Kattegat, a region separated from the arctic localities noted by wide expanses of water where the species is not found at all.

HARTLAUB (p. 275) mentions a series of finds from the Baltic, and a few from the Belts and the Kattegat, He sums up the distribution as follows: (footnote p. 275). "Die Verbreitung in der Ostsee erstreckt sich vom Kattegat über Gotland hinaus mindestens bis zum 59° N. und ist in den tiefer, salzhaltigeren Wasserschichten der östlichen Ostsee am reichsten." The finds noted by HARTLAUB from Bornholm and east of there are all from July and August. — In the list given, there is also mention of the specimens taken by Th. MORTENSEN near Bornholm, but Hartlaub's dating of these finds is very inadequate (see list of material below). From the Kattegat, HARTLAUB notes only two occurrences: northern Kattegat, Johs. Petersen 1887 (precise locality and date not known), and 56° 54′ N., 12° 09′ E. (eastern Kattegat), 4 April 1906, "Poseidon".

As we shall see later on, the medusa is by no means rare in the Kattegat; it has, however, very rarely been taken in vertical hauls, and then only quite young specimens.

The hydroid has been found by HARTLAUB on the back and legs of an *Idothea entomon* from 100 m' depth near Danzig. It is a small *Perigonimus* (HARTLAUB, p. 281, fig. 234).

Material.

1893. Kerteminde, 1 May, Johs. Petersen, 1 young spec.
1894. 16 miles N. by E. of Darserort light, 3 April, Th. Mortensen, 1 young specimen.
Off Dueodde, Bornholm, 7 May, Th. Mortensen, 1 young spec.
Deep Channel off Svaneke, Bornholm, 4 July, 40 fath., do., 4 spec.
1896. Deep Channel off Aarsdale, Bornholm, 11 March, 45—50 fath., do., 4 young spec.
1901. Same place, 28 June, 40 fath., 7 large spec.
1902. Little Belt, April, Johs. Petersen, 5 young and 1 medium sized specimens.

In Table XIII will be found details of the following finds from the cruises of the "Thor" 1903—1907; 1903: 29 April; 1904: St. 234 and 239; 1905: St. 348; 1906: St. 730, 738, and 764; 1907: St. 910, 913, and 919. In 1907, the medusa was also found in the Bornholm Deep in July; see below.

1909. "Thor" St. 1233. Off Fornæs, 56° 22′ N., 11° 08′ E., 18 m, 4 April, Ytr. 16 m buoy rope, 7 specimens, mostly full-grown.
"Thor" St. 1236. Off Spodsbjerg, Langeland, 6 April, Rtr. 26 m buoy rope, 4 fullgrown and 2 small spec.
Same place, 19 April, Hensen net, 35—0 m, 1 spec.
Cruise of the "Karen" from the western Baltic through the Great Belt and western Kattegat to Læsö Channel, at all stations, mostly large specimens. See Kramp 1915, p. 16.
1915. Middelfart Sound, 11 March, surface, 1 spec.; 20 m line 4 spec., all medium size.
Nyborg; Biol. Station's well, 8 April, 2 large spec.; 14 April 1 medium size.
1916. Nyborg, 10 April, several large specimens.
1921. SE. of Slipshavn, Great Belt, 14 m, 19 April, Rtr. near bottom, Biol. Stat., 1 medium sized specimen.

1923. Cruise of the "Dana" (Table XII and Chart 11).

1—2 April: eastern Kattegat and the Sound, single specimens, diam. 1½—7 mm (St. 2939—2941).

17—18 April: at all stations in the south-eastern Kattegat, mostly in the lower water layers; up to 12 mm diam. (St. 2944—2950).

19 April: Bay of Köge (St. 2953), 1 large specimen.

20—25 April: Baltic from south coast of Möen south of Laaland to Als; Great Belt and Bay of Samsö (St. 2958—2978), common especially in the lower water layers, diam. 2—12 mm.

26—29 April: single specimens in eastern channel of the Kattegat, Aalbæk Bay, and coast of Bohuslän (St. 2982, 2984, 2987, and 2992), diam. 6—9 mm.

13—19 May: single specimens in Bay of Aalbæk (St. 3036, 3050, and 3052) and at Hellebæk (St. 3054), diam. 3—11 mm.

9—21 June: in the Baltic proper: Arkona Deep (rare), Bornholm Deep (numerous); diam. 1—16 mm.

Horizontal distribution. — The medusa is found in all parts of our waters inside the Skaw (and off the coast of Bohuslän in 1923). It appears to keep chiefly to the deeper channels, but can also come up into shallow water along the coast. — In the Kattegat, it is never met with in great numbers. It can be rather common in the western Baltic, but is not really numerous until we reach the deep basins of the Baltic east of Bornholm; HARTLAUB notes it as very numerous in the Bay of Danzig, the Gothland Deep and the Bornholm Deep; and on the cruises of the "Thor" in July 1907 and June 1923 it was taken in great numbers east and north of Bornholm; south of Bornholm on the other hand it was not very numerous.

Vertical distribution. — Though we cannot rely on the determination of the Tiaridæ in the journals of the "Thor", it is beyond doubt that it is *Halitholus* which is mentioned from the Baltic cruise at the end of July 1907 as "*Tiara pileata*", the more so as some of the specimens have been preserved. These records are of particular value inasmuch as they afford a view of the vertical distribution, and a means of comparing the occurrence of the medusæ with the hydrographical conditions. This applies especially to St. 1145 and 1148, where fishing was carried on at many different depths (see accompanying table, p. 90).

The great majority of the organisms were found at abt. 50—70 m below the surface, where the salinity was abt. 9.15 ‰, and temperature abt. 4°; higher up in the water, only a few specimens were found, and at the surface itself none at all (salinity 7.6 ‰, temp. abt. 14°5). Further study of the records reveals the interesting feature that it is the temperature rather than the salinity which determines this vertical distribution. The fact that a stray specimen or so may find its way to the upper and warmer water layers (as with the two taken in a two hours' haul at abt. 15 m' depth with temp. 12°4) will hardly count for much against the conclusions to be drawn from the following: At St. 1148, the majority were found at abt. 70 m' depth (near bottom), salinity 14.6 ‰ and temp 4°8. At St. 1145 A, the species was also numerous at the same depth and under like hydrographical conditions, but was taken in far greater numbers at abt. 50 m, where

the salinity was only 9.2 ‰, whereas the temperature was about the same as nearer the bottom, *viz.* 4°3; at 40 m' depth the species was still found in no inconsiderable numbers at this station, with a temperature of 5°3, though the salinity here was as low as 7.9 ‰, *i. e.* almost the same as at the surface. All the hauls here referred to were of half an hour's duration. At St. 1145 B, which lay a little farther out towards deeper water, we actually find relatively more specimens taken in a haul with 40 m buoy rope than in the nearest corresponding depth (45 m buoy rope) at St. 1145 A, and this in water of even lower salinity (7.6 ‰), but also

Stat.	Date	N.	E.	Depth m	Hydrography			Length of buoy rope m	Number of specimens
					Depth m	Temp. ° C.	Sal. ‰		
1128	24/7	54° 39′	14° 55′	55	0	12.6	7.3		
					30	10.4	7.7		
					35	5.9	7.6		
					40	4.8	8.1	45	2
					55	3.9	11.1	55	30
1145 A	27/7	55° 10′	15° 38′	87	0	14.3	7.6	0	0
					20	12.4	7.7	15	2
					30	9.6	7.8	30	6
					40	5.3	7.9	45	20
					50	4.3	9.2	55	500
					60	3.5	12.6		
					70	4.1	15.2	75	150
					87	4.9	17.1		
1145 B	»	»	»	90	40	4.7	7.6	40	50
1148	30/7	55° 03′	15° 16′	73	0	14.5	7.6	1	0
					20	10.5	7.4		
					30	5.5	8.0	30	0
					40	4.2	7.9	45	2
					60	3.7	12.5		
					70	4.8	14.6	75	400

with lower temperature (4°7). At several other stations near Bornholm, pelagic hauls were made with the young fish trawl, but no Halitholus were found; the temperature at the depths covered at these stations was as a rule over 9°, and in no case lower than 7°3. At a station farther west (1122), 13° 14′ E., minimum temperature 5°5, and salinity 14.8 ‰ at 46 m' depth, the species was likewise not found. — This agrees extremely well with the conception of *Halitholus cirratus* as an arctic "outlier" in the Baltic. And as we shall see later on, the occurrence of the species in our other waters does not in any way argue against this view. — The material from the "Dana" investigations in the Baltic proper in June 1923 affords no fresh information of any great value, because on this cruise, fishing was not carried out at several different depths, as in 1907.

Occurrence in the Kattegat and the Belt Sea. — As mentioned, *Halitholus cirratus* is distributed throughout the whole of the Kattegat and the Belt Sea, but whereas in the Baltic, the great numbers are taken in June, July, and August, the medusa is found in our other waters only in early spring, March—April (rarely in May), and keeps mainly to the lower water layers, where the mean temperature even in May does not exceed 6°. — In the spring of 1923, the hydrographical conditions in the Kattegat were highly abnormal; disregarding for the moment the occurrence of Halitholus in the Kattegat during that year, and considering the hydrographical observations separately in cases where such are available, we find that the temperature only twice exceeded 5°, *viz.* at the "Karen" St. 1267 in the Bay of Aalborg, where a specimen was taken at the surface at temp. 5°8; and in the Great Belt 19 April 1921, when a specimen was taken near the bottom at temp. abt. 7°. The great majority of temperature observations lie between 1°5 and 4°. — It is presumably the low salinity of the water which prevents the species from moving up into the Gulf of Bothnia and Gulf of Finland, but as soon as the salinity exceeds a certain low minimum (presumably abt. 7 ‰) it no longer appears to affect the comfort of the medusa; the species is decidedly euryhaline. The facts noted above, however, show that it is stenothermic, and a pronounced cold water form.

Since Halitholus is so abundant in the Baltic, its scarcity in the Kattegat might perhaps suggest that the specimens found there were carried thither from the Baltic by the currents. This, however, is not the case; for if it were so, we should in the first place expect to find it in the surface layers, which are composed of Baltic water, whereas it is found, as a matter of fact, for by far the greater part in the lower, salter water layers; moreover, young specimens have been taken as far up as Læsö, so there can be no doubt but that the species is indigenous in the Kattegat. As far as the temperature is concerned, it might very well keep to the surface layers in March—April; the fact that it keeps mostly to deeper water layers suggests that the hydroid grows in deep water. Hartlaub has, as already mentioned, found the hydroid in the Bay of Danzig at 100 m' depth; and it is a curious coincidence that it should have been found on *Idothea entomon*, which is a relict from the glacial period.

The material from 1923 is particularly abundant, and there is every reason to go further into the occurrence of Halitholus in that year (see Chart 11). — A few small and medium sized specimens (1½—7 mm diam.) were found at the beginning of April in the eastern Kattegat and the Sound. — At St. 2953 in the Bay of Köge (19 April) a large Halitholus was found in a haul with the young fish trawl near the bottom in shallow water (8 m, temp. 3°8, salinity 8.3 ‰); this was in fact the only organism of any sort captured in this haul. Otherwise, the medusa was lacking everywhere east of Sealand. But from the south coast of Möen along the southern side of Falster, Laaland, Langeland, and Ærö, it was taken at nearly all stations, often in quite considerable numbers, and in all sizes from 2 to 12 mm diam.,

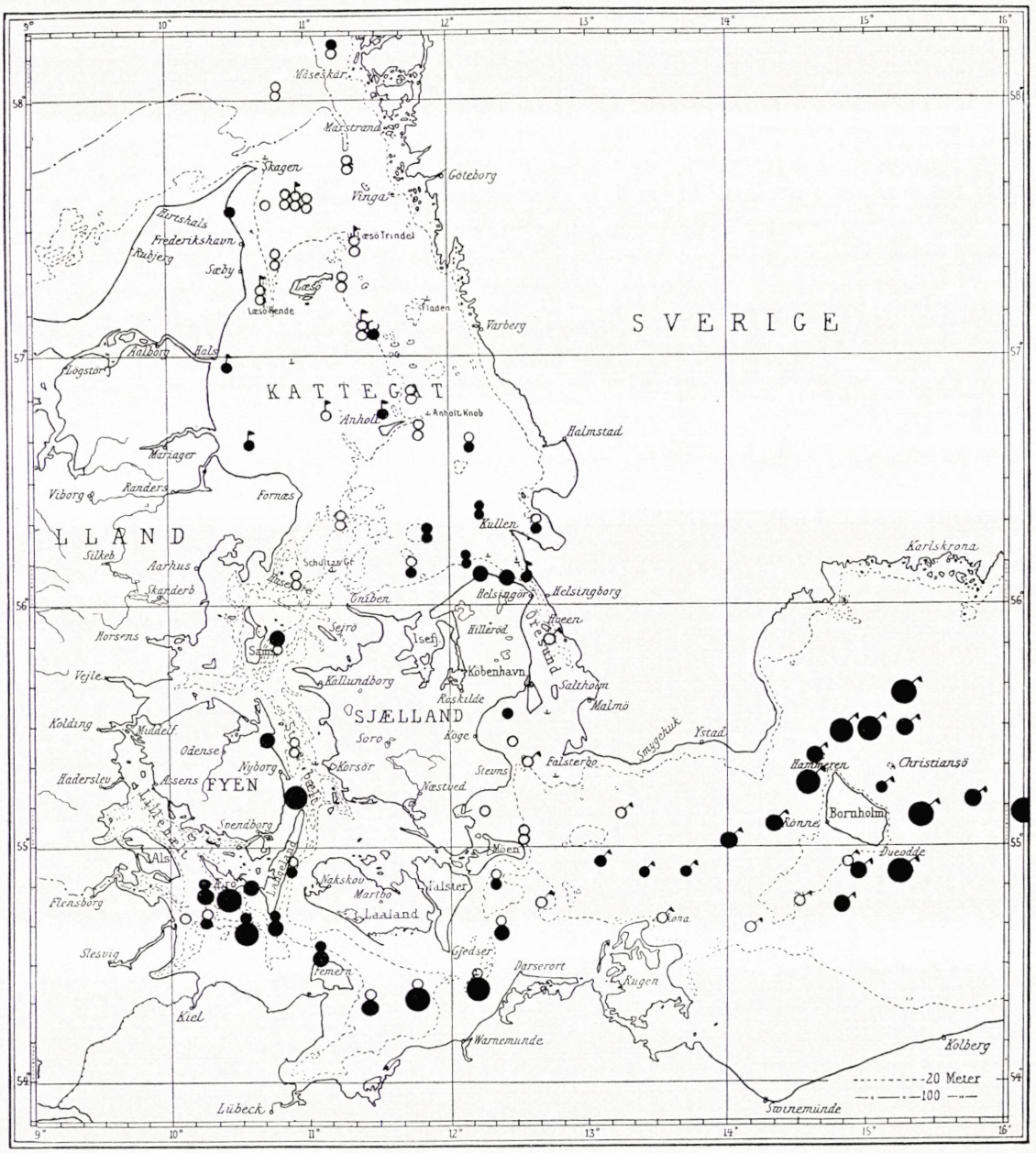

Chart 11. *Halitholus cirratus*. Occurrence on the cruise of the "Dana" in April—June 1923. All pelagic stations within the periods noted below are marked on the chart. The medusa was not found at St. 3055—3095, 28 May—8 June. Two circles, one on top of the other, denote hauls made in upper and lower water layers. Blank circles indicate that the medusa was not taken in the hauls so marked; the three different sizes of filled circles represent the frequency of the species.

○ = St. 2944—2993, 17—29 April.

♂ = - 3036—3054, 13—19 May.

♂ = - 3097—3145, 9—24 June.

mainly in the lower water layers. The temperature here varied from 2°8 to 4°5 and was as a rule below 4°. — The occurrence in the Great Belt and Samsö Bay was rather remarkable; in the deep channel off Spodsbjerg, Langeland (St. 2974, 26 m) only a couple of rather large specimens (7—8 mm) were found; and at St. 2976, N. of Sprogö (26 m) it was altogether lacking. It was found, however, in considerable numbers (diam. 3—11 mm, but mostly large) at the two shallow-water stations, 2975 on the eastern side of the little island of Vresen (11 m) and St. 2977 off Kerteminde (12 m). At St. 2978, E. of Samsö (depth 45 m), Halitholus was found only in the upper water layers (several specimens, 5—10 mm diam.). At the two following stations (east of Djursland), it was altogether lacking. This remarkable distribution in the Great Belt and south-western Kattegat suggests that the specimens in question belonged to the western Baltic and had been carried northward by the surface current; this current, which must a little while earlier have been very strong, had now evidently nearly stopped, the Baltic water being largely checked owing to the great rise in the atlantic water masses of the Skagerrak (see General Section). There must probably have been a considerable stock of Halitholus passing out through the Great Belt, but progress gradually ceased, and the medusæ accumulated for the most part in a few quiet corners such as the Bay of Kerteminde and the northern entrance to the shallow sound west of Langeland.

In the south-eastern Kattegat, during the latter half of April, there was an indigenous stock of Halitholus; the species was found at all stations outside the Sound 17—18 April, and at St. 2982 east of the Great Middelgrund 26 April, mainly in the lower water layers. Most of these specimens were taken in water with a temperature of 4°1—5°3, but a few were found in the salt "atlantic" water, which had a considerably higher temperature, *viz.* abt. 6°5 (St. 2944, 2945, and 2982); the same applies to the specimens (one each) from St. 2984 (west of Groves Flak) and St. 2987 (Aalbæk Bay). This is of course quite a high temperature for Halitholus. But it is an exception that proves the rule! For at these stations, the medusa was extremely rare, both in comparison with the stations of the south-eastern Kattegat, where the temperature was still low, and compared with other years, e. g. 1909. Presumably there was, as usual, an indigenous stock in the deeper parts of the Kattegat, and only a very few specimens survived the inflow of the atlantic water which in April 1923 filled the channels of the Kattegat. — At St. 2902, off the coast of Bohuslän, a single large Halitholus was found in the upper water layers, temp. 5°0.

When the "Dana" returned to the Kattegat about the middle of May, only a few survivors of Halitholus were found in the Bay of Aalborg and at the northern entry to the Sound, with fairly high temperature (6°8—8°5); throughout all the rest of the Kattegat it had disappeared, and investigations in the southern Kattegat, Belts, and western Baltic about 1 June likewise failed to bring any specimens to light.

Halitholus was, however, numerous in the Bornholm Deep in June, and speci-

mens of all sizes, from quite small (1 mm) to as much as 16 mm diameter were taken; evidently, this considerable size is never attained by the medusa outside the Baltic proper.

We may still consider a little further what the data as to size and seasonal occurrence of the individuals tell us regarding the development of the organism and its life history. — The accompanying table shows the distribution of the young, medium sized, and adult specimens in the different waters and in the different months, approximated as closely as possible from all the available material. The sign * indicates that HARTLAUB is the authority; otherwise, the figures are derived from my own examination of all the material dealt with for each area and month, irrespective of the year. HARTLAUB states nothing as to the size of the numerous specimens from the Baltic (in August) but they must doubtless have been mainly adults; the "Thor" journal for July 1907 likewise states nothing as to size; the specimens preserved are all large, but they were only preserved for determination of the species, so there may well have been younger specimens present; there is a good sample preserved from June 1923.

Month	Kattegat			Belt Sea and western Baltic			Baltic proper		
	juv.	m.	ad.	juv.	m.	ad.	juv.	m.	ad.
II	..	..	..	r*	..	..	..	..	..
III	r	r	r	c*	c*	..	+	..	..
IV	r	+	+	r	c	+	(r)	..	..
V	..	..	r	..	..	..	(r)	..	..
VI	..	..	..	..	..	..	+	c	c
VII	..	..	..	..	..	..	?	?	cc
VIII	..	..	..	..	..	..	?	?	cc*

* according to Hartlaub.
juv. = young; m. = medium sized; ad. = adult specimens.

The comparatively large number of young and medium sized individuals in the Kattegat and the Belt Sea in April suggests that many fail to attain maturity, perishing about the beginning of May owing to the rise in temperature. — The medusa is evidently hatched, in the Kattegat and the Belt Sea, during the first months of the year, attains maturity comparatively soon, in the course of abt. 2 months, and disappears altogether when the temperature of the water exceeds the maximum it can bear. For the remainder of the year, only the hydroid form exist, and this presumably lives in the deep holes where there is cold water all the time.

In the Baltic proper, young specimens have been taken in March, April, and May, but no adults have been observed before June, and the great bulk of the specimens have been taken in July and August. If it is not a coincidence that adult specimens have not been taken before June, it must mean that the development here takes longer, *i. e.* abt. 4 months or more. Liberation of medusæ con-

tinues throughout a long period, to some way on in June at any rate. The medusa here grows to a considerable size, and keeps alive for a long time, being very numerous at least as late as August.

How are we to explain the isolated occurrence of *Halitholus cirratus* in the Baltic and the Kattegat, far from the remaining purely arctic parts of its area of distribution? It cannot be a relict from the glacial period dating from the time when the Baltic was in open connection with the White Sea; for it cannot have lived either in the Ancylus Lake (which was fresh) or in the Littorina Sea (which was too warm). At the present day, it is lacking all the way from the Murman Coast round the west of Norway to the northern Kattegat, but must at one time have immigrated by this route, presumably in the course of some cold period following on the termination of the Tapes period. We must, then, consider it as an arctic "outlier" or "pseudo-relict" which has, since the rise of temperature in western Europe, been able to maintain its existence to the cold depths of the Baltic. Its present occurrence in the Kattegat is possibly due to its moving out from the Baltic again.

Leuckartiara octona (Fleming).

Chart 12.

Syn.: *Tiara pileata* autt. partim.

Hydroid: *Perigonimus repens* (Wright).

This common and widely distributed species has also been confused with Forskål's *Medusa pileata*, and is referred to again and again in the literature as *Tiara pileata*. Hartlaub (1913, p. 285 ff.) has made it the type of a new genus, *Leuckartiara*, and gives a very complete list of synonyms, the correctness of which I have no reason to doubt. Hartlaub also gives (p. 289 ff.) a complete list of localities at which the medusa has been found up to date, with abundant details as to time, etc. More recent finds are noted in Kramp and Damas 1925 and Kramp 1926 a.

Geographical distribution.

The Medusa. — *Leuckartiara octona* is an extremely widely distributed species (see Kramp 1926 a, p. 78). In the North Atlantic area it is one of the commonest medusæ, ranging from the Channel to the South of Iceland, and along the west coast of Norway as far as Lofoten, its frequency decreasing towards the north. Finally, it is very common in the North Sea, both in the northern parts and off the coasts of Holland and Germany. The distribution of the species in the northern Europe must be designated as southern-boreal, and within this area it is a summer form. Off the southern coasts of England, young specimens appear in April or May; off the west coast of Norway not until June; it is found everywhere throughout the summer to far on in the autumn, and may indeed survive the winter, at any rate in the North Sea.

The Hydroid, *Perigonimus repens*. — Hartlaub (1913, p. 302 ff.) has discussed the various *Perigonimus* species and shown that several of them e. g. *P. vestitus*

Allm., are identical with *P. repens*. The hydroid is known in the main from the same waters as the medusa; it grows most frequently on the shells of molluscs, especially *Nucula* species, but also on all shell-bearing molluscs of the lower littoral zone; it is rarely found in quite shallow water. A peculiar and much favoured site is the back and tail of the crab *Corystes cassivelaunus* (see the figure in HARTLAUB 1913, p. 136).

Works dealing with *L. octona* and *P. repens* in waters round Denmark. The medusa is mentioned as early as 1836 by EHRENBERG (p. 77, *Oceania pileata*) from the Christiania Fjord; according to ASLAUG SVERDRUP (1921, p. 21, *Perigonimus repens*) the medusa occurs in the Christiania Fjord from August to September. — BROCH mentions it from Söndeledfjord on the south coast of Norway in May. — It has often been taken in the fjords of Bohuslän (AURIVILLIUS 1898a, pp. 194, 290, 316, 360; 1898b, p. 8, *Tiara pileata*), most frequently in October and November, sometimes in great numbers; once or twice also at the end of July and in September; HARTLAUB (1913, p. 291) adds to these: 2 young specimens end July 1901, and a medium sized specimen in February 1908. — JOHANSEN & LEVINSEN (1903, p. 277) have mixed it up with our other two species of Tiaridæ, under the name of *Tiara pileata*; the specimens still preserved are mentioned below.

The hydroid is mentioned by WINTHER (1880, p. 230—231) under the three names of *Perigonimus repens, vestitus*, and *linearis*, from Frederikshavn, Hellebæk, and some localities in the Bay of Samsö. LEVINSEN (1893, p. 377) adds two finds from the Kattegat. It has also been taken at the islands of Wäderö and off Bohuslän (JÄDERHOLM 1909, p. 45).

Occurrence of the hydroid in Danish waters. — Since LEVINSEN (1893), *Perigonimus repens* has been found in several places. I found it in the North Sea at 44 m' depth west of Horns Rev 13 Sept. 1922 ("Dana" St. 2805) on *Corystes*. In the Skagerrak, it has been found north of the Skaw at 75 m' depth (TH. MORTENSEN), and east of Skagens Rev at 20 m by myself (August 1921, on *Corystes*). I also found it at 150 m, NE. of the Skaw, 11 Oct. 1922 ("Dana" St. 2893), fertile colonies on *Scaphander punctustriatus*. It is fairly common in the northern Kattegat near the Skaw and Frederikshavn, but rather rare in the southern Kattegat; its inner limit of distribution in our waters lies at the northern entry to the Belt waters: Samsö, Gniben, and Hellebæk. It is most frequently found on molluscs on clay bottom or sand mixed with clay; in the Kattegat, it has been taken from 11 to abt. 50 m' depth. A unique find is that in the Bay at Nyköbing in the Limfjord, where TH. MORTENSEN found it on *Rissoa* and *Zostera* in shallow water (numerous organisms are found in the Limfjord living under conditions widely different from their customary habit). In May and June, only sterile colonies have been found; fertile ones are met with in July, August, and September. In November 1919, I found several specimens at the Skaw, all sterile. The hydroid appears to be perennial.

Occurrence of *Leuckartiara octona* in Danish waters.

Material.

1893. Kerteminde, Sept., 5 young spec. (Biol. Stat.).
1896. Sallingsund, Limfjord, 26 June, 1 young spec. (Th. Mortensen).
1898. Frederikshavn, 16 May, 1 young spec.; 25 August, 3 young spec.; Sept. 9 young spec.
1903. "Thor" St. 83. Slugen, 29 Sept., 13 medium sized spec.
1904. "Thor" St. 186. WNW. of Hirtshals, 17 Feb. 5—0 m, 2 rather small spec.
"Thor" St. 221. NE. of the Skaw, depth 135 m, 16 March, surface, one rather young spec.
1910. The Sound, N. of Hveen, depth 26 m, 10 Sept. Ytr. 26 m wire, 2 medium sized spec. (Kramp).
1911. Horns Rev, 28 Novr., 1 medium and 2 large spec. (Table V).
Schultz's Grund, 29 Aug. 26—0 m, 1 rather small spec.; 26 Sept. 26—0 m, 1 young spec. (Table VIII).
Cruise of the "Thor" (Table X):
North Sea, 19—20 June, St. 1545 and 1565; Bay of Aalbæk and Læsö Channel, 28 June —3 July, St. 1579, 1586, and 1598, partly in young fish trawl.
1912. Horns Rev, 30 Sept., 1 young and 1 medium sized spec.; 7 Oct., 2 young and 1 nearly full grown spec. (Table V).
1913. Horns Rev, 13 Oct., 1 young spec.; 27 Oct., 1 young spec. (Table V).
1922. Cruise of the "Dana" 28 Sept.—19 Oct., in nearly all hauls with Ytr. near bottom, in the North Sea, Skagerrak (except the deepest stations), northern and eastern Kattegat, and the Sound, sometimes in very great numbers (Table XI).
1923. Cruise of the "Dana": 5—6 May, S. and W. of Horns Rev (St. 3007 and 3009), a few specimens, 5—10 mm high. — 19 May, off Hellebæk (St. 3054), 2 large spec., 12 mm high (Table XII).

As regards the horizontal distribution of the medusa in Danish waters, it will be seen from the list above and from the chart, that it is common in the North Sea, Skagerrak, and northern and eastern Kattegat. It has also been taken in the Sound, at Schultz's Grund, and off Kerteminde in the northern part of the Great Belt, and may at times be met with in the Limfjord. The records in the literature are all from the Skagerrak. — The available data as to vertical distribution show that it has been taken both at the surface and at quite considerable depths, (e. g. "Thor" St. 1565, where a large specimen was taken in the young fish trawl with 125 m wire, abt. 75 m below the surface, and "Dana" St. 2888, 2889, and 2892, where it was found, sometimes in great numbers, near the bottom at 85—90 m' depth). — Vertical hauls in the Kattegat yielded almost exclusively young specimens; at Horns Rev lightship and other places in the North Sea, full grown and medium sized specimens have several times been taken in vertical hauls; this suggests that the medusa is more common here than at Schultz's Grund and Anholt Knob, so that there is more chance of getting large specimens in the net.

According to the literature, the medusa is, as regards the fjords of the Skagerrak, commonest in autumn, but may also be met with in summer and in spring or even in February (Hartlaub, *vide supra*). The material I have investigated likewise shows that it is most common in the Danish waters in autumn (August—October), but may be taken at almost all seasons of the year. Full grown and medium

sized specimens have been taken from June to November, young ones in all the months from June to October; the specimens found in February and March 1904 were young but not altogether tiny, and in May 1923, rather large specimens were found both near Horns Rev and at the northern entry to the Sound (at the beginning of April 1925, after a very mild winter, several specimens 5—9 mm high were taken S. of Horns Rev, in Jammer Bay and in the south-eastern Kattegat). This shows that the liberation of the medusæ extends over a lengthy period, probably only interrupted for a little while in the winter. In the Kattegat, however, the interruption is doubtless of somewhat longer duration; as we have seen, the hydroids found in May and June were all sterile.

The scarcity of the medusa in the south-western Kattegat agrees with the fact that the hydroid is likewise rare in this water, whereas it is common in the northern and eastern Kattegat. It is possible, however, that investigations with larger implements, working horizontally, in autumn in the south-western Kattegat might show the medusa to be commoner than has been supposed. Throughout the whole of the area covered by the autumn cruise of the "Dana" in 1922, the medusa was found in great numbers, even in places where it was hardly known before. The fact that it was taken at several of the "Thor" stations in 1911, as early as June and July, distinctly suggested that it must be common later in the year; and this view was confirmed to a surprising degree on the cruise of 1922. The relatively few earlier finds of *Leuckartiara octona* afforded, it is true, some slight idea as to the occurrence of this medusa in our waters, but it was only from the collections of the "Dana" that we have obtained material giving a true idea of the importance of this organism in the plankton of our waters, and I will therefore devote some space to consideration of the results of these collections, which I had the pleasure of helping to make myself.

The collections of the "Dana" with the Petersen young fish trawl were made as a rule close to the bottom, often in such a manner as just to touch it. They were commenced on the 28 Sept., and continued throughout the following days off the west coast of Jutland between Nissum Fjord and Hanstholm out to the Jutland Bank and Little Fisher Bank, at depths from 18 to 48 m. *Leuckartiara octona* was found in every single haul made throughout this area, though not as a rule conspicuously numerous. If we look at the figures for the different stations (see chart) we find that south of Bovbjerg, the species decreases in numbers from the coast outwards, whereas the reverse is the case off Thyborön, and on the Little Fisher Bank it was only common on the north side at St. 2852, where the water was coldest. The complicated hydrographical conditions in this area will be dealt with in detail in the General Section. There seem to have been three water masses of different origin: 1) the Jutland Current (warm and salt) south of the Little Fisher Bank; 2) a cold and salt water mass thrusting itself from north or north-west down to the northern edge of the Little Fisher Bank; 3) relatively cold water of rather low salinity, moving from the intermediate layers at the mouth of the Skagerrak southward be-

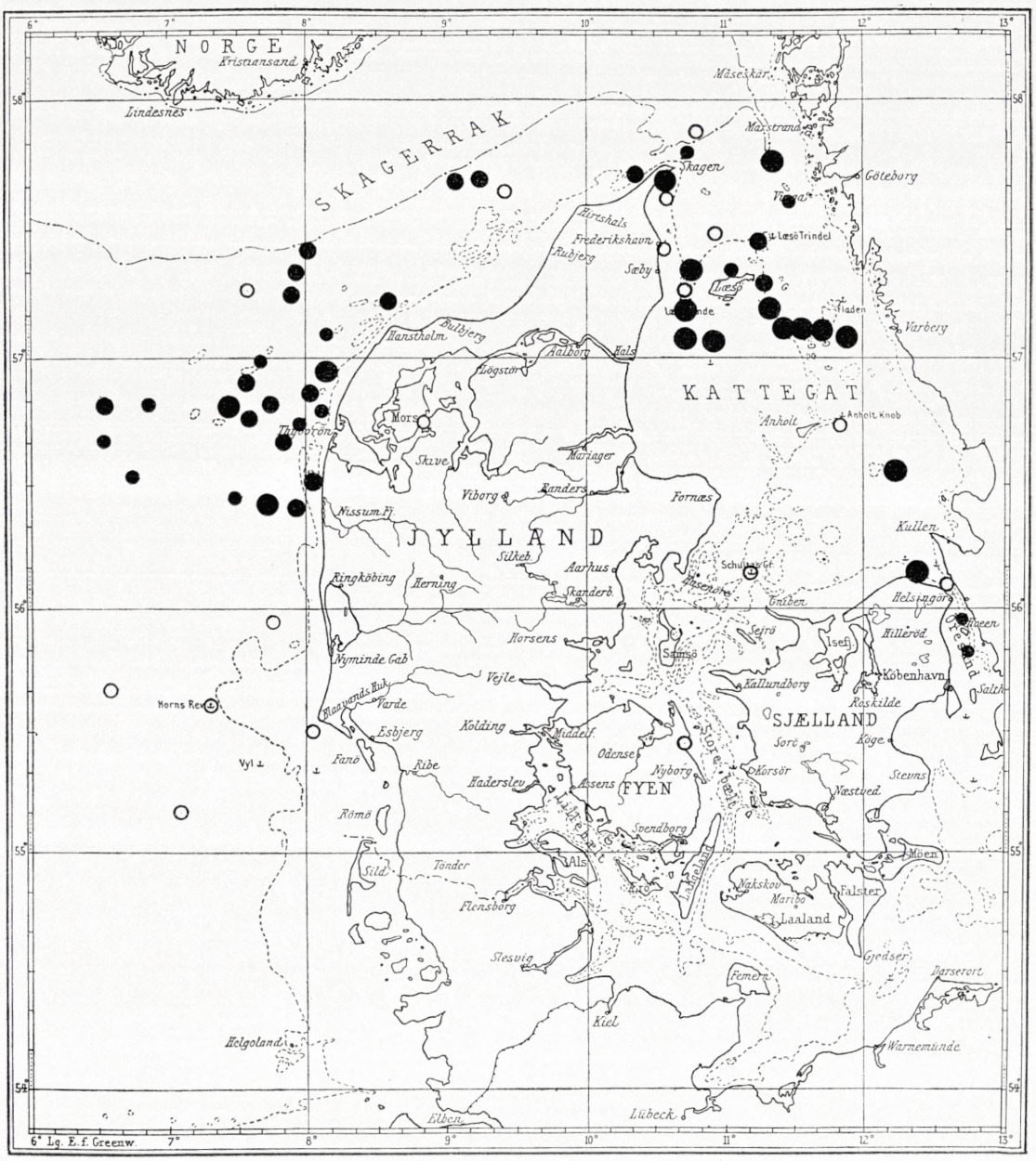

Chart 12. *Leuckartiara octona*. The filled circles denote finds made on the cruise of the "Dana" Sept. —Oct. 1922; the three different sizes represent the frequency of the species. Blank circles: other finds.

tween the banks, to mix with the Jutland Current, especially outside Thyborön. *Leuckartiara* was commonest, partly in the cold, salt water north of the Little Fisher Bank (2) partly in the area where the water from the mouth of the Skagerrak (3) seems to have been least mixed. From this we may conclude that, even though the species be indigenous both north and south of the area in question, the greater portion was not brought by the Jutland Current, but belongs to the colder bank water of the Skagerrak and northern part of the North Sea.

In the Skagerrak, the young fish trawl was used for the most part actually on the bottom; in hauls of this character Leuckartiara was not taken as a rule. In the few pelagic hauls near bottom within a depth of abt. 70 m it was found, but not in great numbers.

In those parts of the Kattegat investigated, the medusa was extremely common, lacking only at two stations (St. 2875, where no medusa of any sort were taken, and St. 2887 near Vinga, *vide infra*); and as a rule, it was extremely numerous, constituting indeed, at times, the main bulk of the plankton. It was numerous in the Læsö Channel, even in the southern part, where the salinity at bottom was only 25.6 ‰. In the eastern channel also it was numerous (salinity at bottom 32.0—34.6 ‰, temp. 10°—12°1). It was still met with off the north coast of Sealand and in the deep channels of the Sound. Special mention must be made of the stations at 85—90 m' depth in the boundary area between the Skagerrak and the Kattegat. The bottom water was of considerably lower temperature than in the southern parts of the eastern channel of the Kattegat, at St. 2892 (N. of the Skaw) only 8°2. In these hauls, cold-water forms such as *Neoturris pileata* and *Tima bairdii* were the types mostly found, but despite the low temperature and the considerable depth, *Leuckartiara octona* was also present. It was lacking, however, at St. 2887 (90 m' depth) where the young fish trawl was working quite close to the bottom (200 m wire), though the medusa was numerous at St. 2888, where the depth was the same, but length of wire out only 180 m. The hydroid, *Perigonimus repens*, was also found in the immediate vicinity of these localities, *viz.* at St. 2889 (85 m) on *Nucula*, and St. 2893 (150 m) on *Scaphander*.

The specimens of *Leuckartiara octona* taken on the cruise of the "Dana" varied in size from 3 to 15 mm (height of bell); the commonest size was 4—8 mm. Specimens over 8 mm were found chiefly in the Skagerrak; there is, however, no distinct connection generally apparent between the size of the specimens and locality, or hydrographical conditions.

The collections from the "Dana" show that *Leuckartiara octona* is one of the commonest medusæ in our waters in the autumn, occurring at this season practically everywhere, at any rate as far as the northern entrances to the Belt Sea, and as far down at least as abt. 90 m' depth; also, that within this area, temperature and salinity do not affect the occurrence of the medusæ to any extent. That the species should, as above noted, apparently be somewhat rarer in the water masses of the Jutland Current off the southern part of the west coast of Jutland is presum-

ably due to the fact that the hydroid is less common on the sandy and stony bottom here than on the softer ground up towards the Skagerrak. It is certain at any rate, that the specimens of *Corystes cassivelaunus* found in the Horns Rev area — and these were not a few — were as a rule clean and without any alien growth, though the crab in question is generally a favourite host for *Perigonimus repens*.

Leuckartiara nobilis Hartlaub.

Syn: *Tiara pileata* partim.

Hydroid unknown.

On the cruise of the "Dana" in the spring of 1923, a specimen of this medusa was taken in the Great Belt:

St. 3065, E. of Vresen, 31 May, depth 26 m, Ytr. 40 m wire, 1 spec., height of bell 12 mm, diam. 9 mm.

The species has previously been found in the Mediterranean and, according to Hartlaub (1913, pp. 308 ff.) near Valencia Harbour in Ireland. I have myself seen a number of specimens from 6 localities in the north eastern Atlantic: S. of Iceland, off the Rockall Bank, W. of the Hebrides, and a little west of the Orkneys. The dates of capture in the Atlantic are from May and July (Kramp 1926 a). The medusa occurs in the Irminger Current and in the Gulf Stream; its presence in the Great Belt in the spring of 1923 is undoubtedly due to the unusual inflow of Atlantic water from the Skagerrak into all the channels of the Kattegat, which brought with it many interesting organisms. Some of these, e. g. the siphonophore *Physophora hydrostatica*, had undoubtedly come all the way from the Atlantic Ocean, and the same undoubtedly applies to *Leuckartiara nobilis*.

Neoturris pileata (Forskål).

Chart 13.

Syn: *Tiara pileata* autt. partim.

Turris digitalis Forbes.

Hydroid unknown.

Geographical distribution: Mediterranean. — Northern Europe: Valencia Harbour, Ireland; common round Scotland (not found in English waters); several places between Ireland and Iceland (but not above the Wyville Thomson ridge), off the south coast of Iceland and between Iceland and Greenland. Also off the west coast of Norway as far as the Romsdal Bank. Several places in the northern part of the North Sea, rare in the southern part. — The medusa has thus, in the north-european area, a rather more northerly distribution than *Leuckartiara octona*, and is far more oceanic in its occurrence. It is met with from May to September (exceptionally in December, Browne 1903, Herlöfjord, Norway).

Occurrence in Danish waters. — Of this large and magnificent medusa (height up to 35 mm), there were until 1922, only 2 medium sized specimens recorded from Danish waters:

Deep channel off Vinga, 15 June 1901, 1 spec.
9 miles N. of the Skaw, 14 June 1901, 1 spec.

Both were determined by JOHANSEN & LEVINSEN (1903) as *Tiara pileata* and both are referred to by HARTLAUB (1913, p. 329) but under the heading of "Mittlere Nordsee".

On the autumn cruise of the "Dana" in 1922, several specimens of *Neoturris pileata* were taken about the middle of October, at the following seven stations, all near the bottom at 23—90 m' depth, some in the eastern channel of the Kattegat off Varberg and between Vinga and Paternoster, some N. of the Skaw: St. 2887, 2888, 2889, 2890, 2892, 2922, 2923 (see Chart 13 and Table XI).

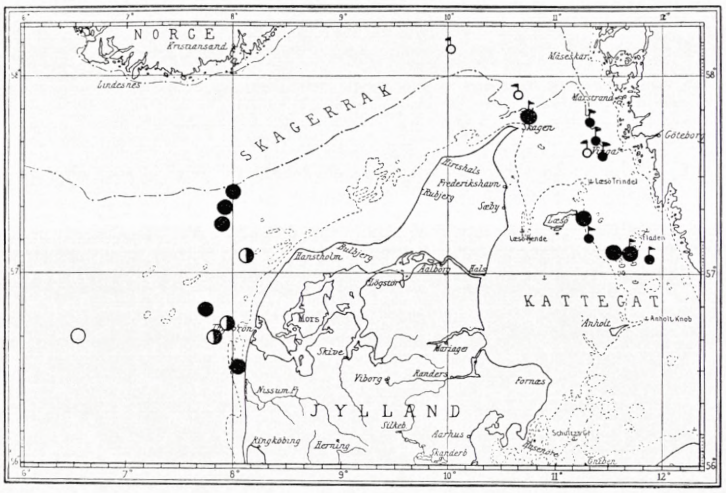

Chart 13. Occurrence in 1922 of ○ *Laodicea undulata*; ● *Cosmetira pilosella*; ◑ both species.
Occurrence of *Neoturris pileata*: ♁ Cruise of the "Dana" in 1923, ♁ other finds.

The bottom temperature in the deeper parts of the Kattegat was as a rule abt. 11°5, but in the northern part of the channel, where Neoturris was mainly found, the water was considerably colder, 9°5—9°6, and at St. 2892, N. of the Skaw, only 8°2. The largest specimens of Neoturris were 10—11 mm high, most of them considerably smaller, right down to 3 mm. They cannot therefore have come from any great distance, and the species must be indigenous in the immediate vicinity of the localities where these medusæ were found. The fact that finds in our waters are mostly from water with remarkably low temperature agrees well with what has been noted above as to the northerly distribution of the species. The unknown hydroid must live at intermediate depths in the eastern Skagerrak and northern Kattegat; the medusa keeps to the lower, colder water layers, whence it can, in autumn, occasionally be picked up by the inflowing warm southern bank water, and carried with it farther down into the eastern channel of the Kattegat; this would explain its occurrence at such localities as St. 2890 (temp. 12°1) and St. 2923 (temp. 11°5).

On the spring cruise of the "Dana" in 1923, a young specimen of *Neoturris pileata* (5 mm high) was taken in an intermediate haul with 70 m of wire, over deep water (300 m) midway out in the Skagerrak (St. 3044, 16 May). The temperature

of the water layer in question was abt. 6°. As we have seen, in 1922, small specimens 3—4 mm high, were taken well on in October; the medusa of this species can thus be hatched in our waters over a lengthy period, from May to October at least. It is plainly one of our rarer species, and does not, in our waters, attain the considerable size that it does in the Norwegian Sea and the Atlantic Ocean.

Leptomedusæ.

Fam.?

Cyclocanna welshi Bigelow.

Bigelow 1918, p. 384. Pl. 3, figs. 2—5.
Kramp 1926 b, p. 245.

Hydroid unknown.

This remarkable medusa, which has its four radial canals curved in a manner unique among medusæ, has been described by Bigelow from two specimens taken off the east coast of North America: 37° 28′ N., 74° 25′ W., 13 Aug. 1916. Until quite recently, these were the only specimens known. To my great surprise, I found a specimen of this species in deep water in the Skagerrak in 1922:

46 miles N. by W. of Hirtshals. 58° 13′ N., 9° 34′ E. 12 Oct. 1922. Depth 650 m. Ytr. with chain, at bottom. "Dana" St. 2895. 1 spec., diam. 44 mm.

The medusa was extracted from the soft mud brought up by the trawl, together with 14 specimens of *Tiaranna rotunda*. Its morphology, and the structural features in which the specimen from the Skagerrak differs from Bigelow's, are discussed in a smaller paper by the present writer (Kramp 1926 b). The systematic position of the species among the Leptomedusæ has not yet been determined.

Fam. *Laodiceidæ.*

Laodicea undulata (Forbes & Goodsir).

Chart. 13.

Syn: *Thaumantias undulata* Forbes & Goodsir 1851.
Laodicea calcarata A. Agassiz, in L. Agassiz 1862.
Laodice ulothrix Haeckel 1879.
Laodice cruciata autt. partim.

Hydroid: *Cuspidella* sp.

Geographical distribution.

In a previous work (KRAMP 1919, p. 25 ff.). I have dealt at length with the distribution of this species, and subjected the nomenclature to detailed consideration at the same time. — The medusa lives in the Mediterranean, the tropical Atlantic, off the east coast of North America south of Cape Cod, and off the coasts of northern Europe. It is very common everywhere from the Channel to southern Iceland, and may be met with at a considerable distance from land, but is most frequently taken near the coast; all young specimens in particular have, up to now, been found in the coastal water. All along the coast of Norway it is common out at sea, less frequent in the fjords; it occurs in the vicinity of Bergen in May; farther north in August (KRAMP & DAMAS 1925). In northern Europe, the medusa is hatched in spring or early summer, attains maturity in the hot season and disappears in autumn.

Occurrence in Danish waters.

Material:

1904. "Thor" St. 273, Skagerrak, NW. of Hirtshals, 9 Oct., depth 640 m, Ytr. intermediate, 7 large spec.
1907. "Thor" St. 1074. Skagerrak, S. of Oxö, 28 May, depth 510 m, 2 spec., diam. 10—12 mm.
1912. Horns Rev Lightship, 23 Sept., 1 spec., diam. 5 mm.
1922. Cruise of the "Dana" (Table XI, Chart 13): Off the northern part of west coast of Jutland, near bottom, 28 Sept.—2 Oct.: St. 2837 (2 spec., diam. 6 mm), 2844 (1 spec., 8 mm), 2851 (1 spec., 9 mm), 2859 (1 spec., 5 mm).
1923. "Dana" St. 2981. E. of Anholt, in the Kattegat, 25 April, depth 44 m, Ytr. 90 m wire, 1 spec., diam. 7 mm.

This medusa is evidently somewhat rare in our waters. It occurs mainly in two different areas, *viz.* in deep water in the Skagerrak and in shallow water off the west coast of Jutland. Unfortunately we have not the exact depth at which the large specimens from the Skagerrak were taken, whether from the Atlantic water or the bank water. The only specimen hitherto known from the Kattegat ("Dana" St. 2981, April 1923) was taken in the Atlantic water mass which at that time filled the channels of the Kattegat, and this was a rather young specimen (7 mm). It must doubtless have come in with the inflowing Atlantic water, and its small size suggests that it had not come farther than from the Skagerrak; *i. e.* that the species is indigenous in the deeper parts of the Skagerrak.

The specimens from the North Sea are all rather small, down to 5 mm diameter, and cannot therefore have been brought from any great distance, so the hydroid must be able to live near the coast of Jutland. The question then is, whether we are to look for it in the north or in the south. The small specimen of 5 mm from Horns Rev, Sept. 1912, was presumably living in the Jutland Current. Consideration of the four finds from the cruise of the "Dana" in 1922 might seem to suggest that the same was the case with these 5 specimens, the bottom water at the stations where they were found being relatively warm, whereas the species was lacking in

the colder water coming down from the north towards the northern edge of the Little Fisher Bank. We find, however, that the size of the specimens decreases towards the north; this might possibly be accidental, but at the northernmost locality, (St. 2859) a specimen of only 5 mm was found. This certainly suggests that the species must have been indigenous at the entrance to the Skagerrak. The question as to how the medusæ can then have come to the waters where they were found will be further discussed in the General Section. — In the upper water layers of the Skagerrak, the species has not hitherto been found. I have found hydroids of the genus *Cuspidella* in several places in our waters, some in the Skagerrak, some off Hellebæk at the northern entry to the Sound, but wether they belong to the species which produces the medusa *Laodicea undulata* I do not know; the hydroid form of this has hitherto only been observed in an aquarium, at Valencia Harbour, Ireland.

It is very remarkable that the stock of *Laodicea undulata* located by these investigations in the North Sea should be found to occur far later in the year than the North Atlantic stock. In the Atlantic, no specimens of so small a size have been found later than the end of May (coasts of Scotland, see KRAMP 1919, p. 26, localities 18, 20, and 21).

Staurophora mertensii Brandt.

Chart 14.

Syn.: *Staurophora laciniata* L. Agassiz 1849.
Staurostoma arctica Haeckel 1879.

Hydroid unknown.

Geographical distribution.

Staurophora mertensii, the largest of all known Hydromedusæ, is an arctic form, which was not found in Danish waters until 1923. I have previously (1919, p. 39—47) given a full account of the distribution of this species. In the Atlantic region, as well as in the Pacific, its range lies mainly within the Arctic, but it can, in both the oceans mentioned, penetrate some distance southward, though with decreasing frequency. On the eastern side of North America it is indigenous in the Gulf of Maine, but is only occasionally met with south of Cape Cod, and then only in spring. — It is extremely numerous north and east of Iceland, but comparatively rare off the south coast of Iceland. From Spitzbergen and the Barents Sea, its distribution extends southward along the west coast of Norway, where it is common in the fjords. South of Cape Stat, it decreases in frequency, but is nevertheless not uncommon in the fjords near Bergen (KRAMP & DAMAS 1925). It has occasionally been found near the Færoes and the Shetlands, and east of Scotland. An altogether isolated occurrence is noted by HARTLAUB (1897, p. 484 ff.), who found young specimens at Helgoland in April 1895; the species is however, doubtless not normally indigenous so far to the south. — The unknown hydroid must be a pronounced

littoral form, the young medusæ being invariably found in the vicinity of the coast; the medusa however, has evidently a fairly long span of life, enabling it to be carried far from the spot where it was hatched. The young medusæ are always found in spring, April—May, full grown specimens mainly in August or later.

Occurrence in Danish waters.

Material.

1923. Cruise of the "Dana" (Table XII): 30 April—9 May: at abt. half the localities investigated (St. 2994—3023) in the North Sea and the Skagerrak, as a rule in small numbers, mostly in the lower, but occasionally also in the upper water layers; diam. 7—33 mm.—15 May: North of the Skaw (St. 3042), diam. 16—24 mm. — 17 May: eastern channel of the Kattegat (St. 3047 and 3048), diam. 18—23 mm.

It was something of a surprise to me to find, on the 30 April, a young specimen (7 mm) of this species, which was new to our fauna, taken west of the Skaw. During the next few days, further specimens were taken at three other stations, rather far apart, off the coast of Jutland (St. 2997, 3001, and 3004), all rather small, 8—18 mm diam. The medusa was also met with farther out from land in the North Sea, at St. 3010 and 3012, on the 6 and 7 May; at the first of these two stations indeed, 20 specimens were taken in one haul of a quarter of an hour's duration with the young fish trawl near bottom; the specimens from these stations varied from 8 to 33 mm in diameter. There can thus be no doubt but that there was an indigenous stock of *Staurophora* on the coastal banks off Jutland in the Skagerrak and the North Sea.

It was even more surprising to find this northern form south of Horns Rev (St. 3006 and 3007, 5 May), both in the upper and lower water layers. True, only three specimens were taken (7, 11, 21 mm diam.), but in view of the fact already noted (cf. *Sarsia tubulosa* and *Bougainvillia britannica*) that there was certainly no inflow of water from the northward over Horns Rev for some time before this date, and that the specimens were small, we must take it that the distribution of the stock of Staurophora in west Jutland waters extended right down to the banks off the west coast of Slesvig. The hydroid must have been living here in the previous winter, and this again means that the medusa must have been there in the summer of 1922. The question is further considered in the General Section.

On the 9 and 15 May, some specimens of Staurophora (16—24 mm) were found in somewhat deeper water in the Skagerrak (41—130 m, St. 3022, 3023, and 3042), in the bank water now flowing eastward, and on the 17th of May it was found that the species had actually found its way into the eastern channel of the Kattegat, where specimens were taken at St. 3047 and 3048, NE and SE of Læsö, in the intermediate water layers, *i. e.* in the bank water, which was now forcing its way at a great pace into the Kattegat between the Baltic surface water and the Atlantic bottom water, now moving back. Staurophora does not however, appear to have penetrated far into the Kattegat, as it was not found in the course of the investigations in the

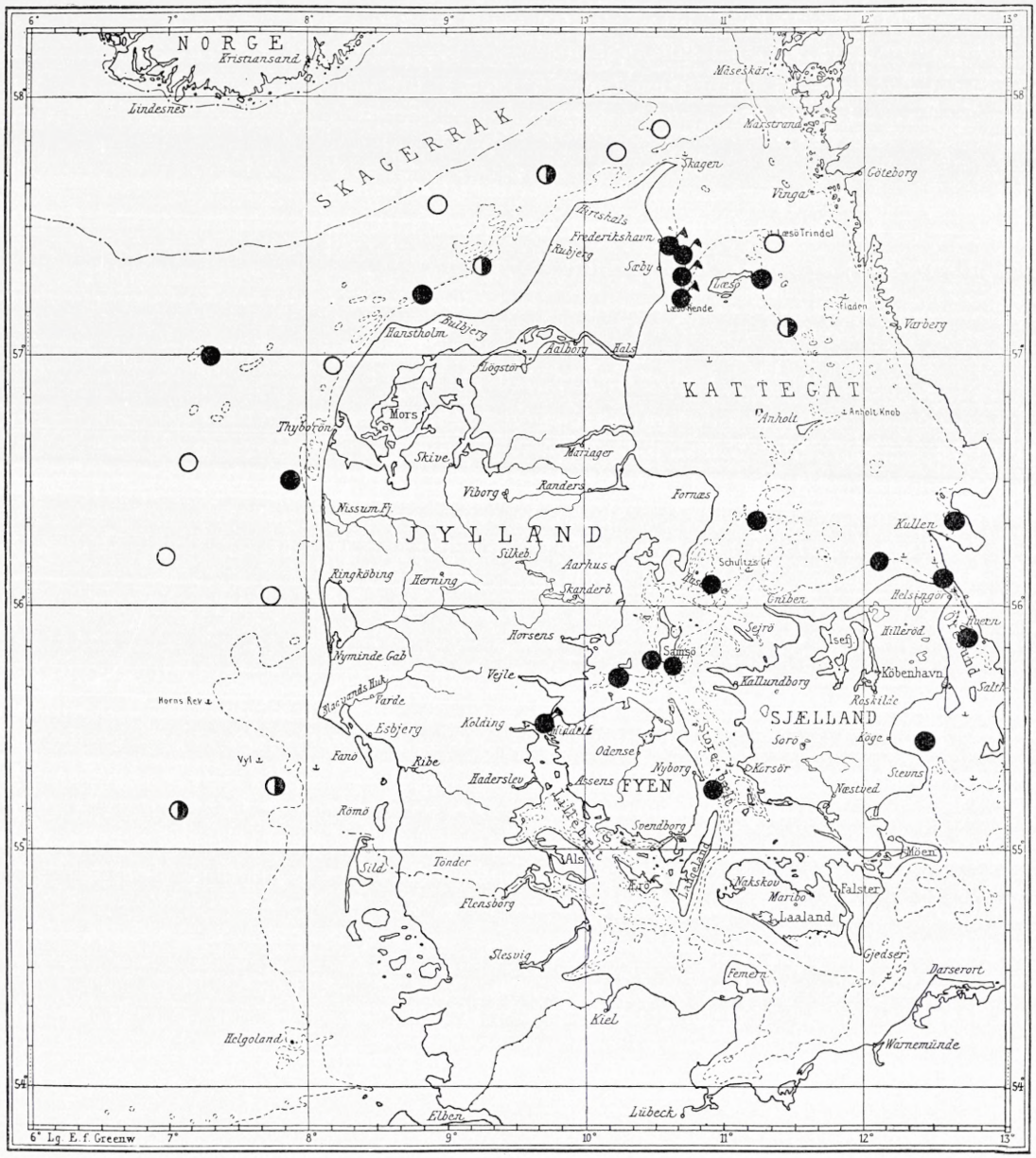

Chart 14. ○ *Staurophora mertensii*, cruise of the "Dana" April—May 1923. *Tiaropsis multicirrata*: ● "Dana" 1923; other finds.

southern Kattegat at the end of May. A large and conspicuous medusa of this sort, and one which, moreover, in its native waters often appears right at the surface, could hardly have escaped notice if normally present in our waters. There can be no doubt but that its occurrence here in 1923 is unique, or at any rate, exceptional.

Fam. *Melicertidæ.*

Melicertum octocostatum (M. Sars).

Syn.: *Stomobrachium octocostatum* Forbes 1848.
Melicertidium — Haeckel 1879.
Hydroid unknown.

Geographical distribution.

A neritic, northern boreal species, common in Scottish waters, but rare off the southern coasts of the British Isles. Fairly common off the south and north coasts of Iceland, and west coast of Norway from Stavanger to Lofoten, chiefly in the fjords, where it is met with from early spring to some way on in autumn. Has also occasionally been found on the Murman coast. HARTLAUB (1894 p. 192) notes it as taken near Helgoland "im August und September vereinzelt".

Occurrence in waters round Denmark.

Literature. — Mentioned already by EHRENBERG, who found it at Dröbak, in the Christiania Fjord, in 1833, and gave the first illustration of the species (EHRENBERG 1836, p. 77, Pl. VIII, Figs 5—7, *Melicertum campanulatum*). — From the eastern Skagerrak it is mentioned in the International Plankton Catalogue 1906 (p. 70 *Stomobrachium octocostatum*) from November 1904. — AURIVILLIUS (1898a, *Melicertidium octocostatum*) mentions a series of finds from the fjords of Bohuslän in 1896. Finally, it has, according to MÖBIUS (1873a, p. 101, *Stomobrachium octocostatum*) been taken off Kiel in the autumn, at the surface.

Material.

1901. North of Anholt Knob, 16 Aug. Johs. Petersen. 1 spec., diam. 6 mm.
1911. Schultz's Grund Lightship, 21 June, 26—0 m, 1 rather small spec., 3½ mm (Table VIII).
Cruise of the "Thor" (Table X):
St. 1551 off the west coast of Jutland, 19 June, depth 32 m, near bottom, 1 spec. 4 mm.
St. 1597, off Hals, 30 June, 4 spec. 5—6 mm.
St. 1592, Aalborg Bay, 1 July, 2 spec. 5—6 mm.
St. 1593, Aalborg Bay, 1 July, 1 spec.
St. 1623, S. of Anholt, 8 July, 2 spec. 5 mm.
1922. "Dana" St. 2879. Eastern channel of the Kattegat, 7 Oct., depth 77 m, Ytr. 100 m wire, 1 spec., diam. 5 mm.

Melicertum octocostatum evidently visits our waters only occasionally, not every year. All the finds recorded by AURIVILLIUS from the fjords of Bohuslän are from

a single year (1896), but it was found then in quite considerable numbers, and in February, September, and October. The hydroid must presumably have been living in the fjords there the winter before. — In the Kattegat, apart from a specimen in August 1901 and another in October 1922, it has only been taken in 1911, when it was found at several places in June and July, including a small specimen at Schultz's Grund 21 June. Wherever the medusa is found, it is present throughout a considerable period, and presumably grows rather slowly, so that the specimen from Schultz's Grund is no proof of there having been any indigenous stock in the Kattegat in 1911. All the specimens from the cruise of the "Thor" were taken near the bottom, presumably brought down with the northern bank water, of which there was a considerable inflow in the spring of 1911, also, which is unusual, passing southward along the west coast of Jutland. A specimen of Melicertum was also found at St. 1551 off the west coast. There was in this year a marked inflow of northern water into the Kattegat, passing through the Læsö Channel into Aalborg Bay, and it was here that most of the Melicertum were found.

Fam. *Mitrocomidæ.*

Mitrocoma polydiademata (Romanes).

Syn: *Mitrocomella fulva* Browne 1903.

Hydroid unknown.

Geographical distribution.

This handsome medusa, of considerable size (diam. up to 22 mm) is distributed throughout a rather small area, *viz.* off the coasts of Scotland and in the Irish Sea, round the Shetlands and Færoes, along the whole of the west coast of Norway (very common, especially in the fjords), and in part of the North Sea. It is doubtful whether it has been taken at Plymouth, and it is not known from Helgoland. I have previously dealt at greater length with the distribution (Kramp 1919, p. 59—61; Kramp & Damas 1925, p. 296). We must thus consider its distribution as mainly northern-boreal. Off the west coast of Norway, and round the British Isles, it seems, from the data available, to have a somewhat restricted period of occurrence, the young medusæ appearing in April, or sometimes in March, adult specimens in May and June, the species disappearing about end June—July. In the light of these records, its occurrence in Danish waters is somewhat remarkable.

Occurrence in Danish waters.

There is no mention in the literature of *Mitrocoma polydiademata* from Danish waters; some medusæ from the Skagerrak, noted by Johansen & Levinsen (1903, p. 280) as *Euchilota maculata*, are however, actually *Mitrocoma*.

Material.

1898. Skagerrak, 29 July (Biol. Stat.), 3 spec., diam. abt. 9 mm.
1899. Anholt Knob, 2 Nov. (Biol. Stat.), 1 spec., 8 mm.
1903. "Thor" St. 83, S. end of Slugen, 29 Sept., 3—0 m, 2 spec., 9—11 mm.
1904. Abt. 25 miles NW. of Hirtshals, 57° 48′ N., 9° 21′ E., 27 June. "Michael Sars" (Damas' collection), 2 spec., 8—12 mm.
1907. "Thor" St. 1080, NW. of Hanstholm, 1 June, 120 m, 1 spec., 7 mm.
1911. Horns Rev Lightship, 11 Sept. 1 spec., 6 mm (Table V).
do. 9 Novr. 1 spec., 9 mm.
1923. Cruise of the "Dana" (Table XII), Skagerrak and eastern channel of the Kattegat:
St. 3042, 15 May, depth 130 m, Ytr. near bottom, 15 spec., 7—11 mm, fully mature.
St. 3044, 16 May, depth 300 m, Ytr. 70 m wire, 1 spec., 10 mm.
St. 3047, 17 May, depth 65 m, Ytr. 85 m wire, 1 spec., 4 mm.

The above-mentioned specimen of 4 mm from the "Dana" St. 3047, near Læsö Trindel, is the smallest hitherto seen in Danish waters; it must undoubtedly have come from the Skagerrak with the bank water which at that time was rapidly pouring in, and its small size suggests that the species must have been indigenous in the Skagerrak, where it had been found a few days previously at two localities. *Mitrocoma* is, however, hardly of common occurrence in the Skagerrak. In April—May 1923 is was lacking throughout the well investigated area off the Jutland coast of the Skagerrak out to about the 40 m curve; the two stations at which it was found both lie in rather deep water north of the Skaw and Hirtshals. The medusa has only three times previously been taken in the Skagerrak, always over rather deep water (see list). The specimens from the Skagerrak vary in size from 7 to 12 mm diam., and are all mature. The species is presumably not a regular inhabitant of the Skagerrak, but is carried thither occasionally from the west coast of Norway, and may at times propagate on arrival. The finds in the Skagerrak are all from May—July. In 1899, a specimen was taken at Anholt Knob at the beginning of November, *i. e.* much later than it is generally met with round the British Isles and off the coast of Norway. Off the southern part of the west coast of Jutland (Slugen and Horns Rev), Mitrocoma has only been found in September and November, and the specimen from Horns Rev 11 Sept. is only 6 mm in diameter. It is very likely that these late-comers, like the specimen noted from Anholt Knob 2 Novr., belong to a new generation, but no definitive explanation of the remarkable occurrence of this species in Danish waters can be given until we have learned something more as to its distribution in the North Sea, and the rate of growth and length of life of the medusa.

Cosmetira pilosella Forbes.

Chart 13.

Hydroid unknown.

Geographical distribution.

The area of distribution of this species as hitherto known is rather small, embracing only the southern and western shores of the British Isles, the Shetlands,

and Bergen. It is found in the Channel from May to September, off the south-west coast of Ireland from April to October. It has been taken at the Shetlands in July, and at Bergen in November. The medusa propagates as a rule in the last few months of summer, and has thus a rather long span of life (for details, see KRAMP 1919, p. 61—64).

Occurrence in Danish waters.

This medusa is, it is true, rather large (diam. up to abt. 20 mm) but is easily destroyed in the nets and therefore liable to escape notice; the specialist will easily recognise it by the numerous stiff marginal cirri. The first find in Danish waters was made on the cruise of the "Dana" in the autumn of 1922, when it was taken at no fewer than 12 stations, comprising the North Sea, Skagerrak, and Kattegat.

Material.

1922. Cruise of the "Dana" (Table XI and Chart 13):

Off the northern part of the west coast of Jutland, 28 Sept.—3. Oct., mostly near the bottom, St. 2837—2863; diam. 5—16 mm.

Eastern channel of the Kattegat, 6—18 Oct., near bottom, St. 2878, 2886, 2892, 2922; diam. 9—13 mm

In the North Sea, *Cosmetira* was found near the coast from Bovbjerg northward in water which, as we shall see in the General Section, was presumably a mixture of the Jutland Current with the intermediate layers from the mouth of the Skagerrak. The minimum size of the specimens found along this range decreased on the whole from south to north, showing that the species was indigenous at the mouth of the Skagerrak north of the banks, and not brought thither by the Jutland Current; it was lacking in the warm water on the southern side of the Little Fisher Bank, as also in the cold water mass coming from the north-west over the bottom towards the edge of the plateau between Little Fisher Bank and the Jutland Bank.

In the Kattegat, Cosmetira was found only in water of relatively low temperature (10°8—11°0) in the eastern channel SE. of Læsö. The only find in the Skagerrak (St. 2892 N. of the Skaw) is likewise from cold water (8°2). The species was taken at these stations only in small numbers, and none of the specimens measured less than 9 mm diameter. — The specimens from the Kattegat thus do not appear to be indigenous to the warm, southern bank water, but are rather a remainder brought with the northern bank water of early summer, either from the same area where the stock found near Hanstholm belonged, or from the southern coast of Norway, where the species is also known to be indigenous.

Tiaropsis multicirrata (M. Sars).

Chart 14.

Syn: *Tiaropsis diademata* L. Agassiz.

Hydroid unknown.

Geographical distribution.

Tiaropsis multicirrata is a northern-boreal, neritic species. It lives both in the northern Pacific and in the coastal waters of the North Atlantic region. It is very common off the east coast of North America north of Cape Cod, and off the west coast of Greenland as far as Disko Bay. In Northern Europe, it occurs from the Channel to northern Iceland and the Barents Sea. It is fairly common in the Scottish waters, but rare in the more southerly parts of the British shores. It has also been taken at the Shetlands and the Færoes, and, in great numbers, in the fjords on the north-western coast of Iceland. It is less numerous, but still fairly common, in the fjords all along the west coast of Norway, at any rate from Bergen to the Malangsfjord. It has also been taken in the Barents Sea. For details, see Kramp 1919, p. 80—81 and 86—89; Kramp & Damas 1925, p. 298.

The medusa is decidedly neritic. Throughout the greater part of its area of distribution, its occurence is restricted to the spring months, the young specimens appearing in March, attaining maturity in May and disappearing in May or June. In Greenland and Iceland waters however, its occurrence falls somewhat later; it is met with right on into August. Off the west coast of Norway it is found mainly from March to May, but in certain fjords may remain until July or August. — At Helgoland it is found only in March and April.

Occurrence in Danish waters.

Tiaropsis is mentioned by Johansen & Levinsen (1903, p. 280) but these writers have confused it to some extent with *Eutonina indicans*, and most of the specimens still preserved, noted as *Tiaropsis*, belong in reality to *Eutonina*. — The two specimens noted below from Læsö Channel 1909, are mentioned in Kramp 1915.

Material:

1898. Frederikshavn, May, 15 spec., diam. 3—6 mm.
1900. Læsö Channel, 2 and 15 May, 23 and 11 spec. respectively, 5—10 mm.
1909. "Karen" St. 1270, Læsö Channel, 28 April, depth 22½ m, Rtr. 19 m buoy rope, 2 spec., 5—11 mm.
1911. "Havörnen" St. 1516, E. of Frederikshavn, 12 May, 23—0 m, 2 spec., 5 mm (Table IX).
1915. Middelfart Sound, 4 April, 6 spec., 3—7 mm.
1916. Næs Sound, Limfjord, 10 May, surface (Biol. Stat), 60 spec., 9—16 mm, mostly large.
1923. Cruise of the "Dana" (Table XII):
18—26 April, Bay of Köge (St. 2954); southern Kattegat (St. 2948, 2979, 2980); eastern channel of the Kattegat (St. 2984, 2985), lower water layers, rare.
30 April—7 May, Jammer Bay and Vigsö Bay, and off west coast of Jutland (St. 2997—3013); 8 May, off Hirtshals, St. 3023.
17—19 May, Kattegat W. of Groves Flak and off Hellebæk, St. 3048 and 3054.
28—31 May, The Sound, Bay of Samsö, and Great Belt, St. 3055—3065.

From this it appears that *Tiaropsis multicirrata* does not occur regularly in our waters, but only occasionally, and then chiefly in the northern Kattegat. It

may, however, appear in quite large numbers, as in Læsö Channel in May 1900, and it must have been very numerous in the Limfjord in May 1916. — It will further be noted that all the occurrences fall between middle of April and end of May, *i. e.* within a comparatively short space of time. The species is doubtless not regularly indigenous in our inner waters; now and again, however, a native stock may appear there, and in any case, it cannot come from very far away. The finding of small specimens at Middelfart in 1915 suggests that the species must in that year have been indigenous in the Kattegat. The fact that *Tiaropsis* occurs together with the great hosts of *Hybocodon* and *Rathkea* which come into the Kattegat with the northern bank water, strongly suggests that it is as a rule carried by the same water masses; and this is confirmed by what we know as to the further distribution of the species. The occurrence in 1923 presents several features of interest, and calls for more detailed discussion (see Chart 14, p. 107).

In the latter half of April 1923, a few specimens of Tiaropsis were found in the lower water layers of the southern Kattegat, some off the north coast of Sealand, some on the eastern side of Djursland. A single specimen was, indeed, found in Köge Bay, at a salinity of no more than 14.3 ‰, brought down from the Sound. The Kattegat specimens were all of medium size, 5—9 mm diam. It is possible that the small stock of Tiaropsis may have been indigenous in the southern Kattegat, the absence of quite small specimens being due to the stage of development of the stock at the time. As, however, specimens of no more than 3 mm were taken as late as 26 April, E. of Læsö, it seems to me more likely that the stock belonged to the northern Kattegat, and that part was carried down into the southern portion, before the advancing atlantic water had attained the volume noted in the latter half of April.

In the bank water which was displaced by the atlantic water, and which, about 1 May, was found in the western part of the Skagerrak and off the northern part of the west coast of Jutland, Tiaropsis was represented by a few medusæ, mostly of small size, the majority only 3—4 mm diameter. The species must therefore undoubtedly have been indigenous in the vicinity of the mouth of the Skagerrak. Some few days later, considerable numbers of the medusæ were taken at the Jutland Bank, the sizes ranging from 4 to 12 mm. Tiaropsis has never been taken at Horns Rev Lightship, and is presumably not ordinarily indigenous there; in 1923, however (5 May), a few specimens, 4—10 mm diam., were taken south of the reef. This species must thus be included among the northern medusæ (such as *Staurophora* and *Tima*) which had, in this remarkable year, a native stock in the area south of Horns Rev, an interesting point which will be further discussed in the General Section. — On the 9 May, a few Tiaropsis, 4—9 mm diameter, were taken off Hirtshals (St. 3023), in the bank water now flowing eastward (salinity abt. 32.8 ‰).

At the interesting station 3048 in the eastern channel of the Kattegat (17 May) where the typical rich bank water fauna was met with in the intermediate water

layers, Tiaropsis was also found, a few large specimens, 9—13 mm; whether these had come in with the bank water which was now flowing in strongly, or belonged to the native stock located in the northern Kattegat in April, cannot be decided. The specimen of 10 mm taken at the northern entrance to the Sound 19 May (St. 3054) was at any rate doubtless one of the Kattegat stock. The same presumably applies to the specimens taken in the Sound and E. of Kullen 28 May. — On the other hand, I consider it highly probable that at any rate some of the large Tiaropsis (up to 17 mm diam.) taken in the Bay of Samsö and the Great Belt at the end of May, were brought from the Skagerrak by the rapidly inflowing bank water; they were found in company with several other medusæ, which may safely be assumed to have been so transported (e. g. *Bougainvillia britannica*) and they were taken in considerable numbers, whereas the stock in the Kattegat in April was, as we have seen, very small.

The peculiar, and, as far as we know, uncommon distribution of Tiaropsis in Danish waters in 1923 agrees very closely with what we have seen as to the distribution of other medusæ in that year, and is doubtless due to the same causes: the altogether abnormal hydrographical conditions. The occurrence of the medusa in 1923 does not by any means argue against the conclusions as to general occurrence of the species in our waters, which may be briefly summed up as follows:

Tiaropsis multicirrata is probably indigenous in the Skagerrak, whence it is frequently, though not every year, carried down into the northern Kattegat in April and May; it may, exceptionally, be met with as far down as in the Belts (Little Belt 1915, Great Belt and the Sound 1923); the unknown hydroid also, can under certain circumstances live in the Kattegat; on the whole, however, *Tiaropsis* must be regarded as a relatively infrequent visitor from the north to the Danish waters inside the Skaw.

Fam. *Eucopidæ.*

Phialidium hemisphæricum (L.).

Chart 8.

Syn: *Thaumantias hemisphærica* Forbes.
in parte *Phialidium variabile* Haeckel.
Hydroid: *Campanularia johnstoni* Alder.

Geographical distribution.

Phialidium hemisphæricum is a very common medusa in all north-european coastal waters from the Channel to the south coast of Iceland, and along the west coast of Norway at any rate as far as Lofoten. It has, presumably, a far wider range of distribution, as the hydroid, *Campanularia johnstoni*, is also known from the Mediterranean, the Sargasso Sea, the east coast of North America, and the Pacific. Broch (1918, p. 163) notes the hydroid as a southern form; the only known

finds on the west coast of Norway are Bergen and Hammerfest (!); it is fairly common off the southern shores of Iceland. — Round the British Isles, and in the North Sea, the medusa is met with all the year round. In spring and summer, small and medium sized specimens are found; large ones (about 20 mm diameter) in autumn and well on into the winter. In Icelandic waters, very large specimens are found (up to 25 mm, with as many as 58 tentacles) in July—August.

Occurrence in the waters round Denmark.

Literature. — This species is the first medusa to be noted from the waters round Denmark, being described by O. F. Müller from the Christiania Fjord (Zoologia Danica 1781, p. 25—26). It has since been mentioned by F. E. Schultze (1875, p. 138, *Phialidium viridicans*) from the south coast of Norway in July; by Möbius (1884, *Thaumantias hemisphærica*) from Kiel, and by Aurivillius (1898a, *Phialidium variabile*) among the endogenetic plankton forms in the Gullmarfjord in July—November (pp. 266, 276, 290, 298, 348). Johansen & Levinsen (1903) refer to the medusa under the names of *Thaumantias forbesi* (p. 279) and *Phialidium variabile* (p. 280); with regard to the latter, they state: "in the Skagerrak and the Kattegat, this form has been met with fairly often between August and March". It was taken once in November at Knudshoved in the Great Belt (Table p. 292). — Specimens of this species have doubtless often been taken in the course of the international plankton investigations, but without determination of species.

Distribution of the Hydroid in Danish waters (see Chart 8, p. 63).

Campanularia johnstoni doubtless lives all round our coasts as far as the northern entrances to the Belts and the Sound. The hydroid is mainly associated with the bottom vegetation, where any such is found, but will also attach itself to larger hydroids and bryozoa. It is very common on algæ and Zostera all over Samsö Bay and in the northern part of the Little Belt. In the rich algæ growths of Frederikshavn it is remarkably rare, but this area is altogether rather poor in hydroids. I have taken it at the Skaw in quite considerable numbers, on algæ and hydroids. It has not been taken in deeper water in the Kattegat. It has been found at Nyköbing in the Limfjord, and in the Thyborön Channel (on *Flustra*); also in the Ringköbing Fjord, in the salt water period, on *Flustra*. In the Skagerrak and the North Sea, it is very common in places on Bryozoa (especially *Flustra foliacea*) and larger hydroids (*Hydrallmania falcata*, *Sertularia cupressina*, *Tubularia indivisa*), mostly in deeper water, 23—71 m. It seems, however, to be rare off the coast between Blaavandshuk and Nissum Fjord, but is common south and west of Horns Rev and on the stony grounds off Thyborön.

I have made some interesting observations with regard to the life history of the hydroid in our waters. The gonothecæ begin to develop in May. On the 21st May 1915, I found, off Snoghöj, in the Little Belt, in 16 m of water, a very rich growth of *C. johnstoni* with a number of young gonothecæ, none more than half developed.

In the summer months, a lively development of medusæ takes place, and this is continued on into autumn. A colony from the Kristineberg Zoological Station (in Sweden) 15 Oct. 1918 has gonothecæ all quite or nearly emptied. The same applies to the colonies I found in the Little Belt 2 Novr. 1915 and at the Skaw 1—3 Novr. 1919; a large colony from Frederikshavn 8 Novr. 1914, had two gonothecæ containing blastostyles, one of these having still a couple of small medusa buds. — Particularly interesting is the hydroid's method of hibernation, which I have studied more especially in the Little Belt. Many species of hydroids lose their hydranths in the winter, and form them again in the spring. In the case of *C. johnstoni*, I have found that the hydrotheca stalks break in the middle. This may begin to take place in the autumn, but is not completed until later on in the winter. In Middelfart Sound, on the 2 Novr., I found the species in great numbers, at 10—15 m' depth, with hydranths in all the hydrothecæ. With regard to the colonies I found at the same place on the 18 Decr., I have noted: "Some of the colonies still have their hydranths, and there are also a few empty gonothecæ; in most of the colonies, however, some or nearly all of the hydrotheca stalks are broken". I had observed this feature already the winter before, and noted in my journal for 26 March: "A number of *Delesseria* and *Furcellaria* are covered with a network of stolons, from which proceed short, ringed stalks. There were some empty gonethecæ and it was therefore possible to determine the species. All the hydrotheca stalks are broken, but the stolons, and also some of the stalks themselves, contain living matter". Regarding some colonies from 16 m' depth off Snoghöj, I wrote on the 21 May: "found en masse on *Delesseria*. In some of the hydrotheca stalks it is easy to see that the lower half is old, the upper portion being newly formed from the point where the old stalk was broken across. There are, however, many hydrotheca stalks which are newly formed right from the stolon," — I have made similar observations with material from other localities, as for instance from Kristineberg and Hirtshals.

The Medusa.

Summary of Material.

1894. Near Hesselö, 31 July (Th. Mortensen), 13 spec., small and medium size.
1898. Frederikshavn, 15 and 26 July, total 12 spec., diam. 1—5 mm.
NE. of Skagens Rev Lightship, 20 Aug., 2 young spec.
N. of Skagens Rev, 50 m, 12 Novr., 5 large spec.
1899. Skagens Rev, 15 Aug., 1 rather large spec.
1900. — 19 Jan., 5 Febr., 18 Decr., large specimens.
1903. "Thor" St. 162, S. of the Skaw, 18 Novr., numerous spec., diam. 6—11 mm, mostly large.
1904. "Thor" St. 186, WNW. of Hirtshals, 17 Feb., 6 full-grown spec.
1906. "Thor" St. 792, N. of Horns Rev, 5 April, 1 large spec.
1909. Frederikshavn, 17 June (Kramp), 1 young spec.
1910. Off Hellebæk, 25 July, surface (Kramp), 7 spec., small and medium size.
The Sound, N. of Hveen, 10 Sept., Ytr. 26 m wire (Kramp), 2 spec.
Schultz's Grund Lightship, 1 Aug.—14 Sept., almost every day, scarce in August, fairly common 8—14 Sept., both in upper and lower water layers (Table VII).

Motor boat from the "Thor", north coast of Sealand, but not in the Sound, end October (Table XIII).

1911. Horns Rev Lightship, January (scarce); 23 Oct.—25 Decr. (fairly common) (Table V).
Anholt Knob, Feb. and Aug.–Oct. (Table VI).
Schultz's Grund, 13 June—21 Novr., common in Aug.—Sept. (Table VII).
"Havörnen" St. 1511, off Hals, 11 May, 9—0 m (Table IX).
Cruise of the "Thor", 18 June—17 July, nearly everywhere in North Sea, Skagerrak, Kattegat, and the Sound, always scarce; not in the Belts, and only at one station in the Baltic (St. 1647, off Skjoldnæs) (Table X).
Motor boat from the "Thor", west coast of Jutland off Bjerregaard and Thorsminde, 3—4 Aug.

1912. Horns Rev, Feb.—April and 23 Sept.—23 Decr., mostly scarce (Table V).
Anholt Knob, singly in Jan., April, Sept., Novr. and 1 Decr. (Table VI).
Schultz's Grund, 30 Jan.—5 Novr., scarce (Table VIII).

1913. Horns Rev, 12 May and 29 Sept.—29 Decr., numerous in Sept. and Oct. (Table V).
Schultz's Grund, 19 Aug.—16 Decr., in most hauls, but scarce (Table VIII).

1914. Horns Rev, 12 Jan.—16 March, in most hauls, not uncommon (Table V).
Skagerrak, 10 miles S. of Oxö, 4 April, 40–0 m, 1 spec. (see General Section, p. 177).

1915. Middelfart Sound, 23 July and 18 Sept.

1919. 2 miles S. of the Skaw harbour, 5 Novr., surface (Kramp), 2 young spec.

1922. Cruise of the "Dana", 28 Sept.—19 Oct. In most hauls with the young fish trawl near bottom in the North Sea, Skagerrak, northern and eastern Kattegat, and the Sound (Table XI).

1923. Cruise of the "Dana", singly at three stations in the North Sea and Skagerrak (St. 3001, 3007, and 3023), 2 and 9 May (Table XII).

Danish specimens of *Phialidium hemisphæricum* do not attain the considerable size of those from English, Norwegian, or Icelandic waters, and the gonads are relatively shorter. In my paper on the Leptomedusæ of the "Ingolf" Expedition (Kramp 1919, p. 91) I have briefly touched on the question as to whether the small *Ph. buskianum* (with short, oval gonads), is identical with the larger *Ph. hemisphæricum* (with elongated gonads), and proposed to make a further investigation, with measurements, of Danish material to throw light on the subject. Such investigation proved, however, extremely difficult, as there were only a small number of specimens in a sufficiently good state of preservation to permit of reliable measurements. In many cases, I had to be content with noting an approximate statement of the size, and the shape of the gonads. These notes, however, together with such measurements as could be made, have given me sufficient grounds on which to assert that there are, in Danish waters, two, not very sharply distinguished, seasonal forms of *Ph. hemisphæricum*; and I have also been able to trace the life history of the species in our waters.

As noted above, the hydroid *Campanularia johnstoni* is, in summer, from June onwards, actively engaged in the liberation of medusæ, and even in October or November one may find gonothecæ not quite empty. — From the above list of material of *Phialidium* it will be seen that the medusa begins to appear pelagically in May or June; by July it is widely distributed, but is never met with in great

numbers. It is found in the plankton throughout the whole of the autumn and winter, and some way on into the following spring. It now appears that in summer, we only find small specimens (max. diameter in July 6—7 mm), whereas in autumn and winter, the medusa attains a diameter of 11—12 mm, and in spring even as much as 16 mm. This does not mean that the individual medusa takes several months to attain its full development; on the contrary, specimens taken in July may be mature already at a size of 5—6 mm, whereas in autumn, larger specimens are found to be still immature. Both in July and in November, the length of the gonads is abt. $^1/_4$ that of the radial canals. But when we look at the proportion between length and breadth of the gonads themselves, we find a distinct difference at the two seasons of the year. In specimens of 6—8 mm diam, the proportion in July is abt. $\frac{1.9}{1}$; in November abt. $\frac{2.9}{1}$; in specimens of 9—11 mm from November the proportion is abt. $\frac{3.0}{1}$. The number of tentacles in July rarely exceeds 16; in November, it is as a rule 24—28. We have thus a summer form, which attains maturity at a diameter of 5—6 mm, having then thick, oval gonads and abt. 16 tentacles (see fig. 2); and an autumn and winter form of 10—12 mm with elongated gonads and 24—28 tentacles or more. Transition forms between these two types are met with especially in early autumn. — To my mind, there can be no doubt but that the position is as follows: The medusæ hatched in early summer have but a short span of life (a few weeks only) before attaining maturity and disposing of their sexual products; from their ova, a new hydroid generation is produced the same summer. The medusæ hatched in autumn on the other hand, continue their growth for a longer period, survive the winter, and do not discharge their sexual products until the end of winter or some way on in spring, producing then a new hydroid generation.

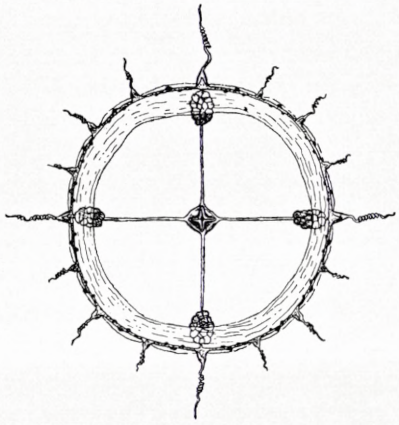

Fig. 2. *Phialidium hemisphæricum* L. Hellebæk 25 July 1910. Drawn from life by the author.

Phialidium hemisphæricum occurs in all our waters as far as the Belt Sea. It goes down into the Sound and the Belts but seems only exceptionally to penetrate into the western Baltic ("Thor" St. 1647, 1911); in the Baltic proper it has never been found. — It keeps for the most part to the upper water layers; has at any rate never been taken in deep water.

The cruises of 1911, 1922, and 1923 afford interesting data both as to the horizontal distribution and the seasonal occurrence.

On the cruise of the "Havörnen" through the Kattegat and Great Belt about the middle of May 1911, only a couple of specimens were taken, off Hals, but on the cruise of the "Thor" from mid June to mid July, it was taken in nearly all parts of our waters, though always in small numbers, and predominantly of small size, some of the specimens being quite young and newly hatched. Only at St. 1566,

midway in the mouth of the Skagerrak, was a fairly large specimen taken, and a few medium sized specimens were taken in July, especially near Anholt. — At the stations S. of Horns Rev, the species was altogether lacking. Between Horns Rev and Hanstholm, it was taken at several stations, but not less than 8 miles from land. In the collections made by the motor boat from the "Thor" along the west cast of Jutland in early August of the same year (at the same time when the medusa culminated in the Kattegat) it was only taken at two stations. The rarity of the medusa near the west coast of Jutland in summer is evidently due to the fact that the hydroid itself is rare on this coast, which is almost devoid of vegetation; it is probably more common in autumn, when the Jutland Current brings in a stock from the southern part of the North Sea. In the Skagerrak, in June, the only specimen found was the large one noted from St. 1566. On the 5 July, the medusa was taken at two of the eight stations in Jammer Bay. — It was lacking in Aalbæk Bay, but was found at some places near land in the Bay of Aalborg and the Læsö grounds about 1 July. It was also taken at nearly all stations near Anholt 7 July. In the Bay of Samsö it was extremely rare 10—11 July, but fairly common 16 July. In the Sound it was taken on the 17 July. — We see, then, that *Phialidium* was found in the North Sea on the coastal banks at some distance from land, but in the Kattegat mainly in shallow water, and that the period of investigation here (first half July) coincides more or less with the first appearance of the medusa in the plankton in this water (cf. occurrence at Schultz's Grund Lightship, noted below).

On the cruise of the "Dana" in 1923, the Kattegat, Belt Sea, and western Baltic were investigated between 17 April and 5 June, but not a single specimen of *Phialidium* was found. A few isolated specimens were, however, taken in the North Sea and Skagerrak in early May, all near the bottom. In the southern part of the area investigated (St. 3007, 23 miles SW. of Vyl Lightship, 5 May) several specimens were found, some very large, having survived the winter (9—16 mm diam.). At St. 3001, off the northern part of the west coast, 2 May, another large specimen was taken, of 13 mm (15 mm when alive); this one, I noted, had the manubrium of an emerald green. The solitary specimen from the Skagerrak (St. 3023, NW. of Hirtshals, 9 May) was rather small, and must have belonged to the spring stock.

On the cruise of the "Dana" in September—October 1922, it was observed that the hydroid *Campanularia johnstoni* is far more common off the west coast of Jutland than was formerly supposed; its occurrence is, however, mainly restricted to the outer part of the Horns Rev area and the stony grounds off Thyborön. — At the end of September, when fishing was carried out with the ring trawl near the bottom off the northern part of the west coast of Jutland, *Phialidium hemisphæricum* was taken in most hauls. The species was, however, lacking at the stations on the Little Fisher Bank and the Jutland Bank, where the temperature of the bottom water was comparatively low; at the remaining stations, it was taken as a rule in large numbers. The size of the specimens varied between 5 and 12

mm diam., most, however, being less than 9 mm. The majority of these specimens would presumably have come from those grounds off the west coast of Jutland where the hydroid grows, being brought in at this time of year, in autumn, nearer to the coast by the Jutland Current, which now reached right in to the coast N. of Bovbjerg. Some of the larger specimens may perhaps have been living for some time in the water masses of the Jutland Current, and have been brought with them from distant parts of the North Sea.

In the Skagerrak, the medusa was rare. It was taken at St. 2864 N. of Hanstholm in rather warm water (diam. 6—8 mm) and at two stations near the coast in the rather cold water (small specimens, 5—7 mm); also in the cold water (8°2) at 90 m' depth N. of the Skaw.

In the Kattegat, *Phialidium* was again taken in most hauls, both in Aalbæk Bay and Læsö Channel, as well as the eastern channel, but always in small numbers. It was taken both at the lowest and at the highest temperatures recorded (9°6—12°8). Both east and west of Læsö, small specimens (3—5 mm) as well as larger ones (7—9 mm) were taken; in one place (St. 2878, west of Fladen), specimens up to 12 mm diameter were measured. At the one station where fishing was also carried out at the surface (St. 2878), the medusa was taken there in about the same numbers as at the bottom. The *Phialidium* medusæ taken at stations in the Kattegat were doubtless of widely different origin, and it is impossible to say whence the main bulk was derived. — In the Sound, north of Hveen, a few specimens were found, 5—7 mm diameter.

The Lightship Collections show that the occurrence of the medusa throughout the year differs greatly at the three localities. — Schultz's Grund Lightship lies in an area where the hydroid is extremely common, and we therefore regularly find the indigenous summer stock here; no distinct correlation could be traced between occurrence of the medusa and hydrographical conditions at the time. In 1911, a single specimen appeared on the 13 June; from 4 July to 17 Oct., the species was taken in nearly every haul, increasing in numbers up to 8 Aug.; after this, it became rare in the surface water, and in the intermediate and deepest water layers the numbers decreased gradually until 14 Novr. after which the species disappeared. In July, all the specimens were rather small; the large quantity taken on the 8 Aug. consisted mainly of rather large ones, in the following months all sizes were recorded. I cannot discover any definite cause to account for the fact that the medusa was lacking in all three hauls on the 3 Oct., though taken in all hauls the week before and for a fortnight after. — The occurrence of the medusa at Schultz's Grund in 1912 was highly remarkable. On the 30 Jan., a large specimen from the stock of the previous year was taken. During February, no collections were made. From 5 March to 9 April, small Phialidium were taken in nearly all hauls from 16—0 and 26—0 m, some of them quite newly hatched. Why the hydroid should have been liberating medusæ this year so much earlier than usual I cannot understand, as the temperature, both at the time and during the previous months,

was rather below than above the normal (the relatively high temperature in the deepest water layers in December 1911 and March 1912 can hardly be supposed to have affected this hydroid, which belongs to the littoral waters), and in February it was so cold that most of the Kattegat lightships had to be withdrawn from their stations for some considerable time on account of the ice. During the summer months, the medusa was very rare; in autumn it was found again with some frequency, both in large and small sizes. In 1913, the work of collection did not begin until 19 Aug. From this date onward, Phialidium was taken in the great majority of hauls right on until the 16 Decr., but always in small numbers; in August—October both small and medium sized, though mostly the latter. In November—December, the specimens were mostly large; as late as the 16 Decr., however, one small specimen was taken. — The most interesting feature in the daily collections during August—September 1910 is the fact that the current as a rule carried an increasing number of Phialidium medusæ past the lightship, whether coming from north or south.

Very different is the occurrence of the species at the Anholt Knob lightship, which does not lie in the immediate vicinity of favourable grounds for the growth of the hydroid. Newly hatched medusæ are not met with here; the species begins to appear in August or September, and must then be supposed to have been brought from other parts of the Kattegat, presumably both from the north with the undercurrent, and with the surface current from the south; in certain years (1913) it may fail to appear at all. In February 1911 and in January and April 1912, very large specimens were found, belonging to the stock of the previous year, and presumably carried all the way from the North Sea; we should be better able to decide the point if we knew at what depths the specimens in question had been captured.

At Horns Rev lightship, the summer stock is conspicuously rare, though the hydroid is by no means uncommon in the vicinity of the reef; young specimens are met with now and again at the end of April and May. Large specimens, on the other hand, occur in quite considerable numbers every year throughout the autumn and winter, right on until March or April; this stock is brought as a rule by the Jutland Current from the southern parts of the North Sea. In September—October 1913, however, a host of Phialidium came down, together with various other medusæ, from the north to Horns Rev (see General Section, p. 175); it was not until November that the Jutland Current gained the mastery over this southward movement of the water and then carried a southern stock of Phialidium to Horns Rev throughout the whole winter. In March 1914, some very large specimens were found, which look as if they must have been dead (spent) before capture and preservation. — It is interesting to note that the large Phialidium at Horns Rev are frequently accompanied by the diatom *Rhizosolenia styliformis*, as for instance in 1912, 23 and 30 Sept. and 7 Oct., but even more noticeable in 1913; in that year both the medusa and the diatom were numerous on the 29 Sept. and 6 Oct. but

scarce on the 13 and 20 Oct.; then again, on the 27 Oct., there appeared enormous hosts of both *Rhizosolenia* and *Phialidium*, after which the diatom disappeared, and the medusæ decreased in numbers, the latter, however, still appearing in various quantity throughout the winter.

Summary.

The medusa *Phialidium hemisphæricum* has approximately the same distribution in Danish waters as the hydroid *Campanularia johnstoni*; the medusa is, however, occasionally carried somewhat farther down into the Belts than the hydroid is found. The medusa occurs in all water layers, mainly perhaps in the upper levels, is carried this way and that by the currents, and appears to be but little affected by hydrographical conditions. In summer, all our waters as far as the northern parts of the Belts have their local stocks of the medusa in its summer form; these are small organisms, which, during the brief span of life before they propagate and disappear, cannot cover any great distance in their progress with the currents. We find, too, that this summer stock is mainly restricted to such areas as offer favourable conditions for the hydroid: in the North Sea, above the coastal bank where the hydroid can grow on the great colonies of Flustra and hydroids, but not near the barren coast, which afford no good sites for growth; in the Kattegat on the other hand, mainly near the coast and above the stony grounds where there is a growth of algæ. — The time at which this summer stock makes its appearance differs somewhat from one year to another. As a general rule, we may say that the medusæ begin to appear in June, increasing thenceforward in numbers in the course of July, August, and September. The ones hatched in autumn have a considerably longer span of life than the summer stock; the autumn form survives the winter and does not propagate until the approach of the following spring. A considerable stock of Phialidium is brought to Horns Rev, and probably carried farther most of the way along the west coast of Jutland, by the Jutland Current all through the autumn and winter; at Skagens Rev also, the medusa has been taken in winter (1900). Even at Anholt Knob, in the Kattegat, the autumn form may still at times be met with towards the spring; at Schultz's Grund, on the other hand it has not been taken later than December or January; it seems likely therefore that the local stock in the Kattegat does not survive the winter as a general rule; and as the stock carried by the Jutland Current evidently does not get so far down into the Kattegat, the maintenance of the species here is secured only by the survival of the hydroid generation through the winter (see above as to the mode of hibernation of the hydroid).

It still remains to note that the summer form seems to occur rather earlier in the year off the west coast of Jutland and in the Skagerrak than in the Kattegat. This is indicated by the finding of a medium sized specimen south of Oxö on the 4 April 1914, a small one at Horns Rev 1 April 1912, a rather small one again NW. of Hirtshals 9 May 1923, and a large specimen NW. of Hanstholm 21 June 1911.

Eucheilota maculata Hartlaub.

Hydroid unknown.

Geographical distribution.

This medusa has been found at Helgoland in autumn, from August to October; an excellent description, with figures, is given by HARTLAUB (1897, p. 499) who also succeeded in hatching out the hydroid, a small form which he referred to the genus *Campanulina*; I am inclined to think, however, that the position of this hydroid in our classification must be regarded as uncertain. At any rate, I have been able to prove that *Campanulina hincksii* Hartlaub, described at the same time, cannot be the hydroid corresponding to *Eucheilota maculata* (see KRAMP 1926 b).

The medusa seems only to have been found again once since it was described by Hartlaub, *viz.* at Thyborön, 31 Oct. 1900 (JOHANSEN & LEVINSEN 1903, p. 280; the specimens from the Skagerrak noted by these writers as belonging to the same species proved to be *Mitrocoma polydiademata*); and also, if the determination be correct, in the south-western part of the North Sea in August 1905 (Catal. 1909).

Occurrence in Danish waters.

Material.

1900. Thyborön, 31 Oct., 7 spec., diam. 6—9 mm.
1903. "Thor" St. 162, S. of the Skaw, 19 Novr., 1 spec., diam. 6 mm (Table XIII).
1910. Off Gilbjerghoved, North Sealand, 26 Oct., 1 spec., diam. 5 mm (Table XIII).
1911. Horns Rev Lightship, 13 Novr., 3 spec., 9—11 mm; 22 Novr., 4 spec., 6—11 mm; 28 Novr., 23 spec., 7—13 mm (Table V).
"Thor" St. 1603, N. of Kobbergrunden (Kattegat) 4 July, 18—0 m, 1 spec., 1 mm (Table X).
Motor boat from the "Thor" along the west coast of Jutland, St. 1679, 55° 37′ N., 8° 06′5 E., 3 Aug., 10—0 m, 26 spec., 1—6 mm (of which 24 less than 3 mm).
St. 1681, 54° 44′ N., 8° 11′ E., 3 Aug., 6—0 m, 2 spec., 1.5 and 6 mm.
St. 1686, 56° 11′ N., 8° 06′ E., 3 Aug., 10—0 m, 1 spec., 1 mm.
1913. Horns Rev, 28 July, 2 spec., 2½—4 mm; 4 Aug., 8 spec., one of which 1½ mm, the rest 4—6 mm; 10 Novr., 3 spec., 1 small and 2 large (Table V).
1922. Cruise of the "Dana" (Table XI). Off the northern part of the west coast of Jutland, near bottom, 30 Sept.—2 Oct., St. 2846, 2849, and 2858. Diam. 7—9 mm.

Eucheilota maculata is not uncommon off the west coast of Jutland in late summer and autumn (July—November), and as quite young specimens have been found in abundance here, the species is evidently indigenous in these waters. In the Kattegat, on the other hand, it is rare. The finding of a young specimen at Kobbergrunden (4 July 1911) shows, however, that the hydroid must be capable of living in the Kattegat, though it is presumably only exceptionally that it does so.

It will be noticed that while young Eucheilota were found in abundance at the coastal stations off the west coast of Jutland in early August 1911, the medusa did not appear at Horns Rev that year until November, and the specimens then found there were nearly all rather large, undoubtedly brought from the south by

the Jutland Current. In 1912, the species was not taken at all. In 1913, when there was an unusually powerful movement of the water from the northward over Horns Rev in summer and autumn, and the Jutland Current did not show any real force until November, young Eucheilota were taken at Horns Rev on the 28 July and 4 Aug., doubtless brought down from the north (see General Section). These facts suggest that the hydroid from which Eucheilota is derived lives north of Horns Rev, but not at a short distance to the south of it.

Obelia spp.

Hydroids: *Laomedea geniculata* (L.).
— *dichotoma* (L.).
— *longissima* (Pallas).

Since there are three medusa-producing species of the hydroid genus *Laomedea* in Danish waters, it follows that there must also be three species of *Obelia* medusæ; for the moment, however, it is impossible to distinguish one of them from the others. I have devoted considerable attention to this problem, but up to now without success. One of the principal objects of my journey to England in 1914 was to hatch out *Obelia* in the aquaria at Plymouth and study their development. Dr. E. J. ALLEN, Head of the Laboratory there, did everything possible to facilitate my work with advise and guidance. There was also abundant material to work on. But, as Dr. Allen wrote to me beforehand, "These experiments are difficult, and one has to put up with a great many failures". I was soon to appreciate for myself the truth of his words. The greatest difficulty in these Obelia investigations lay in procuring the right food for the small medusæ. I managed to keep them alive for several weeks, but they did not seem to grow very much, and at last died off. I made a great number of measurements of *Obelia* medusæ, devoting my attention particularly to the number of tentacles, position of the marginal vesicles in relation to the tentacles, and size of the gonads, with their position on the radial canals. In this last respect, I really thought I could discern a clear and characteristic difference between the three species, but E. T. BROWNE, whom I visited while in England, considered that this difference was due to conditions of nourishment; and I must admit that my subsequent hatching experiments have not confirmed the results I arrived at in the first place. Browne had himself hatched out medusæ of *L. geniculata* and *dichotoma*, and brought them to full size, and he declared that there was absolutely no difference between them. He had not succeeded in bringing *L. longissima* to its full development, and as none of the other species showed pigmented tentacle bulbs, he considered that the *Obelia nigra* which he had described (BROWNE 1903) must be the medusa of *L. longissima*. It is highly probable that he is right in this; and if so, then it should be easy to distinguish these species from the two others. Unfortunately, however, the characteristic peculiarities of *nigra* do not appear until the medusa has reached an advanced stage of development, and

I have myself on several occasions, even with fairly large specimens of *Obelia*, been unable to determine whether they were "*nigra*" or not. — In 1916, I attempted to make some hatching experiments in Denmark. With the kind assistance of Professor Aug. Krogh, I set up a number of plunger aquarians in the Zoophysiological Laboratory at Copenhagen, bringing hydroids and salt water from Frederikshavn. But if the food question had been difficult in Plymouth, it proved altogether hopeless in Copenhagen, and the experiment was a complete failure.

It had occurred to me that the problem might be partly solved by indirect methods: if the three hydroid species exhibited any characteristic differences in point of distribution and time of propagation in Danish waters, then it might perhaps be possible to form certain conclusions as to which of the *Obelia* species were most common at certain seasons and in certain waters, and then, by careful examination (measurements etc.) of plankton material, arrive at some result. This method also, however, I have been obliged to relinquish, at any rate for the present. All three hydroid species are common in our waters, all have about the same horizontal and vertical distribution, and the liberation of medusæ takes places in all three cases at the same time of year.

Nor is there anything definite to be learned in this connection from the sites on which the hydroids grow. True, *L. geniculata* grows for by far the greater part on plants or plantlike animal colonies, whereas the two other species prefer molluscs, ascidians or inanimate objects; all three may, however, be found on the same species of plants or "Zoophytes", so that a comparison between the biology of these and the breeding season of the *Laomedea* species gives us nothing to go upon.

Nevertheless, I have not altogether given up hope of finding a solution of this difficult problem at some future time.

Despite the similarities mentioned in the biological features of the hydroids, we cannot take it for granted that the medusæ also behave similarly in biological respects (rate of growth, length of life, season of propagation etc.). And it would therefore be useless to go through all the available plankton material of Obelia in detail under one head. I shall in the following restrict myself to a very brief account of the occurrence of the Obelia medusæ, with such information as I am able to furnish regarding the biology of the three hydroid forms.

Laomedea geniculata (L.).

This hydroid is very common in shallow water throughout the Kattegat. It does not appear to penetrate into the Sound south of Elsinore. It is extremely numerous in Middelfart Sound, and has been met with here and there in the western Baltic, but not east of Femern Belt. Inside the Skaw, *L. geniculata* has only been found on plants, and then mostly on *Laminaria*; it is, however, also common on *Fucus* and *Halidrys*, rarer on red algæ and *Zostera*, In the western part of the Limfjord, it has been taken on *Zostera* and *Fucus*.

L. geniculata is extremely common all along the west coast of Jutland, at any rate out to abt. 50 m' depth. Throughout this area, it is found predominantly on the bryozoon *Flustra foliacea*. In the Skagerrak, it seems to be extremely rare.

It should further be noted that *L. geniculata* is one of those hydroids most frequently met with on floating objects, both in our own and other waters. It may be met with either on inanimate objects such as boats, driftwood, or "pumice stone" (slag) and on living things (floating algæ such as *Fucus vesiculosus, Ascophyllum nodosum, Sarqassum*), and has even been found on a parasite crustacean, which was itself attached to a fish.

The material I have investigated comprises fertile colonies of *L. geniculata* from all months except January and February. In Middelfart Sound, in 1915, I collected an abundance of material of this hydroid in order to study its appearance at different times of year. It appears that the gonothecæ begin to develop as early as March, and liberation of medusæ proceeds uninterruptedly at any rate until nearly the end of December; from the planula larvæ of the medusæ, fresh hydroid colonies are produced, which grow rapidly, and very soon begin to liberate medusæ in their turn; newly formed colonies may be met with even in November and December. There are thus several sets of generations produced in a year. Colonies growing in deeper water keep their hydranths and remain in full vigour throughout the winter, but have no gonothecæ during the first two months of the year. Colonies growing near the surface lose their hydranths in the coldest season, but commence to develop new ones early in the year (March). A colony growing on a *Laminaria* lives as long as the portion of leaf to which it has attached itself may last; so that in the Little Belt, a colony may attain an age of some 15 months, if formed early in the year, whereas those formed later live only about nine months. My material from other localities was almost exclusively taken in summer. In the harbour of Frederikshavn, where the hydroid is very numerous on *Laminaria*, it behaves, presumably, in much the same way as in the Little Belt; outside the harbour, where the leaves of last year are destroyed and disappear early in the year, I have never seen *L. geniculata* on *Laminaria*. It is found here mainly on *Halidrys*, but has also been taken on *Zostera, Fucus, Delesseria* etc. The Zoological Museum has some fertile colonies taken on *Zostera* near Frederikshavn 8 Novr. 1914 by Hj. Ussing.

Laomedea dichotoma (L.).

In the Kattegat, this species is found as a rule in somewhat deeper water than *L. geniculata*, and the fact is connected with the nature of the objects on which the species grows. *L. dichotoma* is very common in Aalbæk Bay from the Skaw to Frederikshavn, it has as a matter of fact been taken at scattered localities in all parts of the Kattegat, and in the Great Belt north of Langeland. It has never been taken in the Sound or the Little Belt, but the Zoological Museum has some rather large colonies labelled Holbæk (Johs. Petersen; determined by Levinsen as *L. flexuosa*).

L. dichotoma is very rarely found on *Laminaria*, but generally on algæ with narrower leaves, such as *Halidrys*, *Desmarestia*, *Delesseria* and other red algæ, *Fucus* etc. It is occasionally met with on *Zostera*. It is rarely found on dead shells, but is fairly common on living molluscs, especially gastropods. It seems to have a peculiar preference for *Ascidians*, the mantles of which may frequently be found entirely overgrown by the stolons of this hydroid. It is also one of the commonest hydroids found on crabs (*Stenorhynchus*, *Hyas*). — In the western part of the Limfjord, it is common on *Ascidians*, *Buccinum*, *Mytilus*, and *Fucus*. — In the Skagerrak and the North Sea, *L. dichotoma* is fairly common, and has been taken as far out as 100 m' depth. It grows here for the most part on hydroids, bryozoa, and crabs, sometimes on shells or live molluscs.

Apart from a sterile colony from Hjerting Bay, taken in January 1923 by Dr. Spärck, I have no winter material of this species. Fertile colonies have been met with from June till October; the numerous colonies which I collected at the Skaw in November 1919 were all sterile.

Laomedea longissima (Pallas).

The distribution of this species in Danish waters is almost identical with that of the foregoing; it has, however, been taken at Hellebæk, and at Fænö in the Little Belt. It is extremely common in the North Sea, especially in the Horns Rev area, and was numerous in Ringköbing Fjord during the salt water period (1911—1913). — It is commonest everywhere on shells of living or dead molluscs, and on small stones; now and again it is found on algæ (especially *Halidrys*), *Zostera*, hydroids, and crabs.

Fertile colonies have been met with from February to November.

Obelia spp.

As explained above, I do not propose here to enter into any detailed account of the occurrence of the *Obelia* medusæ in our waters, but will merely give a survey of the material, referring for the rest to the tables quoted.

1909. Spodsbjerg, Langeland, 10 April—23 June, in most hauls from bottom to surface, often in great numbers, very rarely in the upper water layers; maximum in the latter half of May. Fluctuations very marked from day to day. See also Kramp 1915.

1910. Schultz's Grund, 1 Aug.—14 Sept., in practically all the daily hauls, varying quantities, rather more frequent in lower than in upper water layers; particularly common towards middle of September (Table VII).

1911. Horns Rev., 29 May; 30 Oct.—28 Novr., scarce (Table V).

Anholt Knob, in nearly all hauls throughout the year, numerous from 16 March to 1 July (Table VI).

Schultz's Grund, from the time the collections commenced on the 14 May, to 26 Decr. especially numerous in June, Sept., and Novr. (Table VIII).

"Havörnen" 11—17 May. Very numerous everywhere throughout the Kattegat, rare in the Great Belt and western Baltic, but still found east of Femern at St. 1529 (Table IX).

Cruise of the "Thor" 17 June—17 July. Lacking at the first stations in the Horns Rev

area, but found otherwise at nearly all stations in the North Sea and Skagerrak except over very deep water; always in small numbers. It was taken at practically all stations in the Kattegat, and was very numerous in some localities, especially in quite shallow water, but otherwise in rather small numbers. Almost entirely lacking in the Belts, though a few specimens were found S. of Ærö; common in the Sound (Table X).

1912. Horns Rev, 28 April and 6 May (Table V).

Anholt Knob, 1 Jan. and in most hauls from 15 April to 15 Novr., common in April and May (Table VI).

Schultz's Grund, 2 Jan.—5 Novr., rare in upper water layers, especially during the first part of the time; numerous in intermediate and lower water layers in April—June (Table VIII).

1913—14. Horns Rev, 4 Aug., 29 Sept.—27 Oct. 1913 (Table V).

Anholt Knob, 1 May—15 July (numerous in June), 15 Novr. 1913; 1 and 15 Jan. 1914 (Table VI).

Schultz's Grund. Collections commenced 19 Aug. Obelia found in nearly all hauls till the end of the year; very small numbers at first, but numerous in November and especially in December; then scarce again and only in intermediate and lower water layers, nearly every week until 31 March 1914 (Table VIII).

"Havörnen", Skagerrak, 4—5 April 1914, in most hauls, but small numbers (see General Section, p. 177).

1915—16. Middelfart Sound; common in May, then scarce until 18 Jan. 1916.

1919. The Skaw, 5 Novr., surface, quite young specimens (P. K.).

1920. Limfjord, near Nyköbing, 17 March, quite young specimens. Great Belt, east of Slipshavn, 13 April, large specimens.

1923. Cruise of the "Dana" 19 April—31 May. Lacking in the Baltic, but found nearly everywhere in the Great Belt, Kattegat, Skagerrak, and North Sea. Also some specimens east of Gedser 5 June (St. 3082, cf. *Eutonina indicans*). Both quite small specimens, newly hatched, and very large ones which had evidently survived the winter (Table XII).

Eutonina indicans (Romanes).

Chart 15.

Syn. *Eutonina socialis* Hartlaub.

Hydroid unknown.

Geographical distribution.

The distribution of this species has been dealt with in detail in earlier works (Kramp 1919, p. 98—101; Kramp & Damas 1925, p. 313). I have also seen a large specimen taken at Blankenberghe (Belgium) in April 1914. The distribution of the medusæ, outside Danish waters, as known to date is as follows: Northern Pacific in May (Bigelow); fjords on the NW. coast of Iceland in June; E. coast of Scotland from May to August; coast of Belgium in April; Helgoland from end March to early July, very numerous in the middle of May; west coast of Norway from Skagerrak to the fjords at Aalesund from end April to mid July. — Its occurrence in the southern parts of the North Sea thus falls somewhat earlier than in more northerly localities. The distribution may be described as northerly-boreal.

Occurrence in waters round Denmark.

Literature. — AURIVILLIUS (1898 a, p. 172 and 174, *Eutimalphes indicans*) mentions this species from the Gullmarfjord in April—June 1895; according to THÉEL (1908 p. 58) it is common off the coast of Bohuslän for some days in the first half of June every year. — In the Christianiafjord, according to information received from HJ. BROCH, it may now and again appear in great hosts; it is not mentioned by SVERDRUP (1921). — In JOHANSEN & LEVINSEN (1903) it is referred to under different names: *Eucopium quadratum* (p. 279) and *Eutonina socialis* (p. 280) as well as *Tiaropsis multicirrata*, this last name covering both the true *Tiaropsis* and *Eutonina indicans*. — It is possibly also this species which is referred to by MÖBIUS (1884) from Kiel in February under the name of *Eucopium quadratum*, though the time of year does not argue in favour of this.

Material.

1895. Thyborön, 18 June, 4 spec., diam. 14—18 mm.
1897. Frederikshavn, June, 7 spec., 8—16 mm.
1898. Skagerrak, 29 July, 3 spec., abt. 14 mm.
1 mile N. N. E. of Skagens Rev Lightship, 20 Aug., 1 spec., 10 mm.
1899. Skagens Rev, 20 April, 1 young spec.
1900. Læsö Channel, 2 May, 1 spec., 6 mm; 15 June, 3 spec., 9—16 mm.
1901. Schultz's Grund, 6 April, 7 young spec.; 19 April, 5 young spec.
1902. Little Belt between Brandsö and Bogö, 17 May, 4 large spec.
Northern part of the Sound, 9—10 June, in deep water, 2 large spec.
Læsö Channel, 18 June, near bottom, 23 m, 3 spec., 13—18 mm.
1903. "Thor" St. 50, W. of Hirtshals, 17 April, 11 spec., 6—13 mm (Table XIII).
"Thor, E. S. E. of Læsö Trindel, 29 April, 2 spec., 20—21 mm.
1906. "Thor" St. 802, N. of Blaavandshuk, 9 April, 1 spec., 14 mm.
1907. "Thor" St. 982, Horns Rev, 29 April, surface, 2 large spec.
"Thor" St. 991, SW. of Horns Rev, 2 May, 2 spec., 13—22 mm.
Middelfart Sound in July, 1 spec., 14 mm (P. K.).
1909. "Karen" St. 1267, Aalborg Bay, 27 April, surface 7 spec.; $7^1/_2$ m, abt. 50 spec., all young; St. 1270, Læsö Channel, 28 April, 19 m, abt. 300 spec., $1^1/_2$—10 mm.
Spodsbjerg, Langeland, 29 April, 20 and 21 May, young spec.; 1—25 June, frequent, full-grown spec. (see KRAMP 1915).
Frederikshavn in June, 1 spec., 15 mm (P. K.).
1911. Horns Rev, 8 and 15 May, young spec.; 22 and 29 May, 7—13 mm (Table V).
"Havörnen" St. 1513, Læsö Channel, 11 May, Ytr. 13 m wire, 3 spec., 13—18 mm; St. 1517, SW. of Læsö Trindel, 13 May, 28—0 m, 3 young spec. (Table IX).
Cruise of the "Thor", at the following stations in the North Sea and Skagerrak, 18—27 June, Ytr., as a rule near the bottom, sometimes in great numbers: St. 1537, 3 spec., 12—17 mm; 1542, 3 large spec.; 1551, 121 spec., 7—18 mm; 1552 abt. 250 spec., 12—23 mm; 1563, 8 spec., 15—25 mm; 1575, 1 large spec.; 1576, 3 spec., 11, 22 and 26 mm (Table X).
1912. Horns Rev, 22 April, 2 spec., 13 mm (Table V).
Anholt Knob, 15 March, 1 young spec.; 15 April, 3 young spec.; 1 May, 2 large spec. (Table VI).
1913. Horns Rev, 28 April, 1 young spec. (Table V).
Anholt Knob, 15 May, 1 very large spec. (Table VI).

1915. Nyborg, well of the Biological Station, 17 May, 2 large spec.
1916. Nyborg, well of the Biological Station, 17 May, numerous spec., 4—17 mm.
1921. Nyborg, well of the Biological Station, 9 April, 3 spec., 5—10 mm.
1923. Cruise of the "Dana" (Table XII).
19 April, Köge Bay (St. 2954), 1 spec., diam. 4 mm.
24—26 April, Great Belt, Samsö Bay, and southern Kattegat (St. 2975—2983), in lower water layers, scarce, diam. 1½—17 mm, mainly small specimens.
30 April—9 May and 15—16 May. Almost everywhere in Skagerrak and North Sea (St. 2995—3023 and 3042—3044), generally in very large numbers, all sizes from 1½—33 mm.
13—19 May, Northern Kattegat and Aalborg Bay (St. 3036—3040 and 3047—3052); also at Hellebæk (St. 3054), sometimes in large numbers, diam. 3—34 mm.
28 May—7 June, almost everywhere in the Sound, southern Kattegat, Samsö Bay, Great Belt, Little Belt, and Baltic from Langeland to Möen (St. 3055—3068, 3072—3074, 3078—3089), fairly common, diam. 7—33 mm.
24 June, The Sound (St. 3145), diam. 24—33 mm.

The horizontal distribution of *Eutonina indicans* in Danish waters comprises the entire range of the west coast of Jutland, the Skagerrak, the whole of the Kattegat and Belt Sea, and the western Baltic. In the North Sea and the northern Kattegat, the medusa seems to keep mainly to the intermediate water layers, and may be met with at quite considerable depths; it was taken, for instance, at the "Thor" stations 1575 and 1576 in the Skagerrak, pelagically, near the bottom at 140 and 110 m' depth. In the Sound, it has only be taken a few times and then in deep water, whereas in the Belts, great hosts of the medusæ may be found at the surface. In the course of the "Thor" collections off Spodsbjerg, Langeland, in June 1909, it was taken mostly in the upper water layers, and off Middelfart, on a calm sunny day at the end of May 1916, I saw the surface of the Belt covered by enormous numbers of this elegant medusa, drifting southward with the current.

Adult specimens of a medusa of this size (diam 25—30 mm or more) are rarely taken in vertical hauls; they must be present in great numbers before there is any chance of getting one or two specimens in the Hensen net. At the "Thor" stations 1551 and 1552 in the North Sea, horizontal hauls with the young fish trawl yielded several hundred specimens (mostly of medium size), whereas the vertical hauls at the same stations, made with the Hensen net, did not bring up a single one. The complete absence of the species on the cruise of the "Thor" in the Kattegat in June (and July) of the same year is thus doubtless due to the fact that very little fishing was done with the young fish trawl on that occasion. The fact that at Spodsbjerg, from 1—9 June 1909, one or two (in one case seven) full-grown specimens were taken in almost every vertical haul thus indicates that there must have been very great numbers of the medusæ in the water at the time.

Quite young specimens have been taken in all parts of our waters except the Baltic, so that the species must be indigenous from the North Sea to the Belts. As, however, the young specimens are never taken except in small numbers inside the Skaw (never more than three in any one vertical haul) the native stock there must nevertheless doubtless be rather small, and not sufficient in itself to account for the

occurrence of large specimens in such enormous hosts later on, in our inner waters. I conclude that the great majority of Eutonina seen in the Belts about the 1st of June must belong to a stock brought from more distant waters. The occurrence at Spodsbjerg in 1909 is eloquent in this respect; in April and May, the species was only taken three times, and all were small specimens; at the beginning of June, when the current, both at the surface and deeper down, was mainly flowing southward, a great mass of Eutonina was carried down through the Belt, consisting now exclusively of full-grown individuals. The few specimens taken at Anholt Knob lightship (1912 and 1913) were likewise either quite small or very large. In the North Sea and the Skagerrak, we find a different state of things: on the cruises of the "Thor" and the "Dana" in these waters in 1911 and 1923, Eutonina was found in all sizes (diam 7—26 mm in 1911, $1^1/_2$—33 mm in 1923); here, then, there must evidently be a large native stock. At Horns Rev lightship also, vertical hauls yielded both small and medium sized specimens.

The cruise of the "Dana" in 1923 afforded an extremely clear view of the occurrence of Eutonina in the Danish waters (see Chart 15, p. 132). The small specimen (4 mm) taken in Bay of Köge on the 19 April (St. 2954) was undoubtedly carried thither from the Sound. Otherwise, the species was lacking throughout the Baltic and the southern part of the Great Belt.

On the 24—26 April, a small native stock was located in the nothern part of the Great Belt, Samsö Bay, and the southern Kattegat as far as a little south of Anholt. A few specimens of medium size (up to 17 mm) were taken, but the majority were quite small. A few days later, great numbers of full-grown specimens were found in the North Sea, so that the Kattegat stock must have been relatively far behindhand in development. The Kattegat specimens were taken exclusively in the lower water layers, at highly varying temperature and salinity (temp. 4°7—6°3; salinity 18.9—34.8 ‰) — In the eastern channel of the Kattegat north of Anholt there was evidently no indigenous stock, and, with the absence of the bank water, we note also the entire absence of any trace of a stock brought down from the north. On the other hand, there must have been a small native stock in Tannis Bay (Skagerrak), where a number of quite small specimens ($1^1/_2$—4 mm) were taken on the 30th April.

About the 1st of May, when we found the displaced bank water in Jammer Bay and Vigsö Bay, it was observed that the pelagic fauna of this water consisted predominantly of *Eutonina*. There were specimens of all sizes, from quite small to big full grown ones; most, however, were of medium size.

Farther south, along the west coast of Jutland, the species showed a rather marked decrease in numbers, but in the area south of Horns Rev and at the outer stations (about the 40 m line) up to the Jutland Bank, it was again extremely numerous, though not common at the outer stations in the Skagerrak. Throughout all this range of water the medusæ were found in all water layers, though most numerous as a rule in the lower ones. Both large and small specimens were taken

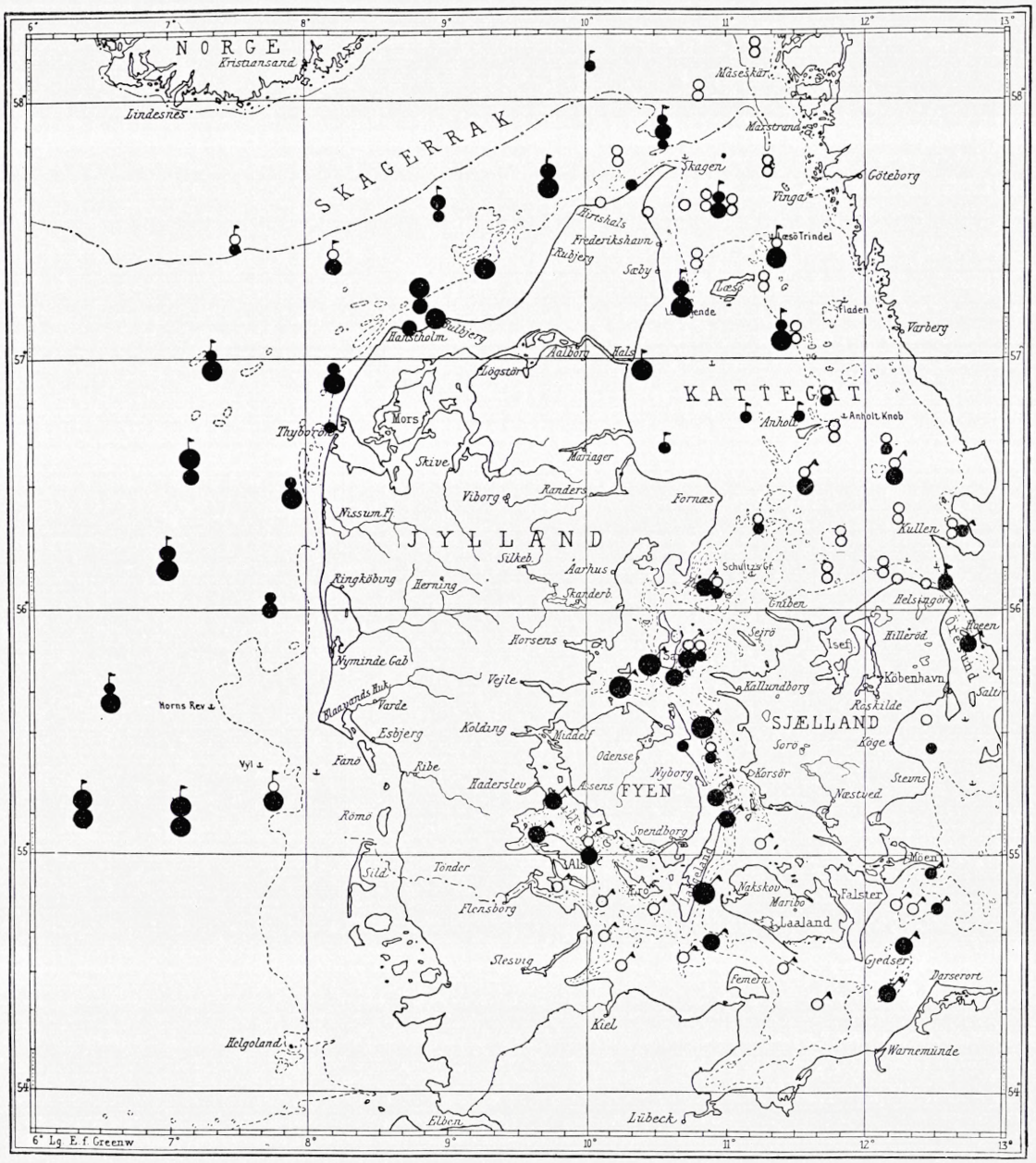

Chart 15. *Eutonina indicans*. Occurrence on the cruise of the "Dana" 17 April—7 June 1923. All pelagic stations within this period, except St. 2956—2975, 19—24 April, in the Baltic and the Great Belt, are noted on the chart. Two circles, one on top of the other, denote hauls made in the upper and lower water layers; blank circles indicate that the medusa was not taken in the hauls so marked; the three different sizes of filled circles represent the frequency of the species.

o = St. 2944—3004, 17 April—2 May.

♂ = - 3006—3054, 5—19 May.

♂ = - 3055—3089, 28 May—7 June.

everywhere. There was evidently an extremely numerous stock of Eutonina in the North Sea and south-western Skagerrak, the hydroid forms of which would have grown on the coastal banks in Jammer Bay and Vigsö Bay, in the area south of Horns Rev, and on the outer portion of the plateau off the west coast of Jutland; not, however, or at any rate only in small numbers, close inshore along the west coast, or on the slope of the Norwegian Channel.

Towards the middle of May, when the bank water was beginning to force a passage into the Kattegat, *Eutonina* came with it; the species was found, for instance, in great numbers on the 9 May, at St. 3023 NW. of Hirtshals, and a few days later in Aalbæk Bay and the eastern channel of the Kattegat.

In the Bay of Aalborg, which was investigated on the 13, 14, and 18 May, Eutonina vas found, sometimes in great numbers, both small specimens (from 2 mm) and large, but none very large (none over 23 mm). These doubtless belonged to a stock indigenous in Aalborg Bay, scarce in the southern portion, but common in the Læsö Channel; particularly interesting are the two stations 3036 and 3038 (off Hals and in Læsö Channel), where the medusa was common; here, specimens from 3 to 23 mm were taken, but none larger, as one would have expected if it had been a portion of the Skagerrak stock, nor was the salinity of the water high enough to assume any inflow of water from the Skagerrak (27.4 ‰ at Hals, 33.3 ‰ in Læsö Channel). At Herthas Flak on the other hand (St. 3040) specimens up to 34 mm diam. were found, undoubtedly brought in by the bank water from the Skagerrak.

At the two interesting stations 3047 and 3048 in the eastern channel of the Kattegat, 17 May, Eutonina was lacking at the surface, but extremely numerous in the intermediate water layers. At the southern of these two stations, some few small specimens (4—5 mm) were found, which probably belonged to the Kattegat stock; the majority, however, were of medium size or very large (33 mm) and these, together with other species of medusæ, proved that the water mass in which they were found was the bank water from the Skagerrak, now flowing into the Kattegat between the Baltic surface water and the Atlantic bottom water. Finally, it should be noted that a few, though not many, specimens, evidently from the Kattegat stock (28 mm max.) were taken off Hellebæk at the northern entrance to the Sound on the 19 May.

When the "Dana" again set out from Copenhagen (28 May) Eutonina was found almost everywhere throughout the southern Kattegat and the Belt Sea; this was undoubtedly a mixture of native Kattegat specimens, which had now grown to a somewhat considerable size, and the stock brought in with the bank water from the Skagerrak. — Not a few specimens were found in the southern part of the Little Belt (St. 3072—3074); these doubtless all belonged to the Kattegat stock. In the waters south of Als and Fyen, the species was altogether lacking. A quantity had, however, been carried down through the Great Belt into the Langelandsbelt and thence eastward again. In all probability, the advancing bank water had at this time (early June) not reached beyond the Langelandsbelt, but had been thrust-

ing before it a mass of Kattegat water in towards the Baltic. This water brought a part of the Eutonina stock from the Kattegat through the Kadetrende in to the Baltic proper; the species was not found, however, east of a line drawn from the eastern side of Möen to Darserort (salinity 20.3 ‰); these specimens measured from 8 to 28 mm.

In the deep water of the Sound, some large specimens (24—33 mm) were taken on the 24 June (St. 3145).

Summary.

Taking the waters outside and inside the Skaw separately, we get the following general view of the occurrence of *Eutonina indicans* in Danish waters: In the North Sea and Skagerrak, the unknown hydroid occurs everywhere along the coastal banks, and begins to liberate medusæ at the end of March or beginning of April, continuing throughout April or May; young medusæ may, exceptionally, be taken as late as the middle of June. In May, the majority of the specimens found are of medium size; full-grown specimens may be met with in May, but even in June, the medium size predominates; the medusa thus probably takes 2—2½ months to attain full size. We have very little material from the later months, but two of the samples from the Biological Station, 1898, show that the medusæ may be found, at any rate in the Skagerrak, as late as July and August.

Inside the Skaw, a young specimen has once been found as early as 15 March (Anholt Knob 1912). In April and the first half of May, young specimens are not uncommon in the Kattegat and the Belts. Full-grown specimens are taken from the middle of May to middle of June, and even occassionally in July. The great hosts that appear in the Belts at the end of May or during the first half of June must presumably have been brought in from outside. Large specimens being so rarely taken in the lightship collections, we have not sufficient material to trace this immigration, except as regards the year 1923; in this case, however, its progress was abnormal. It is worth noting that large specimens have been taken at Anholt Knob on the 1 and 15 May (in vertical hauls with the Nansen net, which suggests that they must have been present in great numbers) whereas the masses that appear in the Belts do not arrive there until the end of May or in June. The great importation is effected by the northern bank water. In 1923, this water doubtless came from the coastal banks off the Danish shores of the Skagerrak; in other years, there may possibly be a considerable quantity brought from the southern part of the west coast of Norway, where this medusa is known to be very numerous. It is impossible, however, to say anything for certain as to the origin of the imported stock on the basis of the material at present available.

Saphenia gracilis (Forbes & Goodsir).

Chart 16.

Syn: *Saphenia mirabilis* (Wright) Haeckel.

Hydroid unknown.

Geographical distribution.

This elegant medusa seems to have a very restricted area of distribution, and is only common in the English Channel. It rarely enters Plymouth Sound, but outside, round the Eddystone, it may occur in great numbers in June, and is found in smaller numbers in the Channel throughout summer and part of autumn. It has not infrequently been observed off the south-west coast of Ireland, and isolated specimens have been seen in the Firth of Clyde (BROWNE 1905, p. 713), Sound of Mull (FORBES & GOODSIR 1853) and in the Firth of Forth (WRIGHT). At Helgoland it does not appear until August—October, and is rare (HARTLAUB 1894, p. 194). The International Plankton Catalogues note it from the Skagerrak in November 1902 and 1903. From the point of view of the Danish waters, it is a southerly form.

Occurrence in Danish waters.

Material.

1899. Schultz's Grund, 4 Sept., 1 spec., diam 4 mm.
Læsö Channel, 3 Oct., 1 spec., diam. 5 mm.
1900. Thyborön, 22 July, 1 spec., diam. 6 mm.
1922. Cruise of the "Dana" (Table XI):
Off the northern part of the west coast of Jutland, 2—3 Oct., near bottom, St. 2856—2864. Near Bulbjerg in the Skagerrak, 13 Oct., St. 2902. Eastern channel of the Kattegat and Læsö Channel, 6—19 Oct., near bottom, St. 2874, 2878, 2883, 2923, and 2924.

Until 1922, the only specimens recorded from Danish waters were the three above mentioned, from 1899 and 1900, which have also been referred to by JOHANSEN & LEVINSEN (1903 p. 280, *S. mirabilis*). I was therefore very much surprised when on the autumn cruise of the "Dana" in 1922, I found this medusa at several localities, including the North Sea, the Skagerrak, and the Kattegat. Saphenia was taken about 1 Oct. at 7 stations near Hanstholm, both in water of high temperature (12°9—13°) and in the comparatively cold water (11°4) near the coast at Bulbjerg (St. 2902, 13 Oct.). It was altogether lacking, however, on the Jutland Bank and Little Fisher Bank and off the coast between Thyborön and Nissum Fjord. At this time, a mass of warm water (the Jutland Current) was located coming from the south-west, and extending right in to the coast from Bovbjerg to Hanstholm. The species was lacking, however, in the southern and western portions of this mass of water, and the specimens taken farther north can thus hardly have been brought thither by the Jutland Current. Again, the medusa was not found in the cold water which at the same time extended from the north-west down towards the edge of the Little Fisher Bank and the Jutland Bank. The size of the specimens taken varied from 6 to 12 mm diameter, most of them being 7—9 mm, and the smallest sizes were met with in the most northerly localities. I cannot but suppose therefore, that the unknown hydroid must live somewhere in the neighbourhood of the mouth of the Skagerrak and, judging from the temperature at which the medusæ were found,

in water of no great depth. — The medusa was not met with farther up in the Skagerrak, but we encountered it again (6—19 Oct.) at 5 stations in the Kattegat. The bottom temperature at these stations varied from 11°0 to 12°3. The most interesting feature is that quite small specimens were found in the Kattegat, *viz.* one of 5 mm diam. at Great Middelgrund, and in Læsö Channel one of only 3 mm. The specimens from Schultz's Grund, and Læsö Channel, September—October 1899 were likewise small, 4—5 mm. There can thus be no doubt but that *Saphenia gracilis* is indigenous in the Kattegat, though it must be reckoned among the less common species. — Since the medusa occurs off the British coasts mainly in summer, it is remarkable that small specimens should be found in our waters in October. We have here a case analogous to those of *Laodicea undulata* and *Cosmetira pilosella* above noted, these species likewise appearing far later in the year in our waters than in those where their principal area of distribution lies.

Chart 16. Occurrence in 1922 of: ○ *Saphenia gracilis*; ● *Eutima insignis*; ◑ both species. Furthermore: ◢ *Eutima gegenbauri*; ◣ *Eirene viridula*.

Eutima insignis (Keferstein).

Chart 16.

Hydroid unknown.

Geographical distribution.

This medusa has been described from St. Vaast in Normandy, by KEFERSTEIN (1862, p. 29, Pl. 2, figs. 3—8, *Siphonorhyncus insignis*). The generic name of *Eutima* McCrady was first used for this species by HAECKEL (1879, p. 192). At the same time, HAECKEL described another species, "*Eutimium elephas*", from Helgoland; it resembles *Eutima insignis* in the main, but differs from it in having no cirri. It is therefore remarkable that HARTLAUB (1894, p. 194), who found two specimens of *Eutima* at Helgoland in August and September, should refer these to *E. elephas*, though, as he himself points out, they differ from HAECKEL's description in possessing marginal cirri; there can be no doubt but that HARTLAUB's specimens were in reality *E. insignis*. — *E. insignis* has since been taken off Plymouth (in September and October), at Port Erin, and at Valencia Harbour (July and August)

(Browne 1895 p. 282; 1896 p. 493; 1900 p. 719). The international plankton catalogues (1909) note it from the English Channel and the Bristol Channel in August 1905. — It is thus a form hitherto found only in small numbers at a few localities, all situated south of our own waters; and it occurs only in summer and autumn.

Occurrence in waters round Denmark.

There is no mention in the literature of *Eutima insignis* from waters round Denmark. It is possible, however, that it was this species which Aurivillius referred to (1898 a pp. 26 and 298) under the name of *Eutima elephas*, as found in the Gullmarfjord in November.

Material.

1911. Horns Rev Lightship, 9 Novr., 1 spec., 9 mm diam. (Table V).
1922. Cruise of the "Dana" (Table XI):

At several stations off the northern part of the west coast of Jutland, 28 Sept.—3 Oct., sometimes in great numbers. — At St. 2902 and 2906 in the Skagerrak, 13—14 Oct. — At St. 2878, 2887, 2890, and 2922 in the eastern Kattegat, 6, 9, 10, and 18 Oct., in small numbers.

Until 1922, the above-mentioned specimen from Horns Rev lightship was the only one taken in Danish waters. But on the autumn cruise of the "Dana" in 1922 it was found that *Eutima insignis* is in reality one of our commonest medusæ in the autumn. It was taken in the North Sea, the Skagerrak, and the eastern Kattegat, altogether in 18 hauls with the young fish trawl, mostly near the bottom. In the Kattegat, it was very scarce, but at some stations in the North Sea it was extremely abundant. Its occurrence here is rather peculiar. It was found, sometimes in great numbers, at all the four stations round the Little Fisher Bank, both in the warm water (13°6) and in the colder water on the north side of the bank (St. 2852, 10°6), and was also common at all stations off the coast from Bovbjerg to Hanstholm, within 11 miles of the shore, and at St. 2863 at the mouth of the Skagerrak. It was altogether lacking, however, at stations south of Bovbjerg (temp. 12°7—13°4) and on the Jutland Bank (12°3—12°5). A few specimens were taken at St. 2902 off Bulbjerg (temp. 11°4) and St. 2906 about the middle of the Skagerrak (depth 70 m, temp. 9°0). Since it was lacking at the southern stations and the Jutland Bank, but was found at some places with low temperature, it cannot be characteristic of the Jutland Current. Most of the specimens were abt. 9 mm diameter, the largest 13 mm; some were only 6 mm; one, indeed, only 5 mm diameter, and this last was taken at one of the most northerly localities (St. 2859). The occurrence of these small specimens, together with the different temperatures at which the species was taken, shows that it is indigenous in this area. Probably the hydroid is rather more widely distributed in these waters than those of *Laodicea undulata*, *Cosmetira pilosella*, and *Saphenia gracilis* (vide supra).

The medusa was not taken in the neighbourhood of the Skaw, and was likewise lacking in the western Kattegat. In the eastern channel, a few specimens were

taken (7—10 mm diam.) at four stations in all, from Vinga to Groves Flak, under widely different conditions of temperature (9°6—12°1). Possibly the species may be indigenous in the northern part of the eastern channel of the Kattegat, but nothing definite can be stated as to this.

Eutima gegenbauri (Haeckel).

Chart 16.

Syn: *Octorchis gegenbauri* Haeckel 1879.
— *campanulatus* Haeckel 1879.
Octorchandra germanica Haeckel 1879.
Eutima campanulata Mayer 1910.
Hydroid: *Campanopsis* Gegenbaur.

Geographical distribution.

This medusa, which was first described as from the Canary Islands and the Mediterranean, was first found in Northern Europe by Schultze, at Helgoland (1875 p. 138, *Tima sp.*). It is a rather rare form off the coasts of Great Britain; has been taken in the Firth of Clyde in September and November (Browne 1905, p. 771) and in the English Channel from July to September. At Helgoland, it is met with from August till mid October, and is common at the end of September (Hartlaub 1894, p. 105, *Octorchandra germanica*). — An interesting investigation of the development of the genital organs and position of the sexual cells in this species has been published by I. Apstein (1913).

Occurrence in Danish waters.

Literature. — This species is mentioned by Johansen & Levinsen (1903, pp. 280 and 281) under the names of *Eutimeta gentiana* and *Octorchandra germanica*, taken in the Limfjord and at Thyborön and Skagens Rev in Sept.—October. I have had an opportunity of examining the specimens in question (vide infra). Asl. Sverdrup (1921, p. 25) found a specimen at Dröbak, in the Christiania Fjord in August 1915.

Material.

1911. Horns Rev Lightship, 16 Oct.—9 Novr. (Table V).
1913. Horns Rev Lightship, 6 Oct.—10. Novr. (Table V).
1922. Cruise of the "Dana", at 8 stations in the North Sea and the Skagerrak, 1—14 Oct., in small numbers (Table XI).

At Horns Rev, only large specimens were found. The medusa makes its appearance here in the first half of October, and disappears in November; the period of its occurrence here thus falls a month later than at Helgoland. In 1911, when it was taken at Horns Rev in nearly all hauls for about a month, sometimes in rather large numbers, it must undoubtedly have been brought up from the south by the Jutland Current; in 1912, it was not found, probably owing to the fact that the

Jutland Current was held back during part of the summer, especially in July, by a southerly movement of the water, as evidenced by the unusually low temperature. In 1913, the species was taken at Horns Rev in October—November, but this time coming from the north, probably all the way from the mouth of the Skagerrak, together with various other medusæ, as there was, all that summer and part of the autumn, an exceptionally powerful inflow of water from the north to Horns Rev; not until about the middle of November did the Jutland Current make itself felt, and then with great force; and *Eutima gegenbauri* then disappeared from Horns Rev (see further under General Section, p. 175).

On the cruise of the "Dana" in the autumn of 1922, this species was found in small numbers at several stations in the neighbourhood of Hanstholm at the beginning of October. One particularly large specimen (16 mm diam.) was taken at St. 2853 between the Little Fisher Bank and the Jutland Bank, in relatively cold water (11°8); otherwise, the species was taken only at the most northerly stations in this area. South of Lodbjerg, and on the Jutland Bank, it was lacking altogether. This does not suggest a stock brought by the Jutland Current; moreover, some of the specimens are rather small (7—8 mm), though most are larger (generally 12—15 mm). A few isolated specimens were taken at St. 2906, about the middle of the Skagerrak, at 70 m' depth; it was not taken east of this point. The species is doubtless indigenous in the western part of the Skagerrak and adjacent waters of the North Sea. Liberation of medusæ evidently takes place a little before the time at which the "Dana" was working these waters, possibly at the same time as at Helgoland, in August—September. The medusa may now and again appear in the eastern waters of the Skagerrak (Skagens Rev 1899, Christianiafjord 1915). It is also occasionally met with in the Limfjord.

The occurrence of *Eutima gegenbauri* in our waters thus falls into two sections: we have an indigenous stock somewhere about the mouth of the Skagerrak, and and imported stock, carried by the Jutland Current beyond Horns Rev, and probably, somewhat later, reaching the northern part of the west coast of Jutland, to mingle with the native stock there.

Eirene viridula (Péron & Lesueur).

Chart 16.

Syn: *Irene pellucida* Haeckel.

Hydroid unknown.

Geographical distribution.

This comparatively large medusa is common in the Mediterranean. In the North Atlantic region it appears to be somewhat rare, though occasionally met with in considerable numbers. Most of the records in extant literature are from the English Channel. It was described from here by Péron & Lesueur (1809, p. 346, *Oceania viridula*). Eschscholtz (1829) introduced the generic name *Eirene* (Haeckel writes

Irene). FORBES found the species fairly common off the coasts of Dorset and Devon in August 1836 (FORBES 1848, p. 39, *Geryonopsis delicatula*). It has since been recorded now and again from the neighbourhood of Plymouth in August—October. BROWNE (1898) has found young specimens in September, and it seems therefore rather unlikely that GARSTANG (1894, p. 232—235) should really have found young specimens in March and halfgrown in May. A single specimen was taken in the Firth of Clyde on the 30 Sept. 1901 (BROWNE 1905, p. 761). — It has been taken at Helgoland in August (SCHULTZE 1875, p. 138, *Tima pellucida*) and in October (HARTLAUB 1894, p. 195).

MAAS (1893, p. 63, Taf. VI, figs 1—2) mentioned "*Irene viridula*" from the Irminger Sea in July, and MAYER (1910) accepts this without question in his list of synonyms. If the determination were correct it would be an altogether isolated occurrence of this medusa, but it can hardly be so. There were several specimens, all lacking the gelatinous stomachal peduncle characteristic of *Eirene*; instead of this, there was, on the subumbrella, at a little distance from the stomach, a circular fold. MAAS took this to be a contraction of the stomachal peduncle which can hardly be correct, as this is, in those medusæ which possess it, as a rule very consistent. Furthermore, the tentacle bulbs are remarkably narrow, and lack the excretory papillæ which are so well developed in *Eirene*. Finally, the position of the cirri does not agree with that in *Eirene viridula*, and MAAS himself notes that they are short and stiff, whereas in *Eirene* they are, on the contrary, long and spirally twisted.

BROCH (1905, p. 7) mentions *Irene viridula* from Puddefjord, near Bergen, in November, but the specimens in question have been found to be *Cosmetira pilosella*. His recording of the same species from Risör and Söndeledfjord (Skagerrak) in April and May must doubtless also be due to an error in identification.

Occurrence in Danish waters.

Material.

1912. Horns Rev Lightship, 23 Sept., 1 spec. (Table V).
1922. Cruise of the "Dana" (Table XI):
Off the northern part of the west coast of Jutland and in the south-western part of the Skagerrak, 28 Sept.—3 Oct., St. 2839—2864, and 14 Oct., St. 2906.

The stations of the "Dana" here mentioned are situated in the North Sea between the Little Fisher Bank and Thyborön, and near the mouth of the Skagerrak. In the eastern Skagerrak and the Kattegat the medusa was not found. Some of the specimens are very large (up to 36 mm diam.) but several are rather small, the smallest 9 mm. Consequently, if they belong to an imported stock, they cannot have come very far. Specimens of less than 15 mm were taken at all stations. Larger ones (23—36 mm) were found at the three stations 2844, 2851, and 2863, which are some distance apart. There is thus no distinct distribution according to size within the area in which the species was found. The stations at which the medusa

was taken showed on the whole a rather high temperature at the bottom; at St. 2851, where the species was particularly numerous, we find the highest temperature recorded, 13°6 (for St. 2863, where a great number of specimens were also taken, no hydrographical data are available; the haul here was made about midway between surface and bottom). The medusa was thus found in the Jutland Current, but was hardly imported thereby. As its occurrence in the area here concerned coincides very closely with that of the various other leptomedusæ described in the foregoing, it was probably also, like these, indigenous at and around the mouth of the Skagerrak.

Tima bairdii (Johnston).

Chart 17.

Hydroid unknown.

Geographical distribution.

This large medusa (diameter up to abt. 65 mm) has a somewhat restricted area of distribution, living only in part of the North Sea and in the Danish waters. A detailed account of the distribution of the medusa is given in the Leptomedusæ of the "Ingolf" Expedition (KRAMP 1919). It was not then known from the west coast of Norway. Examination of DAMAS' material however (KRAMP & DAMAS 1925) has shown that it is common throughout the whole of the Norwegian Channel, and is found in the fjords near Bergen and Molde, but not farther north. We can now fix the northern limit of occurrence of the species at 62°20′ N. where the Norwegian Channel opens out into the depth of the Norwegian Sea. The southern limit of distribution is a line from Helgoland (where HARTLAUB, 1894 p. 196, found a single specimen on the 1 Feb.) roughly to the mouth of the Tyne. It has been taken several times at St. Andrews and in the Firth of Forth; it is, however, almost certainly not indigenous off the east coast of Scotland, but appears there only as an occasional visitor in winter, mostly November—January, when it may be very numerous. It has on one occasion been observed in September, and also once in March. It rarely moves down along the east coast of England, but may occasionally, at intervals of several years, appear quite suddenly in great hosts. In the Report from the Dove Marine Laboratory, STORROW states that on the 21 Novr. and 3 Decr. 1921, the beach at Cullercoats and Whitley Bay (a little north of the mouth of the Tyne) was covered with masses of *Tima* and that the medusa was likewise taken in great numbers off the coast of Northumberland on the 15 Oct. and 12 Novr. 1908, and, in smaller numbers, on the 5 Jan. 1909[1]). As regards its occurrence outside the Danish waters, it would seem as if the young specimens are everywhere found in summer, and full-grown ones in winter and spring.

[1]) True, MCINTOSH states (1890, p. 304) that this species is common all along the east coast, from Scotland to the mouth of the Thames; he also notes young specimens from February, May, and August; this is, however, contradictory to all other records, and I therefore consider it best to disregard his statements as to the distribution of *Tima bairdii*.

Occurrence in the waters round Denmark.

Literature. — *Tima* is noted from the Skagerrak several times in the international plankton catalogues in February, May, and November; BROCH (1905, p. 7) mentions it from Söndeledfjord in April, and AURIVILLIUS (1898 a, p. 164 and 204) has taken it in the Gullmarfjord in January and February. JOHANSEN & LEVINSEN (1903, p. 281) also record it from the Skagerrak, 9 miles N. of the Skaw, 14 June 1901. The same writers give us the first mention from the Kattegat, S. of Anholt Knob, 17 April 1902, a large specimen. Finally, according to KRAMP (1915, p. 16) two specimens were taken in Læsö Channel on the 28 April 1909.

Material.

Tima bairdii is often mentioned in the journals of the "Thor"; several of the specimens have been preserved, and the determination in all cases proved correct; I have therefore no hesitation in including in the list below all the finds I have been able to extract from the journals in question.

1903—1907. "Thor" St. 27, 31, 32, Skagerrak 29 April 1903, St. 163, 352, 666, 721, 730, 738, 745, 751, 759, 770, 782, 783, 793, 949, 955, 989, 1013, 1017, 1049, 1050, 1073, 1076, 1079, 1080, 1088, 1112 (Table XIII).

1909. St. 1233, SE. of Fornæs, 4 April, 2 spec.
St. 1270, Læsö Channel, 28 April, 2 spec. (see KRAMP 1915).

1911. "Thor", off northern part of the west coast of Jutland and in the Skagerrak, 20—27 June, St. 1563, 1567, and 1575. E. of Samsö 16 July, St. 1667 (Table X).

1912. West of Samsö, 8 May, St. 1859 (according to Journal).

1914. Middelfart Sound, beginning of January[1]).

1922. "Dana". Off the northern part of the west coast of Jutland and in the Skagerrak, 1—4 Oct. and 12—14 Oct., St. 2850—2869 and 2898—2906, diam. mostly 6—12 mm, two spec. 30—40 mm. — Eastern channel of the Kattegat and NE. of the Skaw, 10—11 Oct. and 19 Oct., St. 2888—2892 and St. 2924, numerous spec., diam. 7—45 mm (Table XI).

1923. "Dana". South-eastern Kattegat, 17 April, St. 2944—2946, diam. 35—50 mm. — All along the west coast of Jutland and in the Skagerrak, 30 April—16 May, St. 2994, 3006, and 3042, numerous spec., diam. 4—66 mm. — The Sound and E. of Kullen, 28 May, St. 3055—3056, 3 spec., diam. 10, 11, and 38 mm. — SE. of Samsö, 30 May, St. 3061, 3 spec., diam. 11—15 mm. — The Sound, 24 June, St. 3145, 4 spec., diam. 15—27 mm (Table XII).

It will be seen from the above list, and from the chart, that *Tima bairdii* is by no means a rare form in our waters. It is commonest in the Skagerrak and immediately adjacent parts of the North Sea, but has also been taken several times in the Kattegat, though it keeps here for the most part to the deeper waters. Off the west coast of Jutland, it seems as a rule to be somewhat rare, and has only been taken here at some distance from shore. The species is evidently indigenous in the

[1]) According to information from cand. A. OTTERSTRÖM and a couple of fishermen from the Fishery High School at Snoghöj, a medusa, which from the description cannot have been other than a large *Tima bairdii*, was taken off Snoghöj at the beginning of January 1914. It was kept alive in a jar of sea water for some days, but ultimately died and was thrown away.

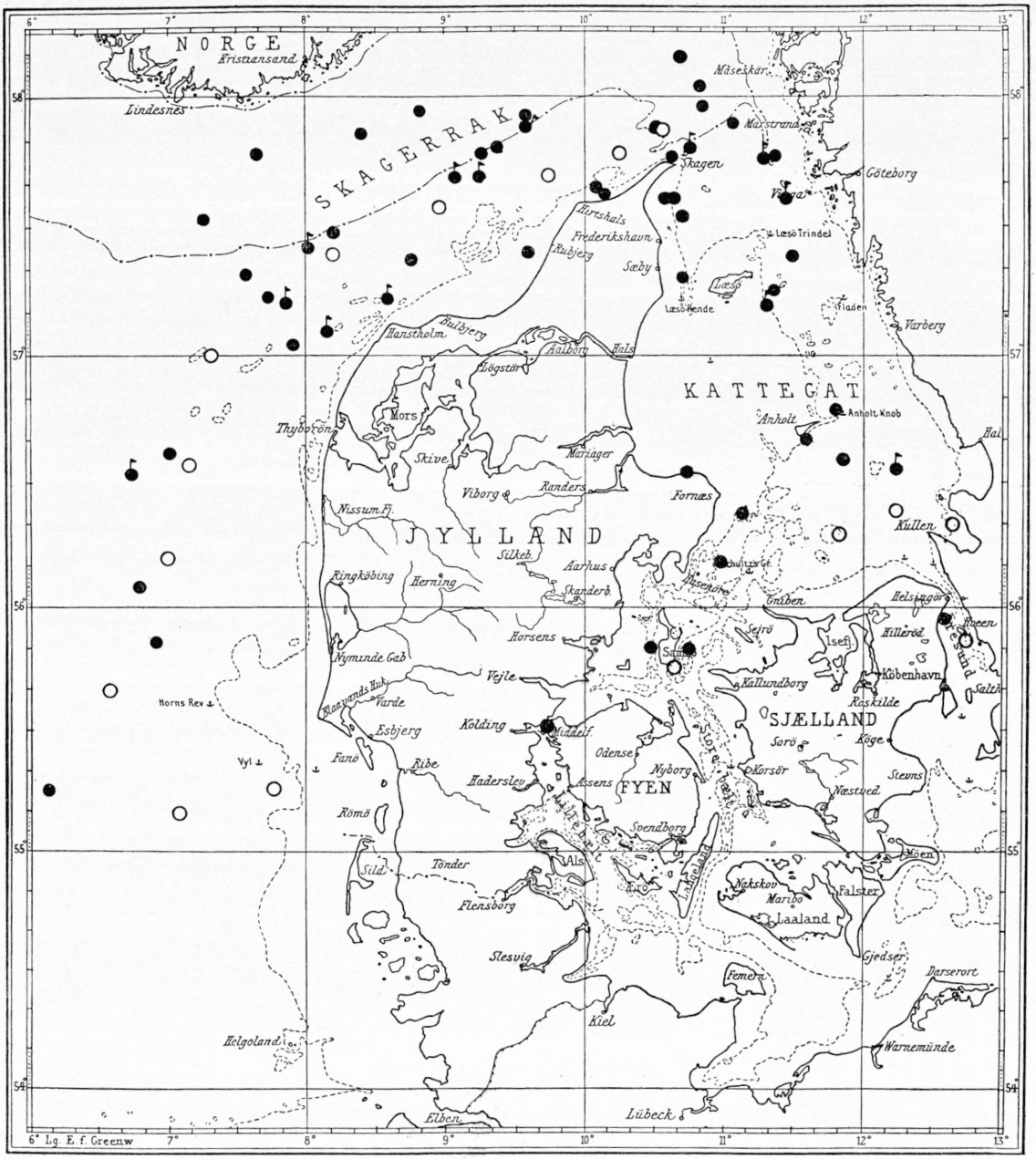

Chart 17. *Tima bairdii*. ⚑ 1922, ○ 1923, ● all other finds known to date.

Skagerrak, as is shown partly by the fact of its being so common here, and further by the frequent finds of young specimens. In the spring of 1923, some young specimens were found in the southern Kattegat; save for this isolated and doubtless unique instance, only large and medium sized specimens have been taken in the southern Kattegat and Belt Sea, as also off the west coast of Jutland S. of Bovbjerg. It is therefore hardly likely that the species should be normally indigenous in these waters.

It will be natural first of all to examine the occurrence of the medusa in the region in which it is indigenous, *i. e.* the Skagerrak and part of the North Sea immediately outside its mouth (for the sake of convenience, this will in the following be understood as included in the term Skagerrak). We find then, to begin with, as regards horizontal distribution, that the species is evenly distributed throughout the whole of this area, and not specially restricted to the deep channel. The data available as to depth of captures show that in the shallower parts, the medusa was mainly taken near the bottom, whereas in deeper waters, it was found mostly in the intermediate or upper water layers, several times, indeed, in the immediate vicinity of the surface. This serves as a guide to the kind of water it frequents. It will be remembered (see hydrographical section, p. 16) that the deep part of the Skagerrak is filled with Atlantic water, salinity over 35 ‰, up to abt. 150—200 m from the surface off the coasts of Norway and Jutland, somewhat nearer the surface in the middle. In this Atlantic water, Tima is not generally found. In those cases where Tima was taken in the surface water, the salinity at that level was as a rule relatively high; the medusa thus evidently also avoids the Baltic water. Its habitat is the "bank water" which lies above the Atlantic water, and is itself, on the northern side of the Skagerrak, again covered by the Baltic water. Hydrographical observations also show that most finds of Tima were made in water of 33—35 ‰ salinity. Also in that part of the Norwegian Channel which extends from the mouth of the Skagerrak to the mouth of the channel itself in the Norwegian Sea, Tima is mainly found at depths between 20 and 100 m below surface, and not in the Atlantic water lower down. — Tima is found in the Skagerrak all the year round (vide infra).

In the shallow part of the North Sea off the west coast of Jutland, Tima is somewhat rare. It was taken in April 1906 (St. 793) and in May 1907 (large specimens). A few young ones (abt. 12 mm diam.) were also taken at the Little Fisher Bank on the 1 Oct. 1922 (St. 2850). On the cruise of the "Thor" in June 1911, Tima was lacking in the North Sea and was not met with until the mouth of the Skagerrak was reached; on the cruise of the "Dana" again, in September—Oktober 1922, it was lacking throughout the closely investigated area between Little Fisher Bank and the coast of Jutland, as far as St. 2859 west of Hanstholm. Inside Hanstholm it was lacking at all stations near the Jutland coast of the Skagerrak, where it had been taken in other years during the spring months. This means that in autumn, it is displaced by the water masses of the Jutland Current.

In May 1923, Tima had an exceptionally wide distribution off the west coast of Jutland. On the Jutland Bank (St. 3013) no fewer than 14 large specimens (30—60 mm) were taken in a $^1/_4$ hour haul with the young fish trawl near bottom (39 m). Large Tima were taken singly at all three outer stations (3010, 3012, and 3013) off the coast between Bovbjerg and Horns Rev; even south of Horns Rev a couple of specimens were found (St. 3006 and 3007). Tima was thus at this time evenly distributed throughout the entire outer portion of the Jutland plateau. In the light of previous records, this is somewhat remarkable, and must undoubtedly be due to importation from the northern parish of the North Sea. But the occurrence of several other species shows that this cannot have taken place for some time previous to the date of the investigations; nevertheless, as all the specimens taken were large, at least 7 months old (vide infra) there is no reason why such importation should not have occurred some considerable time before. Exactly when it took place cannot be determined by a study of the data for Tima alone. True, comprehensive pelagic investigations were carried out off the west coast of Jutland at the end of September and beginning of October 1922, but only along the range north of Nissum Fjord. As already noted, Tima was lacking in this area inside the 40 metre curve until level with Hanstholm; out on the Little Fisher Bank, a few young specimens were taken, but no large ones. This really tells us nothing more than that if the southward drift of Tima down towards the Horns Rev area took place prior to October 1922, it must have passed west of the Jutland Bank and the Little Fisher Bank. This question will be discussed in the General Section, as the occurrence of Tima here, so far to the south, probably has some connection with the simultaneous occurrence of several other northerly forms in the same area.

In the Skagerrak, Tima is found all the year round. It keeps, as mentioned, for the most part to the bank water. In spring, when the "northern" bank water predominates, it may be met with quite close in to the coast of Jutland in rather shallow water. In autumn, when the warmer southern bank water makes its way in, Tima is largely driven to the deeper parts, where the water is still fairly cold, as was distinctly evident on the cruise of the "Dana" in 1922. True, the species was also found at some of the "Dana" stations round the mouth of the Skagerrak, where the temperature was fairly high (12°—13°), but only in small numbers, and all young specimens (less than 12 mm diam.), whereas farther east, and in deeper water, full-grown specimens were taken in abundance, especially at abt. 90 m' depth north and east of the Skaw, where the temperature was only 8°—9°. Since the medusa is thus found mainly at medium depths, it is natural to suppose that the unknown hydroid also lives at medium depths, more especially, we may take it, at abt. 50—100 m. In the western Skagerrak, where the advancing warm water in autumn reaches right down to the bottom even at more than 50 m' depth (see St. 2860 and 2869), the hydroid might possibly be washed by this warm water before it had yet liberated all its medusæ; young medusæ might then be taken in the warm water, while the larger ones followed the retreating cold water out towards the deeper parts.

In the deeper portions of the Kattegat, Tima has often been taken in March—April, *i. e.* at the time when the undercurrent consists mainly of northern bank water. In June 1907, Tima was found close inshore off the north coast of Djursland (St. 1112), and in July 1911, a large specimen was captured E. of Samsö (St. 1657); this was the only specimen of Tima taken in the Kattegat on the cruise of the "Thor" in June—July 1911, and the find is interesting from the fact that this station in particular was found to have an unusually low bottom temperature (7°4). — On the cruise of the "Dana" in October 1922, Tima was found in great numbers in the comparatively cold water (9°6) in the channel off Vinga (depth 85—90 m), both large and small specimens (7—38 mm) being taken here. A few specimens were also taken in the channel SE. of Læsö and near Great Middelgrund; otherwise, the species was lacking in the Kattegat, both as regards the eastern channel and Læsö Channel. Evidently, then, the position in general is as follows: Tima is indigenous not only in the Skagerrak, but also in the northern part of the eastern channel of the Kattegat; in early spring, it is carried hence by the northern bank water down into all the deeper parts of the Kattegat, as far as the northern part of the Belts and the Sound, where it disappears for the most part in summer, keeping only to some few deeper places where the temperature continues fairly low.

In the spring of 1923, however, the occurrence of Tima in the Kattegat was altogether different. In the middle of April, large specimens (35—50 mm) were taken at three stations in the south-eastern Kattegat (St. 2944—2946), whereas the species was entirely lacking in the remaining parts of the Kattegat when investigated during the last few days of the month, owing undoubtedly to the absence of the bank water. The large specimens above mentioned doubtless belonged to an isolated remainder of the imported stock from the previous year. It looks as if individuals of this stock had been able to propagate in the south-eastern corner of the Kattegat, and probably also in the Sound. For at the end of May, besides a large specimen taken in the Sound itself (St. 3055), two young specimens, 10—11 mm diameter, were captured in the bay E. of Kullen (St. 3056). At this time, the bank water had, it is true, passed through the Kattegat and right down through the Great Belt, but the fauna suggests that it had for the time being avoided the grounds about the northern entry to the Sound. The small specimens from E. of Kullen were doubtless hatched in this neighbourhood, and the same probably holds good of four somewhat larger ones (15—25 mm) taken in the Sound on the 24 June in deep water S. of Hveen (St. 3145).

On the other hand, I am absolutely certain that the specimens taken at St. 3061, SE. of Samsö, on the 30 May, must have originated from the Skagerrak. They were found in the bank water which was now flowing in rapidly, and in company with bank water organisms on their way south. True, they were only 11—15 mm diameter, but all the data from May 1923 combine to show that the bank water, when it did, about the middle of the month, make its way into the Kattegat, covered the distance from the Skaw to the Great Belt at an extremely

high rate of speed. The specimens mentioned, of 11—15 mm, would now be presumably a month old (vide infra), so that as far as their size is concerned, there is no reason why they should not have been hatched in the Skagerrak and brought down by the current through the Kattegat.

In determining the life cycle of the species, I have used, for the sake of completeness, not only Danish material, but also that from the west coast of Norway which I examined while with Prof. Damas at Liége. Taken separately, the Norwegian and the Danish material present very nearly the same general view, and as, moreover, both are from adjacent areas with very similar natural conditions, it is surely justifiable to treat the two together. — *Tima bairdii* is found throughout all months of the year. I have not myself had any opportunity of examining material from the winter months (Decr.—Febr.) or from the months of August and September. This is of course a disadvantage, but the material from the remaining months will nevertheless suffice to give us a good view of the life history of the species, and the data found in the literature on the subject confirm on the whole the results at which I have arrived.

I have measured all the specimens I had at my disposal. The measurements are given in the table below.

Sizes of *Tima bairdii* in the different months of the year.

Diam. mm	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
5	....	....	....	....	1	2	5	....	....	14	....	....
10	....	....	....	....	4	3	2	....	....	14	....	....
15	....	....	....	....	1	2	2	....	....	9	....	....
20	....	....	2	1	....	1	1	....	....	6	3	....
25	....	....	5	1	....	1	1	....	....	20	3	....
30	....	....	4	1	6	1	....	....	....	10	2	....
35	....	....	2	5	12	1	1	....	....	7	2	....
40	....	....	....	4	14	....	1	....	....	2	....	....
45	....	....	3	1	10	....	1	....	....	1	....	....
50	....	....	....	2	7	....	....	....	....	....	....	....
55	....	....	....	....	6	....	....	....	....	....	....	....
60	....	....	....	....	2	....	....	....	....	....	....	....
65	....	....	....	....	2	....	....	....	....	....	....	....

Young specimens (4—20 mm diameter) have been taken from May till October, but not at other seasons. From this we may conclude that the hydroid begins to liberate medusæ in May, and continues throughout the summer and autumn until October. The numbers of specimens given in the table cannot of course be taken as representative; they afford, however, a clear idea as to the characteristic phases of distribution into size classes as the year goes on. The table shows that

in May, June, and July both small and large specimens are met with, and there is, especially in May, a distribution into two size groups, which must be age groups, as young specimens are lacking during the preceding period. In October, we find specimens within the same range of variation as in July, but there is a notable difference in their distribution, specimens of medium size being predominant in October. These are evidently the ones hatched in June and July, which have now attained a size of abt. 25—30 mm. Whether the few large specimens of 40—50 mm belong to the same generation is perhaps doubtful; they are probably stragglers from the same batch as the large specimens taken in July. For November there is not much material available, but it can hardly be accidental that all the specimens investigated are of medium size, 20—40 mm; it looks as if the liberation of young medusæ had now ceased, and the last large ones of the previous generation had disappeared. As to the appearance of the stock in winter I cannot say anything definite, but all the records from the east coast of Great Britain agree in stating that large specimens may be met with as late as January, after which the species disappears. In the area where the species is indigenous, the medusa remains far longer. It is still common in May. In March and April, both medium sized and large specimens are found; in May a few small ones and for the rest only large, over 30 mm. The sex-propagation of the medusæ evidently takes place in March—May, giving rise to a hydroid generation, which in May begins to liberate a fresh generation of medusæ. In the course of May, most of the old medusæ disappear, but a few hatched exceptionally late, or of unusually slow growth, may be met with occasionally throughout the summer, perhaps even in October.

Since the first young medusæ appear at the end of May, and large, mature specimens may be met with in January, it follows that the medusa must be capable of developing to its full size and attaining maturity in the course of about seven months. The same result is arrived at by consideration of the material I have investigated from October and May; even in October, but not later, a few young specimens are found; in May, most of the full-grown individuals disappear — which also gives a minimum period of development of about seven months. The comparatively large number of medium-sized medusæ in October however, suggests that the liberation of medusæ proceeds more rapidly during the summer months than in October, so that some of the large specimens found in May are more than 7 months old. And we also find that large specimens are sometimes taken even towards the end of summer. It seems to me likely that the facts are as follows: The medusa can attain full size and maturity in the course of abt. 7 months from the time of its liberation from the hydroid; the normal span of life, however, is nearer 9 months, and may even extend to 11 or 12. — To give some idea of the growth I have here drawn up a small table showing the percentages of small, medium sized, and large specimens at the different seasons; I must expressly point out, however, that the figures are not to be taken as giving any precisely accurate expression of the actual numerical conditions, but are merely an approximate indication.

	Summer VI—VIII.	Autumn IX—XI.	Winter XII—II.	Spring III—V.
% small specimens (< 20 mm)	64	40	?	5
% medium sized specimens (20—40 mm)	28	56	?	41
% large specimens (> 40 mm)	8	4	?	54

Summary.

The unknown hydroid form of *Tima bairdii* presumably lives at a depth of 50—100 m on the slopes of the Norwegian Channel and in the north-eastern Kattegat. It liberates its medusæ from May to October. The medusæ are of slow growth, attaining full size and maturity in the course of 7—12 months, after which they disappear. The medusæ keep mainly to the bank water of the Skagerrak, especially in its lowest layers nearest the Atlantic water. In spring, the medusæ are carried by the "northern" bank water either in towards the Jutland coast of the Skagerrak, or down into the channels of the Kattegat; at times right through into the Belts and the Sound. They may also be carried southward along the west coast of Jutland, but will then keep some considerable distance out from the shore. The entire behaviour of the species marks it as a cold water form.

Trachymedusæ.

Fam. *Aglauridæ.*

Aglantha digitale (O. F. Müller).

Charts 18—19.

Aglantha digitale is the only Trachymedusa hitherto known from Danish waters. — I cannot here enter upon a general discussion as to the various forms or species of Aglantha; only the two north-European forms, *digitale* (O. F. Müller) and *rosea* (Forbes) need be mentioned. They are regarded by some authorities as well separated species, which, according to the earlier descriptions, may be distinguished one from the other partly by their size (*digitale* is larger than *rosea*), partly by the number of marginal sensory organs, of which *rosea* is said to have 8, *digitale* only 4. Actually, however, we may find any number from 4 to 8 in one and the same form, so that this character is not a reliable means of distinction. I am unable to give any information as to the number of these organ in the Danish Aglantha, as they nearly always disappear when the specimens are preserved, and I have had no opportunity of making a thorough investigation of living material.

I am rather inclined to regard them as varieties of one and the same species, *A. digitale* (O. F. Müller). The large one (forma *typica*) is a deep water form, and

has, like many other deep water medusæ, a particularly powerful musculature, which is as a rule distinctly discernible in preserved specimens, where it shows up more especially along the sides of the 8 radial canals. This powerful musculature, in conjunction with the height of bell relative to development of the gonads, will as a rule suffice as a means of distinguishing f. *typica* from var. *rosea*. In a large collection of indubitable f. *typica* from the Skagerrak, however ("Thor" St. 273), the powerful musculature was lacking in some of the specimens; this was doubtless due to preservation, and applies to large and small specimens alike.

Forma *typica* attains a size of 25—30 mm (height of bell). In the Skagerrak, the gonads begin to appear as very small dots at a height of 12—15 mm. The deeper parts of the Skagerrak are the only portion of our waters where this form is indigenous; otherwise, it is distributed throughout the arctic and subarctic regions.

Var. *rosea* is a southern form; as far as is known up to the present, its European distribution ranges from the shores of Britain northward to the Færöes and Lofoten, southward to the Straits of Gibraltar (Kramp 1924). — In our waters, distinction can further be made between two forms of this variety, a larger one inhabiting the North Sea and upper water layers of the Skagerrak, and a smaller found in the Kattegat and Belt Sea.

The form which lives in the North Sea and Skagerrak attains a height of 16 mm. The gonads begin to appear, as dots, at a height of 3—4 mm, and may have the same appearance even in specimens 8—9 mm high, but are rarely found so in those over 6 mm. As a rule, the gonads begin to develop in length as soon as the bell is 4—5 mm high, after which their rate of growth varies considerably; we may find, for instance, gonads 3 mm long in specimens 6 mm high, while specimens of 12 mm not infrequently have gonads only 2 mm long. The commonest length of gonads in proportion to height of bell is as follows:

Height	8 mm	Gon.	2—3 mm
—	10 mm	—	3—4 mm
—	12 mm	—	4—5 mm
—	14 mm	—	4—5 mm

Once the individual has attained a height of abt. 12 mm, the gonads do not seem to increase in length; 4—5 mm is then the commonest length. They may at times grow longer (6—7 mm) but this may take place both in smaller and larger specimens. Individuals of 14—16 mm have often lost their gonads, their genital products being presumably exhausted. — In this form, the fully developed gonads are of a rich lemon yellow; the walls of the bell, and the stomach, are a pale rose.

The form of *Aglantha* indigenous in the Kattegat and Belt Sea hardly grows to more than 12 mm in height. The size at which the gonads begin to appear varies considerably, punctiform gonads being sometimes still present at a bell height of 8 mm, but occasionally making their appearance, when the specimen is only $2^1/_2$ mm

high, as a rule at a height of 3—4 mm. In specimens 8 mm high, the gonads are generally 1—2 mm long; in those of 10 mm they are 2—3 mm, and in full-grown specimens 3—4 mm. — The Kattegat form is as a rule altogether colourless, the gonads mostly whitish, but at times with a faint yellowish tinge.

Works dealing with *Aglantha digitale* in Danish waters.

Though *Aglantha digitale* is very common in most of our waters, it is not mentioned in the literature until rather late. Apart from F. E. Schulze (1875, p. 138, *Circe rosea*), who notes it from the south coast of Norway (Lindesnes 25 July 1872), I know of only the following records of Aglantha as found in the waters round Denmark: Johansen & Levinsen 1903 (vide infra), Broch 1905 (p. 8, *A. digitalis*, Sandnæsfjord, in May; *A. rosea*, Söndeledfjord and Risör in March—May and September); Internat. Pl. Catal; Kramp 1913 (Resumé planktonique, pp. 527—530, chart Pl. XCVI; common in the North Sea, Skagerrak, and Kattegat at all seasons, found at some few localities in the Great Belt as far as Femern Belt in May); Kramp 1915 (everywhere from Langelandsbelt to Læsö Channel). Strangely enough, Aurivillius (1898 a) has not found this medusa in the Skagerrak, a point which he particularly notes (p. 83).

The partial distinction between the two forms, *typica* and *rosea*, introduced in the International Plankton Catalogues, is hardly to be relied on. Johansen & Levinsen (1903) make no attempt to distinguish between them, but take them together (p. 281). According to these writers, Aglantha is found in the Kattegat and Skagerrak at all seasons, with a minimum frequency in Jan.—March; it is occasionally carried southward by the currents right down into the Belt Sea, and has even been met with in the southern portion of the Little Belt, S. of Lyö. The writers add that young specimens are found at all seasons of the year. We shall see in the following how far this is confirmed by more recent investigations.

Forma typica.

Material.

1904. "Thor" St. 188, 30 miles SE. of Oxö light, 17 Feb., depth 210 m, Ytr., near bottom, 7 spec., height 12—15 mm.
"Thor" St. 273, 42 miles NW. of Hirtshals, 9 Oct., depth 640 m, Ytr. intermediate depth, 297 spec., height 6—15 mm.
1911. "Thor" St. 1571, 44 miles N. by W. of Hirtshals, 24 June, depth 635–660 m, Hensen net 550—0 m, 4 spec., height abt. 11 mm.
1922. "Dana" St. 2895, 46 miles N. by W. of Hirtshals, 11—12 Oct., depth 650 m, Ytr. 1000 m wire, 16 spec., height 10—12 mm.
1923. "Dana" St. 3038, Læsö Channel, 14 May, depth 20 m, Ytr. 35 m wire, 1 spec., height 17 mm.

In Table XIII will further be found some records, from the journals of the "Thor", which, to judge by the locality and depth, would seem to refer to f. *typica*, *viz.* St. 190, 213, 224, 286, 621, 938, 939, 1039, and 1076.

As will be seen, there is but very little preserved material of f. *typica*, all from the deep channel of the Skagerrak, save for a single specimen from Læsö Channel ("Dana" St. 3038, May 1923); this one measured 17 mm in height, and had the powerful musculature characteristic of f. *typica*, the gonads being only 3 mm long. This unique find of *Aglantha digitale* f. *typica* in the Kattegat would be highly remarkable in any other year than 1923, when, as repeatedly noted in the foregoing, the salt bottom water of the Skagerrak increased so greatly in volume that it flowed in and filled all the deep channels of the Kattegat. The bottom salinity at St. 3038 was 33.3 ‰, temp. 6°0. At the other stations here noted, the salinity varies from 34.4 to 35.1 ‰, the temperature from 5°1 to 6°0.

Aglantha digitale f. *typica* is indigenous in the deep channel of the Skagerrak, where it keeps to the deep and intermediate water layers, in the Atlantic water, and evidently ascends but very rarely to the bank water above.

Var. rosea.

Survey of Material.

1903. "Thor" St. 17, NE. of Læsö, 12 March, 2 spec., height 6—7 mm.
1904. "Thor" St. 186, WNW. of Hirtshals, 17 Feb., 1 spec., 5 mm.
1909. Spodsbjerg, Langeland, 28 April—3 June, mainly in the lower water layers, very scarce.
Stations of the "Karen", 22—28 April, not common in the Great Belt, numerous in the Kattegat, especially Aalborg Bay (Kramp 1915).
1910. Schultz's Grund Lightship; lacking 1—13 Aug., then taken nearly every day until 14 Sept., mostly in the lower water layers, always in small numbers (Table VII).
North coast of Sealand, 26—29 Oct., scarce (Table XIII).
1911. Horns Rev Lightship, only 10 July—18 Sept., rather scarce except 21 Aug. (Table V).
Anholt Knob Lightship, in nearly all hauls all the year round except in Jan. and Sept., scarce (Table VI).
Schultz's Grund Lightship, from the beginning of the collection work on 14 May to 19 Sept. and again 14 Novr.—12 Decr., scarce, only in interm. and lower water layers (Table VIII).
"Havörnen" 11—15 May, at all stations in the Kattegat, numerous in the vicinity of the Skaw, otherwise rather scarce (Table IX).
Cruise of the "Thor", 17 June—17 July, lacking S. of Horns Rev, but otherwise taken nearly everywhere in the North Sea, Skagerrak, and Kattegat (Table X).
Motor boat from the "Thor", 3—10 Aug. along the west coast of Jutland, a few small specimens at four stations from Nymindegab to Rubjerg Knude (St. 1681, 1711, 1713, 1717).
1912. Horns Rev Lightship, 22 July, 5 Aug., and 23 Sept. (Table V).
Anholt Knob Lightship, regularly from 21 Feb. to 1. June, otherwise only 15 Sept. and 1 Dec. (Table VI).
Schultz's Grund Lightship, 19 March—11 June and 29 Oct.—5 Novr., rare, only in interm. and lower water layers (Table VIII).
1913. Horns Rev Lightship, 27 Jan. and 24 March; in nearly all hauls 16 June—11 Novr., numerous in August and October (Table V).
Anholt Knob Lightship, 17 Jan.; 1 April—1 July; 1 Oct.—1 Decr. (Table VI).

Schultz's Grund Lightship (collection begun 19 Aug.), 14 Oct.—16 Decr., in all hauls from 26 and 16 m to surface, also in some of the hauls from 8 m, small numbers (Table VIII).

1914. Anholt Knob Lightship, 15 Jan. and 1 April (Table VI).
Schultz's Grund Lightship, 3 and 31 March (Table VIII).
"Havörnen", Skagerrak, 4—5 April, at all the four stations (between Oxö and Hanstholm), only in the upper 50 m (see General Section, p. 177).

1916. Middelfart Sound, 17 and 18 Jan.
Nyborg, 10 April, Biol. Stat.

1920. Limfjord, at Örodde, near Nyköbing, 17 March, a couple of quite small specimens, abt. 1 mm (R. Spärck).
E. of Slipshavn, Great Belt, 13 April, Ytr. intermed., 2 spec., 5—8 mm (Biol. Stat.).

1922. Cruise of the "Dana", 28 Sept.—19 Oct. At several of the stations off the northern part of the west coast of Jutland and NW. of Hanstholm, scarce (St. 2839—2863); in the Skagerrak only at St. 2906, 2898, and 2892; extremely rare in the Kattegat (St. 2889, 2886, and 2878 in the eastern channel). All in hauls with Ytr. near bottom (Table XI).

1923. Cruise of the "Dana" (Table XII and Chart 18):
1 April, Jammer Bay, St. 2937.
17—29 April, at most stations in the Great Belt and Kattegat, and eastern part of the Skagerrak, scarce.
20 April—9 May and 15—16 May, at nearly all stations in the Skagerrak and North Sea, scarce near land, numerous at most of the outer stations.
13—19 May, numerous in Aalborg Bay, rather scarce in other parts of the Kattegat.
28 May—5 June, at nearly all stations in the Sound, southern Kattegat, Belts, and western Baltic, to east of Gjedser (St. 3082).
24 June, the Sound (St. 3145).

Aglantha is further noted in the journals of the "Thor" from the following seasons: March, April, Sept., Novr. 1903. — Feb., March, Oct. 1904. — March, April, Oct., Novr. 1905. — March, April, Oct. 1906. — April, May, June 1907. — 29 April —1 May 1908. — 8 May 1912. — See list, Table XIII.

As regards the horizontal distribution in Danish waters, we may briefly say that *Aglantha digitale* var. *rosea* is found regularly everywhere throughout the North Sea, Skagerrak, and Kattegat. In the Belt Sea on the other hand, it is not always present. The charts show all finds in the Belt Sea hitherto recorded, with the year. In the Sound, *Aglantha* has only been taken twice: in Oct. 1910 and June 1923. It is often found in the Bay of Samsö and the Great Belt, but by no means every year. I have already noted that the International Plankton lists give Aglantha as occurring everywhere throughout the Kattegat at all seasons of the year, but in the Belt Sea only in May (1903, 1905, and 1909, see Kramp 1913a; in May 1906 it went right down into the Femern Belt). The remaining finds of *Aglantha* in the Belt Sea are mainly, though not exclusively, from the spring months. Johansen & Levinsen (1903) note it from Knudshoved in the Great Belt in Oct.—Novr. 1899 and April 1901, and from Lyö, in the southern part of the Little Belt in June 1902. In the spring of 1909, Aglantha appeared now and again in the Langelandsbelt (off Spodsbjerg); on the cruise of the "Karen" in April, it was taken in the Great Belt (near Nyborg) but was lacking at the two stations south of Langeland. In the spring of 1911, it

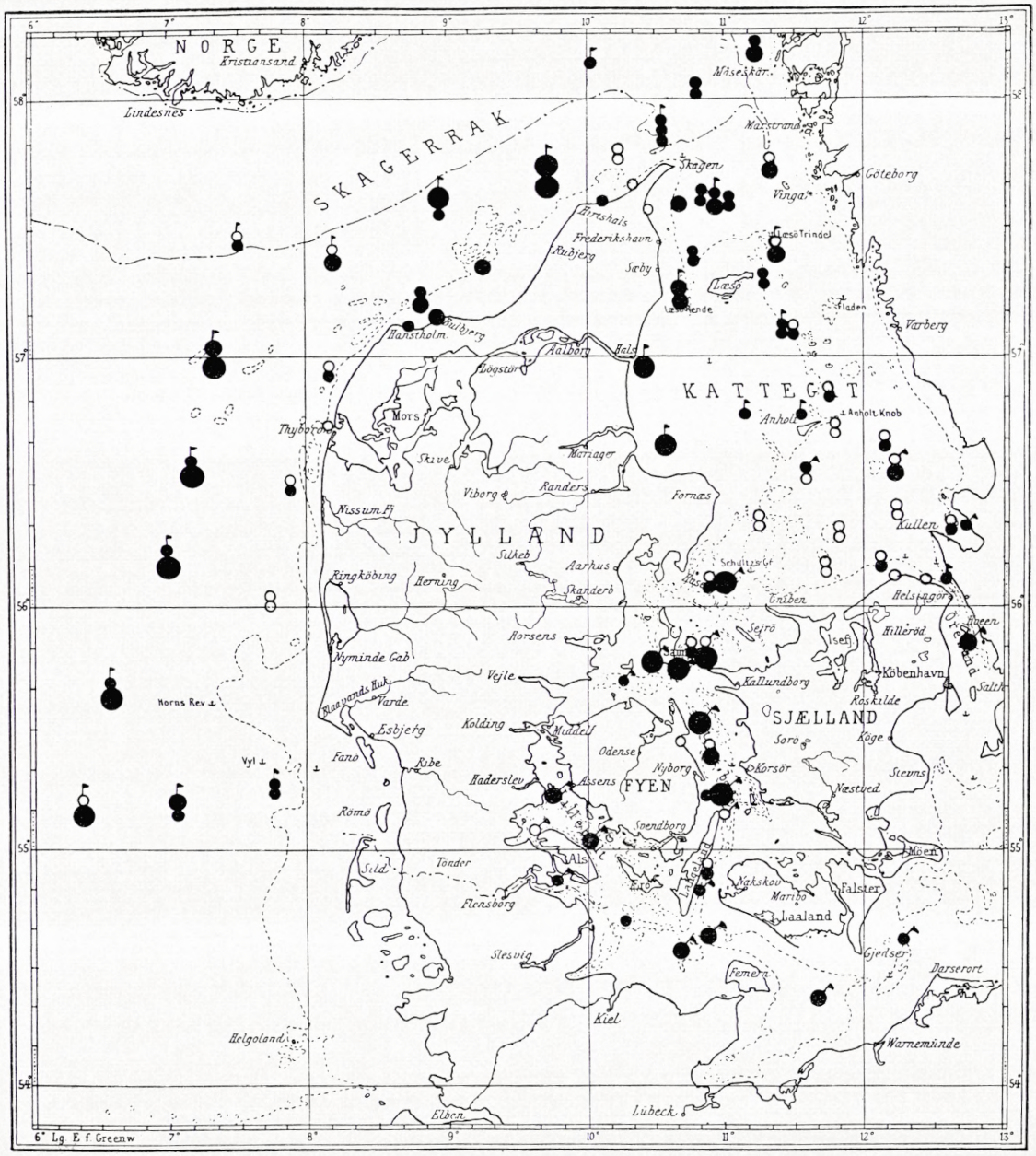

Chart 18. *Aglantha digitale*. Occurrence on the cruise of the "Dana" 17 April—5 June 1923. In the Baltic, only positive finds of the medusa are noted here; in the other waters, all pelagic stations are marked on the chart. Two circles, one on top of the other, denote hauls made in the upper and lower water layers, Blank circles indicate that the medusa was not taken in the hauls so marked; the three different sizes of filled circles represent the frequency of the species.

○ = St. 2944—3004, 17 April—2 May.
♂ = St. 3006—3054, 5—19 May.
♂ = St. 3055—3082, 28 May—5 June.

did not move down into the Belts. — In May 1912, according to the journals of the "Thor", it was taken west of Samsö, but not in the Belts. — In the course of my investigations in Middelfart Sound in 1915, I never found Aglantha; a few specimens appeared, however, in January 1916. In the Great Belt also, the species was lacking in 1915, but in April 1916 a host of full grown individuals came in to the Biological Station at Nyborg; in the channel east of Nyborg, Aglantha was found in April 1920, but was lacking in April 1921. — Aglantha is very rarely met with in the western Baltic; according to the "Thor" journals, a single specimen was taken in the young fish trawl SE. of Femern on the 1 May 1908. In April 1923 (see Chart 18), some specimens were taken S. of Ærö ("Dana" St. 2973) and the medusa was not altogether rare in the Great Belt; about 1 June it was found in considerable numbers everywhere throughout the Belt Sea, even passing through Kadetrenden some way into the Baltic proper; an occurrence which is doubtless unique, due to the unusual hydrographical conditions.

Vertical distribution. Var. *rosea* does not appear to go down into the Atlantic bottom water of the Skagerrak; it keeps to the lower water layers above this, and preferably, to the lower parts of these. In all other parts of our waters, Aglantha is found for by far the greater part in the deepest and intermediate water layers; it is rarely taken at the surface.

Breeding season. It is impossible to give the actual figures for frequency of Aglantha at the different seasons, and numerical proportions of the different size groups, as none of the implements hitherto employed has been capable of taking a representative sample of the stock at a given time. The young medusæ are so small that they pass through the mesh of the larger nets, while on the other hand, larger specimens are very rarely taken in the silk nets (Hensen net, Nansen net etc.). Aglantha is an excellent swimmer; its slender shape, somewhat pointed at the top, and its powerful muscles, enable it to cover many times its own length in a small fraction of a second, by a single muscular contraction; and such movements are made in rapid succession. If a fairly well grown Aglantha, with unimpaired vitality, be placed in a basin of sea water (without too many obstacles in the form of other organisms), it will, when one attempts to capture it, dash about so rapidly that it is often hard to catch, even with forceps; the moment one move to grasp it, it is several centimetres off. The larger individuals are thus easily able to escape the nets, and we also find that the material from vertical hauls consists predominantly of small specimens, from abt. $^1/_4$ mm up to 4 or 5 mm height of bell. We can, however, draw some conclusions from the material available, sufficient to give a reliable general view of the life cycle of the medusa.

To begin with, we have to bear in mind that Aglantha is a Trachymedusa, and as such, propagates directly (*i. e.* without alternative generations). The questions then arise: At what season of the year does propagation take place? What is the rate of growth of the medusæ? How many generations are produced in the year? — The first question may for the present be answered as follows: since small speci-

mens are met with all the year round, it follows that breeding can take place at all seasons. Whether it is equally intensive all the year round is another matter. — The two remaining points may be dealt with as one. The production of more than one generation in a year presupposes rapid growth of the individuals; this would be indicated in the plankton by the fact that the proportion of young and full-grown specimens was more or less the same at all seasons. Supposing the development of the individual to occupy about a year in itself, so that only one generation could be produced in the year, then two possibilities suggest themselves: given a propagation of uniform intensity throughout the year, we should then again find about the same proportion of small and large specimens at all times. On the other hand, with a more or less pronounced maximum of propagation at some particular season, then the distribution of size groups should exhibit a phase dislocation recurring regularly every year; full-grown specimens would be found chiefly at the time when the propagation maximum set in; quite young specimens would have their maximum frequency immediately after, decreasing to a minimum just before the next propagation maximum. — If the present material consisted of truly representative samples, it would be a very simple matter indeed to answer all these questions. As already mentioned, however, we are not so fortunate. I consider nevertheless, that it is possible, from the data available, to formulate conclusions sound enough for a reliable result. Let us first consider the material from the vertical hauls.

At Horns Rev Lightship, only small specimens were taken, 4—5 mm at the outside; in 1911 and 1912, they were only taken in the months of July—Sept.; in 1913, the species was present nearly all the year round, though very scarce in the first half of the year, but common in July—Oct. — At Anholt Knob Lightship, young Aglantha have been present every year in nearly every month, generally in but small numbers, but in 1911 and 1912 with a distinct maximum in May and June; the few larger specimens (6—8 mm) taken here are all from the months of March—June. Altogether, whenever large specimens are taken in a Nansen net, we may assume that they were exceptionally numerous in the water at the time. I may add that at Anholt Knob, a remarkable number of very small specimens, abt. 1 mm or even smaller, appears in summer, whereas during the last three months of the year we find mostly individuals of 2—4 mm. We see then, that the lightship material alone already suggests an annual maximum of larger individuals in the spring, young specimens having a maximum which in the Kattegat falls about midsummer, in the North Sea a little later. This impression is confirmed by the material from the vertical hauls made with the Hensen net on the cruises of the „Thor" and "Havörnen" in 1911. In the North Sea and Skagerrak in June, there were numerous young specimens and some large, up to 10 mm; in July (in the Skagerrak) none over 4 mm, and most quite small, abt. 1 mm. In the Kattegat, a conspicuous change was observed during the period from middle of May to middle of July; in all three months (May, June, and July) young specimens were common; in May, there were also not a few larger ones (5—10 mm), in June only one here

and there, and in July, none over 4 mm, most being less than 3 mm. — All this seems to me to show beyond question that Aglantha takes about a year to complete its cycle of development, and that the majority of the medusæ are hatched in spring and early summer, attaining maturity in the following spring, and disappearing then as soon as they have given birth to the new generation. The propagation maximum falls, as regards the Kattegat, in April—June; in the North Sea May—July.

If this be correct, then it should also be apparent in the material of larger specimens taken in horizontal hauls with the canvas nets; and this also proves to be the case. — In the North Sea and Skagerrak, Aglantha was not particularly common on the autumn cruise of the "Dana" in Sept.—Oct. 1922, and none of the specimens taken measured over 11 mm, most being abt. 4—7 mm (small ones were doubtless numerous, but passed through these nets); in the following May, on the other hand, large numbers of Aglantha were captured, and the great majority were very large, 10—16 mm. In the Kattegat, the position was even more distinctly apparent; in October 1922, only a few isolated specimens of Aglantha were taken, the largest only 5 mm; in April and May 1923, on the other hand, the great majority of the specimens measured 5—12 mm.

As to the vertical distribution of small and larger specimens, I can say nothing with certainty; at Schultz's Grund, Aglantha is hardly ever taken in the upper water layers, and the remaining material from vertical hauls gives no data as to depth at which the specimens were taken.

Occurrence and Distribution in different Years. Influence of Hydrographical Conditions.

1. Occurrence at the lightships.

There is a conspicuous difference in the frequency of Aglantha at Horns Rev Lightship in the three years 1911—13; in 1911 and 1912, it was taken only in July, August, and September, and in 1912, it was scarce in all these three months; in 1913, on the other hand, it was taken nearly all the year round, and was fairly common, sometimes even numerous, in July—Oct. — The variations of temperature and salinity within the ranges recorded for Horns Rev cannot be supposed to have any appreciable influence on the occurrence of Aglantha, nor does any such appear from an examination of the hydrographical data; on the other hand, the difference in frequency above noted seems to have some connection with the prevalent direction of the currents. Below will be found a table showing frequency of the medusæ for the months June—Novr. in the three years, together with the resulting mean current per month at the surface for the same period. The mean directions for in- and outflowing currents at Horns Rev Lightship are towards N. 22 W. (north-going) and S. 21 E. (south-going); the direction changes as a rule several times a day, but the resulting current is practically always in a northward direction; and inasmuch as the observations of temperature and salinity show no conspicuous difference as

between surface and bottom, we may take it that the direction of the current is uniform throughout all water layers.

Occurrence of *Aglantha* at Horns Rev Lightship June—Novr. 1911, 1912, and 1913.

	Month	VI	VII	VIII	IX	X	XI
1911.	Current, cm/sec.[1])	÷ 4.3	÷ 5.1	÷ 2.7	÷ 12.4	÷ 13.1	÷ 24.2
	Frequency of Aglantha	0	+	c	r	0	0
1912.	Current, cm/sec.	÷ 13.3	÷ 10.7	÷ 36.4	÷ 4.6	÷ 23.6	÷ 20.1
	Frequency of Aglantha	0	r	rr	rr	0	0
1913.	Current, cm/sec.	0.3	÷ 0.1	5.5	÷ 4.7	÷ 4.5	÷ 25.8
	Frequency of Aglantha	r	+	c	+	c	r

In 1911 and 1912, the current at the lightship was on the whole rather strong, in a northerly direction. Aglantha was taken during these years only at those times when the young specimens are most numerous, and was only common in Aug. 1911, when the resulting current was particularly weak. In 1913, the north-going movement of the water was extremely weak right from April till October; in April, June, and October, indeed, there was so much water coming in from the north that the resulting current was south-going, the only instances of a south-going mean current at Horns Rev in 1909—13. It is interesting to note that in November, when a very strong northward current set in, Aglantha disappeared from the plankton altogether before the middle of the month. Aglantha is evidently not constantly indigenous over the coastal bank at Horns Rev, and we now see that when it appears there, it is as a rule with a south-going current; this agrees very well with the distribution noted on the cruise of the "Thor" in June 1911, when Aglantha was altogether lacking at stations south of Horns Rev and on the bank itself, but was found almost everywhere from the northern edge of the reef and north of there. — There is really much to be learned from the occurrence in August 1913, inasmuch as it shows how careful one should be in making use of individual current observations. The resulting mean current for August was south-going, and was indeed, particularly strong, but on all the days when Aglantha was taken in numbers during this month, the current happened at the moment of observation to be flowing in a northerly direction.

At Anholt Knob Lightship, the occurrence of Aglantha exhibits no very pronounced fluctuations, and there is no apparent connection with the hydrographical conditions; nor, indeed, could this be looked for, since the species is constantly indigenous in the surrounding waters.

At Schultz's Grund Lightship, which lies near the entry to the Belt Sea, we should be more likely to look for some correlation between the frequency of Aglantha and the hydrographical conditions. Careful examination of the facts, however, shows that the influence of these is but slight, though there is a suggestion

[1]) ÷ = north-going current.

that with an exceptionally powerful inflowing current, Aglantha is somewhat more frequent than with a weak current at the same time of year. (In accurate counting of specimens, it is always neccessary to reckon with the fact that the "vertical" hauls take a larger number of specimens in a strong current than in a weak one, as the stronger current deflects the net from its vertical course, and the amount of water passing through is thus increased; this source of error is not so much in evidence when using only the customary symbols for frequency). The occurrence in the upper water layers in Novr. 1913 is evidently connected with a comparatively strong inflowing current and correspondingly high salinity of the surface layers. From 25—28 Aug. 1910, some Aglantha were also taken in the hauls from 10—0 m; the salinity in the upper 5 metres was not particularly high, but at 10 m' depth, a sudden and marked increase in the salinity occurred during these days (from 17.7 ‰ on the 24 Aug. to 24.3 ‰ the day after); this indicates that the boundary layer was raised somewhat more towards the surface; the Aglantha found must then presumably have been living in the boundary layer. Even at Schultz's Grund, Aglantha is evidently constantly indigenous, though the numbers are occasionally increased when any exceptional inflow of water takes place from the north.

II. Distribution inward towards the Baltic.

Aglantha digitale being a holoplanktonic medusa, with direct propagation, we cannot, as with the meroplanktonic Antho- and Leptomedusæ, take the occurrence of young specimens as a means of determining whether the species is indigenous in a given water or not. We have to take another standard: in those areas where Aglantha is indigenous, it must be capable of occurring at all seasons; if it only appears now and then, we may take it as highly probable that it is not indigenous, but that its occasional occurrence is due to importation by the currents. In view of what has been noted above as to the occurrence in the Belt Sea, we may say for certain that the southern limit of its constant occurrence in our inner waters lies approximately at the northern entry to the Belt Sea, including the Bay of Samsö (within a line from Hasenöre to Gniben). The question then is, what are the factors which determine this limit of occurrence? It is natural to think first of the lower salinity as the most important limiting factor in this case. Johansen & Levinsen (1903, p. 281) give the lowest salinity at which Aglantha has been taken in Danish waters as 19 ‰ (Knudshoved, 20 Oct. 1899). Below will be found some of the lowest salinities at which it has since been found. Where the material is derived from vertical hauls, the figure given is the highest salinity recorded in the column of water in which the medusa was taken. As will be seen, Aglantha has been taken several times at salinities between 18 and 20 ‰, in some few cases even lower, down to 13.4 ‰. It is highly probable that the salinity fixes the boundary for the absolute advance of the species towards the Baltic; but since the medusa is capable of living at such low salinities as those here noted, we should expect to find it far more frequently in the Belt Sea; in the western Baltic, the mean salinity

at 20 m' depth in May is 18—19 ‰; in August 20—23 ‰. On the cruise of "Havörnen" in 1911, the occurrence of Aglantha stopped at St. 1523, NW. of Revsnæs, where the bottom salinity was 31.5 ‰; it was lacking at the two following stations, though the bottom salinity there was 29.0 and 31.1 ‰; *i. e.* abundantly sufficient for the species to thrive there. On the cruise of the "Thor" in the same year, it was taken in the Bay of Aarhus, where the maximum salinity was only 20.1 ‰, but was otherwise lacking everywhere throughout the Bay of Samsö, though several of the stations showed salinities of 31—32 ‰. This looks as if it were not the lower salinity which keeps Aglantha out of the Belt Sea. I think myself that it is rather the slight depth of this water which renders it less suitable as a permanent habitat for Aglantha. As we have seen, this medusa keeps mainly to deeper water; off the west coast of Jutland, it is generally rare close inshore, but numerous farther out; even at Horns Rev, where the salinity at any rate is high enough, it is not of constant occurrence. Evidently, Aglantha requires comparatively deep water for propagation; it is frequently carried by the currents to shallower waters, including the Belt Sea, but cannot make its permanent home there. The fact that it was found in Middelfart Sound on the 17 Jan. 1916 with a north-going current, and S. of Ærö on the 23 April 1923 at a time when there was almost certainly no inflow of water from the Kattegat, might suggest that it occasionally settles for some time in the deep basin of the western Baltic; these cases are, however, evidently exceptional.

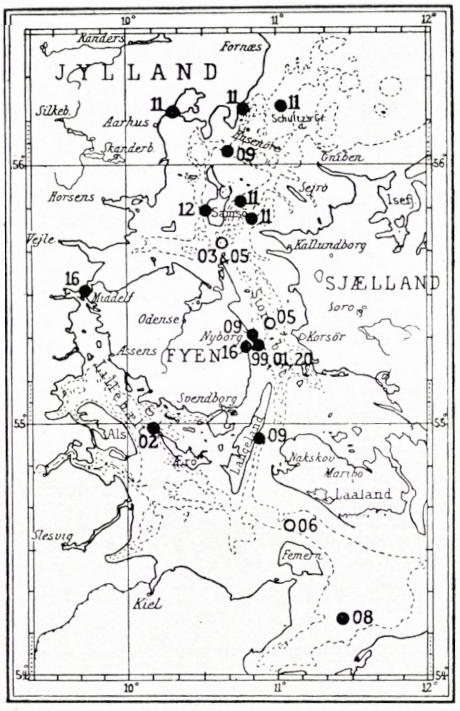

Chart 19. *Aglantha digitale*. Finds hitherto known from the Belt Sea, with the year (1899—1916). Blank circles denote finds according to the Bulletin Planktonique. For finds made in 1923 see Chart 18.

Some occurrences of *Aglantha digitale* in the Belt Sea at low salinities.

1906.	1 May, N. of Femern, St. Da. 32	18.5 ‰
1908.	1 May, SE. of Femern, "Thor" St. 1207	20.6 ‰
1909.	29 April, Spodsbjerg, Langeland, 10—0 m	18.7 ‰
	30 — — — — m	17.2 ‰
	12 May — — — m	19.7 ‰
1911.	10 July, Aarhus Bay, "Thor" St. 1630	20.1 ‰
1916.	16 Jan., Middelfart Sound, Surface	21.3 ‰
	17 Jan., — — —	20.0 ‰
1923.	23 April, S. of Ærö, "Dana" St. 2973	13.4 ‰
	24 April, E. of Vresen, "Dana" St. 2975	18.9 ‰
	5 June, E. of Gjedser, "Dana" St. 3082	21.4 ‰

A few words remain to be added as to the occurrence in the western Baltic in 1923. In April, some few specimens of *Aglantha* were taken, as already noted, S. of Ærö and in the Great Belt; it was rare, however, even in the Bay of Samsö. Consequently, this cannot explain why it should, about 1 June, have been fairly common everywhere throughout the Belt Sea, even passing in through Kadetrenden; moreover, several of the specimens were rather large (10—12 mm) though with rather small gonads. Most of them must doubtless have come from the Kattegat, a few even from the Skagerrak. I have previously referred to the extremely rapid and powerful inflow of bank water through the Kattegat in May 1923, water carrying unmistakable Skagerrak medusæ such as *Tima bardii* and *Bougainvillia britannica* down into the Belt Sea; the salinity of the water was also extremely high, even at St. 3082, E. of Gedser, 21.4 ‰.

GENERAL SECTION.

Chapter I. The Medusa Fauna of the different years 1909—1923.

1909.

Material: Permanent station of the "Thor" in the channel off Spodsbjerg, Langeland, depth 35 m, vertical hauls with Hensen net, daily from 10 April—27 June. — Cutter "Karen", 20—28 April, horizontal hauls with 1 m ringtrawl at different places in the Great Belt and Kattegat.

Species: *Sarsia tubulosa, Euphysa aurata, Hybocodon prolifer, Rathkea octopunctata, Halitholus cirratus, Tiaropsis multicirrata, Obelia sp., Eutonina indicans, Tima bairdii, Aglantha digitale.*

The characteristic hydrographical feature of the spring in 1909 is the fact that the surface water of the Kattegat was very cold, that of the deeper layers, however, being relatively warm. As regards the hydrographical conditions at Spodsbjerg, especially the current, a report on these is given in my paper on fish eggs (KRAMP 1913 b).

The medusa material in the collections here referred to I have dealt with in my paper: Medusæ, Ctenophora and Chætognathi from the Great Belt and the Kattegat in 1909 (KRAMP 1915) to which reference may be made for details. — The low surface temperature can of course only be supposed to have affected such organisms as live mainly in the upper water layers. In the case of the medusæ found at Spodsbjerg, this applies partly to *Sarsia tubulosa* and the low temperature does seem to have affected the occurrence of this species, young specimens being found until well on in May. *Eutonina indicans* also, was, during the time of its occurrence at Spodsbjerg, found mainly in the surface water; the great majority of these medusæ, however, were brought down from the Kattegat, where they had been living in the deeper, warmer water layers, and they were only observed at Spodsbjerg during a brief period (2—9 June), when both surface and bottom water were moving southward at a considerable velocity. — The occurrence of the species found in the lower water layers in 1909 does not appear to differ essentially from the normal, but it is difficult to say anything with certainty as to this, owing to the lack of sufficient comparable material from the Great Belt in other years. The appearance of *Euphysa aurata* at Spodsbjerg in 1909 in June, which is unusually early, is probably due to the presence of the hydroid that year in the Belt Sea or southern Kattegat — an exceptional occurrence. A feature of the greatest interest is the occurrence of *Sarsia tubulosa* in 1909. The appearance of this species in the

Kattegat, especially in the Læsö Channel, at the end of April, suggests that there must in this year have been a considerable importation into the Kattegat of *Sarsia tubulosa* from the eastern waters of the Skagerrak; these imported hosts made their way right down into the Belt Sea, and appeared at Spodsbjerg in June, at a time when the bulk of the Sarsia would otherwise generally have disappeared from our waters.

1910.

Material: Schultz's Grund Lightship, vertical hauls with Hensen net, 25—0 m and 10—0 m, daily from 1 Aug.—14 Sept. — Several localities near land off the north coast of Sealand and in the Sound, 26—30 Oct., vertical hauls with Hensen net from bottom to surface ("Thor" St. 1492—1508). — Also a couple of horizontal hauls with a small plankton net off Hellebæk 25 July and in the Sound N. of Hveen 10 Sept. (P. K.).

Species: *Parena gemmifera, Euphysa aurata, Steenstrupia nutans, Hybocodon prolifer, Bougainvillia ramosa, Podocoryne carnea, Lizzia blondina, Leuckartiara octona, Phialidium hemisphæricum, Eucheilota maculata, Obelia sp., Aglantha digitale.*

The most important medusa material from 1910 is that from the daily collections made at Schultz's Grund from 1 Aug. to 14 Sept. Only 9 species of hydromedusæ were found, 6 of these being indigenous in the surrounding waters. A small remainder of *Hybocodon prolifer* was found in the early part of August. For this and the other species see Special Section. Of more particular interest are *Euphysa aurata* and *Aglantha digitale*. The former was represented this year by an unusually large stock, the origin of which we cannot determine, but which was present in the southern Kattegat before these collections were begun; *Aglantha*, on the other hand, was lacking at Schultz's Grund in the first half of August.

During the first few days of August, the surface current was flowing strongly outward, there being then but little movement in the lower water layers. *Euphysa aurata* was during this time common in the lower water layers. From 7—10 August, the bottom water was also flowing outward at a considerable rate of speed, and the numbers of *Euphysa* increased at the same time; a still further increase in the numbers was observed from the 12 August, when the undercurrent set inward with great velocity; *Aglantha* now began to appear, and remained for the rest of the period. During the next few days, *Euphysa* was very numerous; a few specimens were actually taken right up in the upper water layers, but the numbers began to decrease even before this spell of strong inflowing current had come to an end.

A curious circumstance was noted on the 25 August, the effects of which lasted for about 5 days; the surface current suddenly began to flow outward at a furious pace, the undercurrent at the same time increasing its velocity in the opposite direction. On the 25, the surface salinity dropped a little, but rose at the same time considerably at 10 m' depth (from 17.7 ‰ on the 24 to 24.3 ‰ on the following day) and this despite the fact that the water at this level was taking part in the rapid outward movement. During the following days, the salinity at 5 m and at the surface also rose, *i. e.* the violent outflow of the surface current

carried the boundary layer with it, and led to a greater mixing of the water layers. During these days, both *Euphysa* and *Aglantha* were taken in hauls from 10—0 m, and the numbers of both species in the lower water layers increased. I can only explain this as follows: there must have been an increased importation of the two species with the south-going undercurrent, but both kept in the vicinity of the boundary layer, and when this was raised to a higher level, and a greater mixing of the water layers had taken place, the medusæ in question found themselves so near the surface as to be taken in hauls from 10—0 m. *Euphysa* soon decreased in numbers, but increased again towards the middle of September, after a period with rather strong out-going current.

1911.

Material: Horns Rev Lightship, vertical hauls with Nansen net, bottom to surface (30—0 m), every week all the year round. — Anholt Knob Lightship, Nansen net, bottom to surface, 27—0 m, twice monthly all the year round. — Schultz's Grund Lightship, Hensen net, 26—0, 16—0, and 8—0 m, weekly from 14 May to 26 Decr. — "Havörnen", 11—17 May, vertical hauls with Hensen net in the Kattegat, Great Belt, and western Baltic. — "Thor", 30 May—17 July, numerous vertical hauls with Hensen net, bottom to surface in all Danish waters; also some horizontal hauls with the young fish trawl, mostly in the North Sea. — Motor boat from the "Thor" 3—10 Aug., Hensen net, bottom to surface, at several localities off the west coast of Jutland between Blaavandshuk and the Skaw.

Species: *Sarsia tubulosa, Purena gemmifera, Euphysa aurata, Euphysa tentaculata, Steenstrupia nutans, Hybocodon prolifer, Bougainvillia britannica, Bougainvillia ramosa, Lizzia blondina, Rathkea octopunctata, Leuckartiara octona, Melicertum octocostatum, Mitrocoma polydiademata, Tiaropsis multicirrata, Phialidium hemisphæricum, Eucheilota maculata, Obelia spp., Eutonina indicans, Eutima insignis, Eutima gegenbauri, Tima bairdii, Aglantha digitale.*

We will now consider the appearance of the medusa fauna at the different seasons, in the different waters, beginning with the North Sea. — At Horns Rev Lightship, in January, a few specimens of *Phialidium hemisphæricum*, which had survived the winter, were found. In February, and during the greater part of March, no medusæ were recorded. At the end of March and in April, a few specimens of *Rathkea octopunctata* and *Sarsia tubulosa* appeared. In May, *Eutonina indicans* was taken every week, but only rather small specimens. Temperature conditions at Horns Rev were highly remarkable all this summer, there being an inflow of cold bottom water from the north, producing a striking difference between surface and bottom temperatures. The following figures will serve to illustrate the position:

		May	June	July	August
Deviation from normal temperature (° C)	0 m	+ 1.3	+ 1.0	+ 0.1	+ 1.8
	30 m	÷ 0.3	÷ 0.4	÷ 0.5	÷ 1.3
Difference between surface and bottom temperatures		2.9	3.7	3.3	4.3
Normal difference		1.3	2.3	2.7	1.2

The cold bottom water began to make itself evident in May, increasing during the course of the summer, and attaining its maximum in August, when we find

not only the difference greatest (this being due partly to the high temperature of the surface water) but also the deviation of the bottom temperature from the normal especially great, despite the heat communicated from above. About 1 Sept., the difference of temperature was cancelled out altogether, the temperature of the bottom water rising very rapidly from the end of August, evidently indicating that the cold bottom water was being displaced by warmer water coming from the south, *i. e.* by the Jutland Current. The mean temperature of the bottom water for September was 0°6 above the normal. — The south-going movement of the bottom water in the summer was also found to have checked the northward surface current, the mean values of which were considerably lower in the summer months (especially in August) than during the rest of the year. — The plankton at Horns Rev showed the effects of the advancing cold bottom water in the capture of two specimens of *Lizzia blondina* in June, though this species is otherwise never found there (*vide infra*); in July and August again, a host of *Aglantha* appeared, but in September, when the warmer water from the south took the place of the cold bottom water, *Aglantha* disappeared again. During the following weeks there were no medusæ at all at Horns Rev, but in October and November, a whole host of various Leptomedusæ were carried thither by the Jutland Current, which at the same time increased greatly in velocity.

From the 17—20 June, the "Thor" was investigating the waters off the west coast of Jutland, both south and north of Horns Rev, and out to some considerable distance from land (to abt. 7° E. long. see Station Chart, Chart 20). The hydrographical observations show that the cold bottom water was present everywhere throughout the area north of Horns Rev; not, however, or at any rate not to the same degree, quite close in to shore. The journals of the "Thor" give the following figures for surface and bottom temperature at stations between Graadyb (St. 1538) and NW. of Lodbjerg (St. 1562):

Station No.	Depth m	Temp.		Difference
		Surface	Bottom	
1538	23	12.7	11.7	1.0
1542	30	13.0	7.8	5.2
1543	22	12.7	7.0	5.7
1551	32	12.5	7.7	4.8
1552	32	12.9	7.1	5.8
1554	28	14.0	8.5	5.5
1555	25	13.5	9.1	4.4
1556	20	12.4	10.6	1.8
1558	32	13.9	8.3	5.6
1559	28	13.2	8.4	4.8
1561	16	13.5	10.5	3.0
1562	26	13.3	8.3	5.0

St. 1538 lies south of Horns Rev; 1556 and 1561 are very close inshore; at the remaining stations, we find a difference between surface and bottom temperature varying between 4°4 and 5°8. The surface temperatures recorded may perhaps depend somewhat on the time of day, but as we see, the variation is not great (1°6 at the outside), and does not alter the fact that the vertical differences in temperature are uncommonly great for this area, where the normal difference is abt. 1° in May, and nearly 0° for the rest of the year (see Bull. suppl. hydr. 1909). — Besides its low temperature, the bottom water was also of extremely high salinity, in several places, indeed, exceeding 35 ‰, a further proof of its extraneous origin; we shall presently consider whence it may be supposed to have come. — The only medusa found south of Horns Rev was *Eutonina indicans* (only in one haul with the young fish trawl); north of here, however, several species were taken, the most important of those normally indigenous here being *Obelia*, *Phialidium*, and *Eutonina*. Both *Lizzia blondina* and *Bougainvillia britannica* were found at several stations, the latter form chiefly in hauls with the young fish trawl near the bottom; both these species, however, were doubtless brought down from the northward by the cold bottom water, and the same probably holds good of some of the *Aglantha* found there. *Lizzia*, as already mentioned, came as far as Horns Rev Lightship.

Section from Lodbjerg towards Lindesnes ("Thor" St. 1561—1568, 20—21 June). — The hydrographical observations from this interesting section, together with previous observations, supply information concerning the origin of the cold bottom water off the west coast of Jutland. — The values noted for temperature and salinity in this section are shown in the accompanying figure (fig. 3). It will be observed that in the north-western part of the section, there was a thin surface layer of Baltic water extending very far out from the Norwegian coast; the salinity increased very rapidly from the surface downwards, the 34 ‰ isohaline lying at abt. 15 m' depth. The 35 ‰ isohaline also (the upper limit of the atlantic water) was at a very high level, being in several places only abt. 25 m below the surface. As already mentioned, salinities of over 35 ‰ were noted also at the bottom on the coastal bank of western Jutland. We see from this that the peculiar southerly movement of the bottom water off the west coast of Jutland was due to an unusually heavy rise of the Atlantic bottom water in the Norwegian Channel, so pronounced, indeed, that parts of the Atlantic water mass itself flowed far to the south over the coastal banks. That this was the case is confirmed by other hydrographical observations, published, but without comment, in the Bulletin hydrographique 1910—1911. From 1—14 June, several vessels from the International Investigation of the Sea were stationed at various localities in the North Sea in order to carry out continuous hydrographical observations. Among the localities in question was a point at 57° 33'5 N., 8° 24'5 E., at the mouth of the Skagerrak, about midway between Hanstholm and Oxö, where a Swedish vessel was stationed. The surface salinity was as a rule over 34 ‰ but at times, the Baltic surface water

thrust a very thin layer from the north right down to this station, causing a marked fall in the surface salinity, which on one occasion dropped as low as 24.42 ‰. At a depth of only 10 m, the salinity was constantly above 34 ‰, and varied very little. A salinity of 35 ‰ was found as a rule at 20—25 m' depth, but on some days extended right up to the surface. At the German station also (57° 55′ N., 4° 45′ E.) on the southern slope of the Norwegian Channel farther out in the North Sea, the salinity was extremely high, not infrequently over 35 ‰ at the surface; even here,

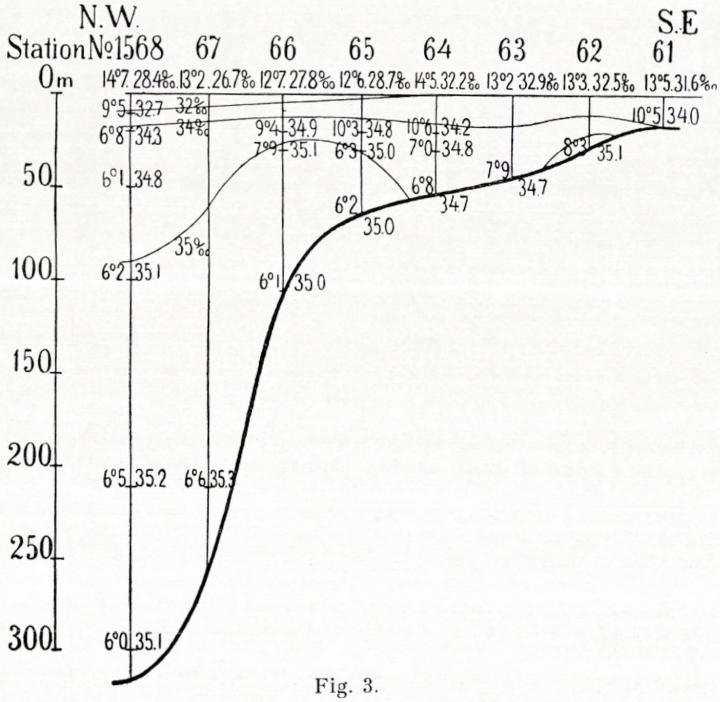

Fig. 3.

however, the Baltic surface water occasionally made itself apparent. At the Danish station on the other hand (56° 10′3 N., 5° 37′ E., SW of the Little Fisher Bank) the salinity showed only very slight variation indeed; it was certainly rather high, as a rule over 34 ‰ throughout the entire column of water, but never attained the 35 ‰, even at the bottom. The Atlantic bottom water then, stood very high in the Norwegian Channel, but its movement towards the south was restricted to a comparatively narrow belt off the west coast of Jutland. — The phenomenon is also apparent in the chart of surface salinities for May (Bull. hydr. 1910—1911, Part A, Pl. I) where we find the usual tongue of water over 35 ‰ salinity from north of Scotland extending unusually far to the east, and following for a considerable distance the southern slope of the Norwegian Channel, but without spreading southward over the North Sea plateau.

There is yet another point to be noted in connection with the "Thor" section

from Lodbjerg to Lindesnes. Water of 35 ‰ salinity was found at St. 1562 at 26 m' depth (at the bottom), and at St. 1565 at 30 m' depth, whereas the bottom salinity at St. 1563 and 1564 (44 and 53 m) was only 34.7 ‰. The bank water, which was otherwise restricted to a thin layer, thus formed here a stratum of greater thickness. These were the only two stations in the section where *Bougainvillia britannica* and *Lizzia blondina* were taken — the two medusæ whose occurrence along the whole of the coastal bank north of Horns Rev has been viewed in connection with the southward movement of the bottom water. This bottom water consisted, as we have seen, partly of Atlantic water from the Norwegian Channel; the medusæ in question cannot be supposed to have been living in this Atlantic water originally, but rather in the bank water. When the Atlantic water rose with such violence as to overflow the coastal banks, it carried with it, or drove before it, some of the bank water, and the medusæ therein contained. Both these water masses were of rather low temperature, the Atlantic water a little over 6°, the bank water somewhat higher, according to its distance from the considerably warmer surface water; both contributed to the remarkable drop in the bottom temperature. But while the bottom water on the plateau north of Horns Rev was marked both by low temperature and high salinity, the salinity at Horns Rev Lightship was throughout rather low, lower indeed than the normal, even when it was coldest. It was thus only the bank water (with *Lizzia blondina*) which reached as far as here, the water north of the reef being a mixture of this and Atlantic water (with the medusæ from the bank water, *Lizzia* and *Bougainvillia*).

Medusæ found in the section Lodbjerg—Lindesnes include (apart from the two Margelidæ), *Aglantha* at all stations, *Obelia* and *Phialidium* here and there; also, in horizontal hauls with the young fish trawl, *Leuckartiara octona*, *Eutonina indicans*, and *Tima bairdii*. — At St. 1571—1577 farther east in the deep part of the Skagerrak NW of Hirtshals, *Bougainvillia* was still found (in vertical hauls at four stations) as also *Aglantha*; horizontal hauls yielded *Aglantha* and *Tima*. The Atlantic water does not seem to have been particularly high at these stations; the Baltic surface water, on the other hand, was here also of extraordinarily wide horizontal extent, which may perhaps explain the finding of forms so neritic as *Steenstrupia nutans* and *Obelia* at St. 1576 and 1577 (surface salinity 27.9 and 29.8 ‰). — After a week in the Kattegat, the "Thor" proceeded to investigate some localities in Jammer Bay on the 5 July (St. 1606—1612), all over rather shallow water (7—25 m) and without any striking hydrographical features. Only a few medusæ were found: *Lizzia*, *Obelia*, *Phialidium*, and *Aglantha*. — Investigations from the motor boat belonging to the "Thor", in August, between Hanstholm and the Skaw, close inshore, yielded very few medusæ, an occasional *Lizzia* or *Aglantha*, but at most stations none at all. — We may now leave the Skagerrak and proceed to consider

The Kattegat and the Belt Sea. The only material for the first 4½ months

of the year is that from Anholt Knob Lightship. *Obelia* and *Aglantha* were found here nearly all the year round. In February some large *Phialidium* were taken, belonging to the stock of the previous year, and in the same month, *Hybocodon* and *Rathkea* began to appear, these being presumably from the indigenous Kattegat stock. In March and April their numbers increased greatly. I have suggested, in the Special Section, that there was then a considerable importation of these two species. In April, *Sarsia tubulosa* also began to appear, doubtless a native stock, and a very small one. After the middle of May, *Rathkea* and *Sarsia* disappeared altogether from Anholt Knob, and *Hybocodon* suddenly showed a marked decrease in numbers; at Schultz's Grund, where investigations had now begun, all three remained, though decreasing in numbers, until some way on in July.

From the 11—17 May, "Havörnen" was cruising between the Skaw and the mouth of the Limfjord, and east of Læsö, west of Anholt and down through the Great Belt into the western Baltic. At the great majority of stations, the following 5 species of medusæ were taken: *Aglantha digitale* (only in the Kattegat), *Hybocodon* and *Rathkea* (as far as the Langelandsbelt), *Sarsia tubulosa* and *Obelia* (as far as east of Femern). *Sarsia* was rather scarce throughout, save at St. 1511 just outside the mouth of the Limfjord, where it was extraordinarily numerous; *Rathkea* also appeared here in far greater numbers than anywhere else, and *Hybocodon* was likewise common. *Aglantha*, again, was fairly common, which is exceptional in such shallow water (9 m). This local accumulation of medusæ is connected with the surface salinity, which was considerably higher than in the adjacent parts of the Kattegat. On the 11 May, the following salinities were recorded:

	Læsö Rende Lightship	Stat. 1511	Östre Flak Lightship
0 m	17.6 ‰	23.3 ‰	16.8 ‰
10 m	29.5 ‰	27.5 ‰	22.9 ‰

These figures show that it must have been water from the lower levels of the Læsö Channel which had been forced up by the undercurrent over the northern edge of the Aalborg plateau and driven right to the surface.

At St. 1514, between the Skaw and Marstrand in Sweden, and at St. 1517 and 1519 east of Læsö, not only *Sarsia* but also *Hybocodon* and *Rathkea* were scarce (*Aglantha* on the other hand common) though these two species culminated at about the same time (15 May) at Anholt Knob lightship and were numerous there. Both species were at the close of their period of occurrence, gemmation being practically at an end in both cases even before 1 May. Presumably, there must have been a considerable inflow of water from the eastern part of the Skagerrak into the Kattegat in May; part of this water passed through Læsö Channel, was forced up over the Aalborg plateau and remained stagnating there; another portion flowed

through the eastern channel; and in that section of this water which, about mid May, was situated east of Læsö and farther north, *Hybocodon* and *Rathkea* were now disappearing; *i. e.* the importation of these species was coming to an end. — The remainder of the cruise does not call for any special remark beyond what has already been stated in the Special Section.

At the end of June and during the first half of July, the "Thor" made extensive investigations in the Kattegat and Belt Sea. Some of the species of medusæ found are of but little general interest; *Obelia* was taken practically everywhere, *Aglantha* nearly everywhere in the Kattegat proper. *Purena gemmifera, Euphysa aurata, Steenstrupia nutans,* and *Phialidium hemisphæricum,* all indigenous in the Kattegat, commenced to appear (according to the lightship records) in July; their horizontal distribution during this month will be seen from the charts. In the Sound, at Schultz's Grund, and E. of Samsö, *Euphysa tentaculata* was taken for the first time in Danish waters. *Bougainvillia ramosa* was found close inshore in the Bay of Samsö, *Leuckartiara octona* in the northern Kattegat. *Sarsia tubulosa, Hybocodon,* and *Rathkea* were by this time disappearing from the plankton. Remains of the year's stock were met with in July at some few places in the coastal waters, especially Aalborg Bay and Samsö Bay, where the bottom water was of low temperature (for the Sound, *vide infra*). — Three medusæ probably not often found in the Kattegat appeared here in 1911. A specimen of *Eucheilota maculata* was taken at Kobbergrunden on the 4 July (St. 1603); it was a young one, and the corresponding hydroid must evidently have been living in the northern Kattegat, which is exceptional. *Bougainvillia britannica* and *Melicertum octocostatum,* on the other hand, were doubtless brought in from the Skagerrak, where both were indigenous; both species were found chiefly in Læsö Channel and Aalborg Bay, but *Melicertum* also penetrated as far as Schultz's Grund. The occurrence of these two species confirms the supposition that the considerable inflow of water which evidently took place from the Skagerrak into the Kattegat in the spring and early summer of 1911, moved principally down through Læsö Channel, at any rate during the first part of the time. *Lizzia blondina,* which appeared somewhat later, seems on the other hand to have come in by way of the eastern channel, in the northern part of which it may perhaps have been indigenous (see chart of distribution for *Lizzia,* Chart 9, p. 68). It was found in Aalbæk Bay and north of Læsö, but not in Læsö Channel; on the other hand it was also taken at several places between Læsö and Anholt and in the southern Kattegat; when the "Thor" was working in Samsö Bay on the 8—11 July, *Lizzia* had not yet appeared there, but was noted on the 16th. In connection with *Lizzia* we must note the remarkable fact that an essential part of the undercurrent in July as a rule did not pass the site of Anholt Knob lightship (see Special Section, p. 67); most of it probably flowed east of the ground in question, but part also through the narrow channel west of Anholt; here, at the very slight depths of 12 and 15 m, we find recorded salinities of no less than 28.2

and 30.2 ‰; and in this channel, *Lizzia* was found. It was likewise present on the southern edge of the Læsö plateau (St. 1617) and it looks as if the undercurrent from the eastern channel had been partly setting westward between Kobbergrund and Anholt. From the Naut. met. Aarbog, it appears that the boundary layer at Anholt Knob lightship shifted upward to very near the surface, often at abt. 10 m, during June and early July, whereas for the rest of July, the salinity was as a rule rather low in the intermediate, and partly also in the lowest, water layers near the lightship. About the middle of the month, however, there was a new rise in the salinity, and *Lizzia* was then found at the lightship, where it was otherwise altogether lacking, though common elsewhere in the Kattegat.

On the cruise of the "Thor" in the Kattegat, a few horizontal hauls were made with the young fish trawl, generally near the bottom; one of these hauls brought up a specimen of *Tima bairdii, viz.* at St. 1657, E. of Samsö, 24 m' depth, in a channel with cold bottom water (see Special Section, p. 146). Particular interest attaches to St. 1665 in the Sound, S. of Hveen, 17 July; here, at 22 m' depth, the bottom water was very cold, only 5°7 at the bottom; a vertical haul here brought up several medusæ, including *Sarsia tubulosa* and *Rathkea octopunctata*, which had otherwise by now almost disappeared from the plankton; both were very backward in development; the *Sarsia* specimens were rather small, and two-thirds of the *Rathkea* were still in process of gemmation (see Special Section, pp. 28 and 80).

The medusa fauna at Anholt Knob and Schultz's Grund lightships during the last five months of the year presents no features of any great general importance; all the species found were indigenous in the Kattegat; their occurrence is given under the respective heads. It should be noted, however, that a new year-class of *Rathkea octopunctata* appeared both at Anholt Knob and at Schultz's Grund in December.

The foregoing observations as to the medusa fauna in the Kattegat during the summer of 1911 may be briefly summed up as follows: In the spring and early summer, there was a considerable importation of medusæ with water from the Skagerrak into the Kattegat, extending over a rather lengthy period. This importation seems for the most part to have tended strongly westward, as for instance in May, and to some extent also in June, when first *Sarsia tubulosa*, *Hybocodon*, and *Rathkea*, later *Bougainvillia britannica* and *Melicertum octocostatum* were carried down through the Læsö Channel right into Aalborg Bay. In June, and to some extent also in July, the salt bottom water of the eastern channel moved westward in across the plateau between Læsö and Anholt (cf. *Lizzia blondina*). In August and September also, the inflow of water from the north was doubtless considerable, judging from the powerful inward surface current at Anholt Knob.

It is natural then to consider whether, and in what manner, the conditions in the Kattegat were affected by the marked rise of Atlantic water in the western

part of the Norwegian Channel, already noted in the foregoing. This rise commenced in May, was very pronounced in June, and continued doubtless right on into August. Part of the Atlantic water was forced over the west Jutland coastal bank, but though doubtless subjected to severe pressure from the west, it did not penetrate very far into the Skagerrak, and did not enter the Kattegat at all. It might have been expected that the violent rise of Atlantic water would at any rate immediately have forced a considerable quantity of bottom water from the Skagerrak into the Kattegat; as it is, however, everything seems to suggest that the inflow of the bank water was fairly evenly distributed throughout a lengthy period. There must, then, have been some pressure in the opposite direction, and this we find in the Baltic water. At the commencement of the year, the surface water was unusually salt throughout the whole of the Kattegat; but from about March or April, the surface salinity decreased very rapidly, and was considerably below the normal until August. This Baltic surface layer does not appear to have been of any great thickness at any of the Danish lightship stations in the Kattegat. In the Skagerrak, it showed a very wide horizontal distribution, certainly in May and June, and doubtless also later; at Skagens Rev lightship, the surface salinity was considerably below the normal from May—August. As regards the thickness of the layer in the Skagerrak, we find in the Bull. hydr. 1910–1911 that it was very thin in May; there are, unfortunately, no observations from the remainder of the year. At Schultz's Grund, a very strong outflow of surface water took place in May. At Anholt Knob also, the surface current was flowing outward in May, but in the subsequent months we find the surface water flowing very rapidly inward at this station; in spite of which, the salinity remained very low (abt. $4^1/_2$ ‰ below the normal in June and August). Not until September was the surface salinity forced up, by the still very forcibly inflowing current, to 2.2 ‰ above the normal. It would have been interesting to have known the conditions on the west coast of Sweden at this period, especially the volume of the Baltic Current. To my mind, everything points towards a powerful outflow of Baltic water, keeping mainly along the Swedish coast, but prevented by the rise of Atlantic water in the Norwegian Channel from flowing far into the Skagerrak, where it could only spread out widely in horizontal directions. It managed to check the advance of the Atlantic water through the Skagerrak, but was itself forced to turn back again into the Kattegat, producing a powerful inward surface current of low salinity (cf. Anholt Knob). In the Kattegat, the Baltic water thus circulating acted on the still inflowing salt undercurrent, pressing it westward, which is most clearly apparent from the distribution of the medusæ as described in the foregoing. There was thus, all through the summer, a conflict in progress between the Atlantic and the Baltic water. In September, however, the Baltic element lost its force, and the salt water from the Skagerrak, which had hitherto remained as an undercurrent, now moved, also at the surface, rapidly into the Kattegat, raising the surface salinity everywhere to abt. 2 ‰ above the normal.

1912.

Material: Horns Rev Lightship, vertical hauls with Nansen net, bottom to surface (30—0 m), weekly all the year round. — Anholt Knob Lightship, Nansen net, bottom to surface (27—0 m), twice monthly throughout the year. — Schultz's Grund Lightship, Hensen net, 26—0, 16—0, and 8 0 m, weekly from 2—30 Jan., 5 March—23 July, 17 Sept.—5 Novr. — The "Thor" journals also contain particulars of medusæ from 6 localities in the Belt Sea 4—8 May.

Species: *Sarsia tubulosa, Purena gemmifera, Euphysa aurata, E. tentaculata, Steenstrupia nutans, Hybocodon prolifer, Bougainvillia superciliaris, B. ramosa, Lizzia blondina, Rathkea octopunctata, Leuckartiara octona, Laodicea undulata, Phialidium hemisphæricum, Obelia, Eutonina indicans, Tima bairdii* (only acc. to the journal of the "Thor"), *Aglantha digitale.*

The medusa fauna. — At Horns Rev Lightship, only one species of medusa was taken during the first three months of the year, *viz. Phialidium* from a stock that had survived the winter. In April and early May came *Bougainvillia superciliaris* with some *Rathkea, Obelia,* and *Eutonina.* During the subsequent two months no medusæ were found. In July, *Euphysa aurata* and *Aglantha digitale* appeared in the plankton. Hydrographical observations show that the surface temperature increased very greatly during this month, while at the same time there was a perceptible drop in the temperature of the lower water layers, so that on certain days there was a difference of temperature amounting to 6° between bottom and surface. About 1 August, the temperature of the bottom water rose considerably. There seems then, in July, to have been an inflow of colder bottom water, coming undoubtedly from the north, and bringing with it the medusæ mentioned; in August, however, the Jutland Current broke through with renewed force, as is also evident from the current observations. The usual host of medusæ brought by the Jutland Current appeared in September, but the numbers of species and of individuals alike were very small.

Kattegat. In the Special Section, mention has been made of the fact that in 1912, no importation took place of *Sarsia tubulosa, Hybocodon,* or *Rathkea*; altogether, the medusa fauna of the Kattegat in that year consisted only of native species. For an explanation of this, we may consult the chart in the Bulletin hydrographique, 1911—1912, Part A. Pl. I, showing the surface salinity for the spring of 1912. We see then, to begin with, that the inflow of Atlantic water round the north of Scotland, though certainly considerable, kept to the western parts of the North Sea; furthermore, that the 34 ‰ isohaline never reached as far as the Skagerrak. This suggests that there was only a slight inflow of North Sea water into the Danish waters. That no conspicuous fall in the salinity of the lower water layers in the Kattegat was caused thereby is due to the fact that the Baltic Current was likewise of but slight extent, as will be clearly seen from the high surface salinity at the lightship stations. Everything thus suggests that there was but a very slight interchange of water between the Kattegat and the North Sea, so that the occasionally rather powerful currents observed in the Kattegat were of a more or less local

character. This agrees well with the fact that the lower water layers at Anholt Knob and Schultz's Grund lightships differed greatly in regard to both temperature and salinity.

1913—1914.

Material: Horns Rev Lightship, vertical hauls with the Nansen net, bottom to surface, 30—0 m, weekly from 6 Jan. 1913 to 30 March 1914. — Anholt Knob Lightship, Nansen net, bottom to surface, 27—0 m, twice monthly, 17 Jan. 1913—1 April 1914. — Schultz's Grund Lightship, Hensen net, 26—0, 16—0, 8—0 m, weekly from 19 Aug. 1913 to 31 March 1914. — Ringköbing Fjord, vertical and horizontal hauls with plankton net occasionally from February to July 1913. — Two localities between Gniben and Hasenöre (St. 2089, 56°04′ N., 11°10′ E.; St. 2091, 56°05′ N. 10°57′ E.), horizontal hauls with closing net, 9 July 1913. — "Havörnen" 4 localities at the mouth of the Skagerrak, 4—5 April 1914, vertical hauls with closing net at various depths.

Species: *Sarsia tubulosa, Purena gemmifera, Euphysa aurata, Steenstrupia nutans, Hybocodon prolifer, Bougainvillia superciliaris, B. ramosa. Lizzia blondina, Rathkea octopunctata, Leuckartiara octona, Phialidium hemisphæricum, Eucheilota maculata, Obelia, Eutonina indicans, Eutima gegenbauri, Aglanta digitale.*

Before proceeding to the occurrence of the medusæ in 1913 it will be necessary to make some remarks as to the hydrographical conditions.

On consulting the charts for surface salinity in the Bull. hydr. (1912—1913, Part A. Pl. IV and V; 1913—14 Part A. Pl. V—VII) we find that about February 1913, the 34 ‰ isohaline, though extending very far into the Skagerrak, kept to the middle of that water, far from the coast of Jutland; this, in conjunction with the fact that the lower waters of the Kattegat were, during the following months, of low salinity, despite the powerful inflowing current, suggests that there was no great inflow of North Sea water into the Kattegat at that time. In May, the Baltic Current in the Kattegat and northern Skagerrak showed a very great increase, forcing the 34 ‰ isohaline close in to the north coast of Jutland. The Atlantic water, which in February had been of considerable extent in the north-western part of the North Sea fell back a great deal at the same time, and was later followed by the bank water, so that the chart for August 1913 shows the 34 ‰ isohaline right outside the Little Fisher Bank. It was evidently this falling back of the water masses in the North Sea which occasioned the powerful outflow of Baltic surface water and consequent low surface salinity in the Kattegat. This was especially noticeable in September, when the mean salinity for the month at Skagens Rev was 6.5 ‰ below the normal (29.7 ‰, minimum 23 Sept. 18.7 ‰) answering to a very powerful out-going current, the mean value of which was 54.1 cm/sec. At Anholt Knob, in the same month, a minium salinity of 11.9 ‰ was registered, at Schultz's Grund 10.8 ‰ (normal for Sept. 18.12 ‰). In the lower water layers of the Kattegat, this phenomenon was followed, first of all by a considerable decrease in temperature, at Schultz's Grund also of salinity, and at Anholt Knob by a sharp definition of the boundary layer (mean salinity for September at 10 m' depth 17.6 ‰, at 15 m 28.4 ‰). This we must probably take as indicating that the outflow of surface water produced

a reaction current deeper down, the water of which this latter was composed, however, being of a different origin from that usual at this season; it was not southern bank water, but water from some cold level in the Skagerrak, presumably in the eastern part, to judge by the comparatively slight increase of salinity at Anholt Knob. — The phenomenon here described made itself apparent at Horns Rev by an unusual inflow of water from the north throughout the summer. — We shall now see how the occurrence of the medusa fauna, in several interesting respects, accords with the current conditions here set forth.

The medusa fauna at Horns Rev lightship presents various features of interest; there is, however, little of importance to note during the first 4 months of 1913. From the 12 May to 15 July, *Steenstrupia nutans* was taken at Horns Rev, and from the size of the specimens it is evident that the hydroid must have been living at no great distance. It is very probable, however, that the occurrence of this medusa at this station was owing to the fact that the current at this period was bringing down an unusual quantity of water from the north. This is in any case the explanation of the fact that *Euphysa aurata* and *Aglantha digitale* were commoner in 1913 than in any other year; *Eucheilota maculata* also appeared here, as an exception, in the summer, about 1 August (together with a host of *Rhizosolenia*). From April to October, the north- and south-going currents held each other in check, which implies an unusual force in the southward movement; in April, June, and August indeed, the resulting current was actually southward, which is unique at Horns Rev. This agrees well with the above-noted retirement of the North Sea bank water and consequent outflow of Baltic water. In Sept.—Oct., a great quantity of *Phialidium* and *Obelia* suddenly appeared. These species may be introduced both from south and north. At the same time, *Eutima gegenbauri* appeared, and after a while became fairly common; this medusa generally arrives at Horns Rev just at this season, brought by the Jutland Current; it was, however, evidently not so in 1913. For we find at the same time *Euphysa aurata* and *Aglantha* increasing very greatly in numbers, which points plainly to importation from the north. It has already been noted in the Special Section that the occurrence of *Eutima gegenbauri* in our waters falls into two groups, one brought by the Jutland Current, and another indigenous near the mouth of the Skagerrak. The hydroids of *Phialidium* and *Obelia* keep mainly, as regards the west coast of Jutland, to the two areas south of Horns Rev and at the entrance to the Skagerrak. There can hardly be any doubt but that the occurrence of *Phialidium*, *Obelia*, and *Eutima gegenbauri* here noted, together with *Aglantha digitale*, indicates that the southward movement of the current in Sept.—Oct. had attained such force as to bring water from the mouth of the Skagerrak right down over Horns Rev. — About the middle of November, a sudden change took place, the Jutland Current now breaking forth with great violence, and literally washing away the whole of the medusa fauna above noted. Nor did it bring any of its usual medusæ in return, presumably owing to the lateness of the season. Only

Phialidium was still found in the plankton, and remained right on till the middle of March 1914.

Kattegat. — For the first 7 1/2 months of 1913 we have, unfortunately, only material from the lightship at Anholt Knob. The most remarkable feature of the medusa fauna here was the mode of occurrence of *Hybocodon* and *Rathkea*; both appeared in great hosts, but only for a short time, and gemmation ceased very suddenly. *Rathkea* did not attain its culmination until gemmation was at an end. Both species had probably been brought from the Skagerrak. The occurrence of imported medusæ en masse might appear contradictory to what has been said above regarding the slight inflow of water to the Kattegat from without. The contradiction, however, is only apparent. The medusæ were probably imported at an early date, and propagated extensively by gemmation while in the Kattegat; on the other hand, the slight inflow of water accounts for the fact that the importation did not last for a longer period (as in 1911), but rapidly came to an end. This explains the brief occurrence of the medusæ, as the whole stock at once became subjected to the same external conditions, and therefore developed at about the same rate. — On the 15 June and 1 July, no other medusæ beyond *Aglantha* were found at Anholt Knob. On the 15 July, there appeared, firstly the indigenous species *Purena gemmifera* and *Euphysa aurata*, and further, a large host of *Lizzia blondina*, which, however, rapidly decreased in numbers. In the southern Kattegat, a few *Lizzia* were taken in horizontal hauls on the 9 July; at Schultz's Grund, however, it was rare even in August and September when it is otherwise common at this station, but in October—November it was common. At Anholt Knob, the salinity of the lower waters began to increase from July onwards; at Schultz's Grund there was a marked increase from September, when the above noted inflowing reaction current gained force; it was doubtless this which shortly afterwards brought *Lizzia* and other medusæ to Schultz's Grund. The stock of *Lizzia* at Anholt Knob was doubtless imported; as already noted, however, there was hardly any inflow of North Sea water into the Kattegat in the summer of 1913, and the *Lizzia* cannot therefore have come farther than from the Skagerrak. The same water which brought *Lizzia* to Schultz's Grund brought with it also a quantity of *Purena gemmifera*, which appeared in the middle of October, at the same time as it disappeared from Anholt Knob. *Aglantha* also, which was lacking at Schultz's Grund in Aug.—Sept., appeared there in the middle of October, increasing in numbers until December; this batch also was doubtless transported in company with the above-mentioned species, and the same presumably holds good of some of the rather large *Phialidium* taken in Novr.—Decr. *Phialidium* disappeared, as usual, before the end of the year; *Obelia* on the other hand, which was extremely numerous in Novr.—Decr., remained, albeit in decreasing numbers, throughout the following winter.

In 1914, *Hybocodon* and *Rathkea* began to appear at Schultz's Grund as early as the middle of February, and were numerous by the end of March; in both cases, doubtless an uncommonly large native stock. These medusæ did not appear

at Anholt Knob until the middle of March. Both are northerly forms, and it is therefore possible that the low bottom temperature in Sept.—Jan. afforded more favourable conditions for the hydroid generation than otherwise found in the Kattegat, where the native stock is not as a rule so numerous. Or possibly it may be that the high temperature in February furthered the gemmation of the medusæ.

The investigations in Ringköbing Fjord in 1913 call for a brief special mention. By far the most important of the medusæ there found was *Rathkea octopunctata*. Apart from this, a few *Bougainvillia superciliaris* and small *Sarsia tubulosa* were taken in March; larger *Sarsia* and *Obelia* in May; in June and July no medusæ were found. *Rathkea* was found singly in February, and in enormous numbers in March, April, and May. This medusa evidently found particularly favourable conditions in Ringköbing Fjord.

It still remains to note the series of vertical hauls made at four localities along the line Oxö-Hanstholm (mouth of the Skagerrak) on the 4—5 April 1914. The Nansen net with closing apparatus was used at various depths; also an open plankton net for vertical hauls through the upper 5 m at each station. We will number the stations I—IV, starting from the coast of Norway:

I. 58° 01′ N., 8° 05′ E.	Depth	100 m.	Hauls:	5—0, 20—0,	75—35 m.
II. 57° 55′ N., 8° 09′ E.	»	550—490 m.	»	5—0, 40—0,	90—50, 200—150 m.
III. 57° 40′ N., 8° 18′ E.	»	250 m.	»	5—0, 40—0,	125—75 m.
IV. 57° 26′ N., 8° 25′ E.	»	65 m.	»	5—0, 20—0,	50—35 m.

At all four stations, *Obelia* and *Aglantha* were taken in most of the hauls; at St. II also a few *Phialidium* and *Sarsia tubulosa* in the upper water layers. The most interesting feature, however, is the distribution of *Hybocodon* and *Rathkea*, which were found in most hauls at St. I and II, but altogether lacking at St. III and IV, *i. e.* on the Danish side. I have expressed the view that the Kattegat normally receives a quantity of these two species, imported with the northern bank water. This water was of considerable volume at St. I and II, lying below a rather thin, but horizontally extensive layer of Baltic water with very low salinity (24 ‰ surface at St. I). St. III lies approximately midway out. The salinity here was abt. 34 ‰ from 30 to at least 200 m below the surface. At St. IV (above the coastal bank of Jutland, depth 65 m), 34.5 ‰ was registered from surface to 50 m. The bank water was thus of considerable thickness and Atlantic water was only observed at the deepest station (St. II) from 150 m downwards. — *Hybocodon* and *Rathkea* were found both in the Baltic surface water and in the bank water, but, as mentioned, only on the Norwegian side, which is remarkable. If this represents the normal state of things (unfortunately, we do not know) it means that the stock of *Hybocodon* and *Rathkea* introduced into the Kattegat from the Skagerrak with the inflowing bank water comes, not from the Danish side but from the Norwegian, and must, farther up the Skagerrak, pass diagonally across that water; the rarity of the species on the Swedish shores of the Skagerrak indicates that they cannot come from there.

1915—16.

My excursions to Thyborön, Little Belt, and Nyborg have been referred to in the Introduction, and there is no need to go further into the results here; they are given in the Special Section.

1922.

Chart 21, p. 245.

Material: Cruise of the "Dana" in the North Sea, Skagerrak, and Kattegat, 28 Sept.—19 Oct. Horizontal hauls with the young fish trawl, generally near the bottom.

Species: *Tiaranna rotunda, Leuckartiara octona, Neoturris pileata, Cyclocanna welshi, Laodicea undulata, Melicertum octocostatum, Cosmetira pilosella, Phialidium hemisphæricum, Eucheilota maculata, Saphenia gracilis, Eutima insignis, Eutima gegenbauri, Eirene viridula, Tima bairdii, Aglantha digitale.*

At nearly all stations, the temperature and salinity of the water were noted (the latter measured by areometer), at bottom and surface. At the deepest stations in the Skagerrak, however, water samples were taken at several different depths, and the salinity determined by titration. — The hydrographical conditions will be best taken in conjunction with the medusa fauna for the different waters.

North Sea. From 28 Sept.—3 Oct., intensive pelagic investigations were made on the banks off the northern part of the west coast of Jutland, between Nissum Fjord and Hanstholm out as far as Little Fisher Bank and Jutland Bank, at depths from 18 to 48 m, as also at the entrance to the Skagerrak (St. 2837—2864). — The hydrographical conditions in this area were rather interesting, but owing to the position of the stations, not easy to unravel. A great number of stations were taken all along the coastal belt out as far as 20—25 miles from land; also four stations on the Little Fisher Bank and western edge of the Jutland Bank, but the intervening water, for some 25 miles, was not examined, and it looks as if this ground in particular presented somewhat peculiar features which it would have been well to have ascertained. Taking the temperature alone, the position might appear simple enough; salinity and medusa fauna, however, show that it is really very complicated. — North of Bovbjerg, the temperature varied but little, 12°3—13°0 at bottom, 12°0—13°0 at surface, the highest temperatures being noted nearest the shore. South of Bovbjerg, matters presented a very different aspect. Here, the temperature was lowest inshore (St. 2847, 11°9 at bottom), rising sharply out to sea, where a warm water mass of almost uniform temperature from surface to bottom was located; at 14 miles from land, the bottom temperature was 13°3 (St. 2848), and on the southern side of the Little Fisher Bank (St. 2850 and 2851, depth 37 m) it was 13°6. It is evidently the Jutland Current we encounter here. The most remarkable feature however, is the great difference in temperature between the southern and northern sides of the Little Fisher Bank. St. 2852, on the north side of the bank (depth 48 m) only 7 miles from St. 2851, showed a bottom temperature of 10°6; the surface temperature was two degrees higher. A cold water mass had thus thrust itself forwards over the bottom as far

as the northern edge of the Little Fisher Bank, where it was met, and partly submerged, by the warmer water of the Jutland Current. The influence of the colder water is still perceptible at St. 2853 (depth 34 m, between Little Fisher Bank and the Jutland Bank), where the bottom temperature was 11° 8. It is natural to suppose that it was the same cold water which occasioned the drop in the temperature from the coast outwards, between Thyborön-Hanstholm. From this, then, the Jutland Current would, in its northward progress have encountered the above-mentioned cold water which forced it to turn off eastward in towards the northern part of the west coast of Jutland. This is perhaps also correct, but there is one point which does not seem quite clear to me. The warm water on the southern side of the Little Fisher Bank was very salt (34.8 ‰ at bottom, 34.4—34.6 ‰ at surface); the water mass close inshore off Thyborön was likewise of high salinity, 34.1—34.5 ‰, with a marked decrease towards the south. But between these two salt (and warm) water masses we have, on the extreme north, a streak of water with very much lower salinity (33.4—33.8 ‰ at bottom, at St. 2841, 2842, and 2840). Whether this completely separated the two water masses above noted or not, we do not know; and it would have been interesting to follow up its further development on the south, west, and north. It is not to be supposed that it was connected with, or formed the outer portion of, the cold water mass found north of the Little Fisher Bank, the salinity of this latter being extremely high (34.7—35.0 ‰).

We will now proceed to consider the medusa fauna of this area. We find here three sections with an extremely poor fauna, *viz.* the cold water north of the Little Fisher Bank, the streak with low salinity between the Jutland Bank and the coastal bank, and the relatively warm but little saline water outside Nissum Fjord. In these three sections, practically nothing was found beyond *Leuckartiara octona*, this form being, however, particularly numerous here. Further, we find two sections with a very rich fauna, *viz.* that of the warm and salt water south of the Little Fisher Bank, and that on the coastal bank between Bovbjerg and Hanstholm continuing northward via St. 2860, 63, 62, and 61, and also in to the Skagerrak at St. 2864. *Leuckartiara octona*, which was met with everywhere, is indigenous both south and north of the area investigated, but of the numerous Leptomedusæ of many different species found in the rich sections, only a very few, if any, can be regarded as brought thither by the Jutland Current; all are indigenous at the entrance of the Skagerrak, probably on the slope down towards the Norwegian Channel, and from here they would be carried southward, some along the coast as far as Bovbjerg, some down to the southern side of the Little Fisher Bank (rather small specimens of all species were found, and the minimum size generally decreases towards the north; see accompanying Table, p. 180).

I consider then, that the following conclusions can be drawn from the occurrence of the medusa fauna. At some time prior to the commencement of the investigations here concerned, water from the intermediate depths of the Skagerrak extended some distance to the southward along the west coast of Jutland (how

far, we do not know). It was met and checked by the northgoing Jutland Current, which was doubtless of somewhat higher temperature, and caused a rise in that of the water masses in question; even by the end of September however, the Jutland Current had not altogether succeeded in repelling the water from the north

Minimum size (diameter in mm) of different species of Leptomedusæ taken off the northern part of the west coast of Jutland in Sept.—Oct. 1922 (cf. Station Chart).

Stat. No.	Laodicea undulata	Cosmetira pilosella	Saphenia gracilis	Eutima insignis	Eutima gegenbauri	Eirene viridula
2850	—	—	—	7	—	13
2851	9	—	—	6	—	15
2852	—	—	—	11	—	—
2853	—	—	—	6	16	10
2845	—	12	—	12	—	—
2844	8	14	—	8	—	13
2837	6	8	—	6	—	—
2839	—	9	—	—	—	11
2854	—	—	—	11	—	—
2856	—	—	9	8	—	—
2858	—	—	9	9	15	—
2859	**5**	9	7	**5**	12	—
2860	—	—	—	—	9	—
2863	—	6	—	8	**7**	10
2862	—	6	**6**	—	—	—
2861	—	**5**	7	—	11	—
2864	—	—	8	—	10	**9**

with corresponding medusæ (the temperature was still, on the whole, falling, not only on the west, but also towards the north). NW. of the Little Fisher Bank and the Jutland Bank there was at the same time a cold, salt water mass, poor in medusæ and of different origin; this water probably never crossed the banks, but was submerged by the Jutland Current; as to the further progress towards the north of this latter however, we have no information. As regards the origin of the above-mentioned streak of less saline water east of the Jutland Bank, I am still unable to say anything with certainty, as its extent is unknown; I am inclined to think however, that it must have had some connection with the water of like salinity outside Nissum Fjord, which was similarly poor in medusæ. This, at any rate as regards its outer portion, undoubtedly belonged to the Jutland Current, and the "streak" would then be a wedge of the same thrust forward in advance.

The results of the investigations in the area here described are highly instructive. They show, in the first place, that a more equable distribution even of a

smaller number of stations, would have been more advantageous, from the point of view of plankton and hydrographical research, than the arrangement actually made, whereby a great number of stations were grouped closely together within sub-areas each of small extent and all some distance apart. (It must be admitted however, that this may have been the best for the main object of the investigations, which was the pursuit of the smallest larval stages of the herring). Then again, our results here show how the composition of the medusa fauna may serve as a guide in determining the origin of water masses at different places. And finally, we see how careful one should be in taking, for this purpose, species alone without regard to size of specimens. The rich medusa fauna being met with for the most part in the warm and salt water, part of which at least belonged to the Jutland Current, one might be tempted to suppose that the medusæ in question had been brought up from the south by that current; the size of the specimens, on the other hand, shows that they had come from the north, and from no great distance.

Skagerrak. We had intended to proceed at once with investigations in the Skagerrak, but succeeded only in getting a couple of stations with the young fish trawl, and these of no great interest, as we were forced to seek shelter from a heavy gale, and for the next week, operations were carried out in the Kattegat. Then followed 4—5 days work in the Skagerrak, mainly fishing with the otter trawl, I will briefly note the results of the few pelagic hauls, beginning from the west irrespectively of the chronological order.

As regards the hydrographical conditions, it will suffice to note the following: along the coast from Bulbjerg to the Skaw, the water was rather cold, 10°2—11°4 at bottom; in the western portion of the Skagerrak on the other hand, we found the temperature, from only a short distance offshore right out to abt. 50 m' depth, abt. 12°, with a slight decrease towards the north (as far as St. 2869). At greater depths, the temperature was considerably lower. The salinity presents no features of particular interest.

At St. 2864, N. of Hanstholm, we found most of the medusæ met with in the "rich" areas in the northern part of the North Sea; at St. 2902 also, off Bulbjerg, a few of these were found, though this station was quite close inshore (depth 15 m, temp. at bottom 11°4); at St. 2867 again, the young fish trawl brought up a quantity of Leptomedusæ; these were, however, so damaged as to be beyond identification, owing to the trawl having caught in the bottom. St. 2906 (depth 70 m, temp. 9°0), yielded such species as *Eutima insignis, E. gegenbauri,* and *Eirene viridula,* but only in small numbers, and a little farther east, at St. 2869 (depth 47 m, temp. 12°0) they were altogether lacking, only *Leuckartiara octona* and *Tima bairdii* being found here. This, then, marks the eastern limit of occurrence of the great stock of Leptomedusæ which was indigenous at the mouth of the Skagerrak, and which had, about 1 Oct. 1922, spread southward along the west coast of Jutland as well as eastward into the Skagerrak itself, though not to any great dis-

tance either way. (Some of the species were met with again in the Kattegat, and were evidently indigenous there). — At the two deep water stations 2895 and 2896 (650 and 450 m) we found, at the bottom, the two interesting medusæ *Tiaranna rotunda* and *Cyclocanna welshi*, both new to the fauna of Denmark. — Investigations in the eastern Skagerrak were very sporadic. St. 2912 (not far from the Skaw) yielded only the two species *Leuckartiara octona* and *Phialidium hemisphæricum*, both of which are indigenous throughout the coastal regions. St. 2892 (N. of the Skaw, 90 m) will best be dealt with in connection with the Kattegat operations.

Kattegat. In the parts of the Kattegat investigated, *Leuckartiara octona* and *Phialidium hemisphæricum* were found nearly everywhere; the latter, however, was rare in the eastern channel, and some of the specimens taken there had probably come from the Skagerrak. — In the western Kattegat, along the coast from the Skaw to Hals and N. of Læsö, only these two species were found, with a solitary young specimen of *Saphenia gracilis*. — The bottom temperature in the deeper portions of the Kattegat was generally abt. 11°5, but in the deep northern part of the eastern channel (St. 2887, 88, and 89, off Vinga, depth 85—90 m) it was considerably less, 9°5—9°6, and at St. 2892 N. of the Skaw (depth 90 m) only 8°2. The most characteristic forms taken in this cold water were *Neoturris pileata* and *Tima bairdii*. These species were both indigenous in this area, but were also found at a few more southerly stations in the eastern channel. — In the channel east of the Læsö plateau, and on and around the grounds of Groves Flak and Fladen, as also in the channel at the Great Middelgrund, several hauls were made near the bottom. In all these hauls, *Leuckartiara* was the dominant species, but *Melicertum octocostatum*, *Cosmetira pilosella*, *Eutima insignis*, and *Saphenia gracilis* were also found, albeit in small numbers; the last named species was evidently indigenous throughout the whole of the eastern channel, the others probably in the northern part, as with *Neoturris* and *Tima*. — Finally, a few hauls were made off the north coast of Sealand and in the Sound; only *Leuckartiara* and a few *Phialidium* were found here.

The cruise of 1922 was of great importance in affording a comprehensive view of the rich medusa fauna living in our waters in autumn, practically nothing being previously known as to this. Apart from the two deep water species from the Skagerrak (*Tiaranna rotunda* and *Cyclocanna welshi*), two further new species were added to our fauna with *Cosmetira pilosella* and *Eirene viridula*; other forms found include *Neoturris pileata*, *Laodicea undulata*, *Saphenia gracilis*, and *Eutima insignis*, all of which were previously known from a very few specimens only, but now proved to be more or less common. Of *Eutima insignis* for instance, only a single specimen was known from Danish waters; it now proved the most numerous of alle medusæ in the vicinity of the mouth of the Skagerrak. It was interesting also to note the importance of *Leuckartiara octona* as a leading form among our autumn plankton. The principal object of the cruise was herring investigations, and the position of pelagic stations, being chosen accordingly, was not always well

suited to the study of other pelagic forms. Consequently, the general view of the distribution of the medusa species is not always as clear as might be wished; it represents nevertheless, a great and valuable advance, and affords a good basis for further studies in the future.

1923.

Charts 22 and 23, pp. 246—247.

Material: Cruise of the "Dana" in all Danish waters, 1—2 April, 17 April—19 May, and 28 May—24 June. — Horizontal hauls with ring trawl and young fish trawl, as a rule both at surface and close to bottom; after 28 May, however, almost exclusively at bottom.

Species: *Sarsia tubulosa, Euphysa tentaculata, Hybocodon prolifer, Bougainvillia superciliaris, B. britannica, Podocoryne areolata, Rathkea octopunctata, Halitholus cirratus, Leuckartiara octona, L. nobilis, Neoturris pileata, Laodicea undulata, Staurophora mertensii, Mitrocoma polydiademata, Tiaropsis multicirrata, Phialidium hemisphæricum, Obelia sp., Obelia nigra, Eutonina indicans, Tima bairdii, Aglantha digitale.*

A sample of the medusæ from each haul was preserved, and the frequency of the species noted in the journal. Only on those parts of the cruise in which I myself was on board (19 April—19 May), however, can these notes be regarded as at all adequate. During the remainder of the period, we cannot be sure that all species present were observed, while some will probably have been unknown to the sorters; in particular, I am convinced that *Rathkea octopunctata* was mostly overlooked in the samples from the south-eastern Kattegat on the 17—18 April. Again, when I was on board, I endeavoured as far as possible to preserve the smallest specimen and the largest of each species, and at times took a really representative sample. The first four stations were situate far apart on the voyage from Esbjerg to Copenhagen 1—2 April; all the material from these stations was preserved, and I sorted it myself.

This was an uncommonly interesting cruise. The stations, which had been fixed beforehand, were very fortunately chosen (the main object of the investigations was connected with pelagic fish larvæ) and the hydrographical conditions encountered proved to be highly peculiar, in some cases altogether abnormal. During the time I was on board, the temperature and salinity of the water was registered (often at several depths) and charted as we sailed, so that we were constantly gaining a clearer insight into the nature of the water masses through which we moved. The salinity was determined by areometer. Table XII however, is based as far as possible on the revised determinations made by titration of water samples brought home. — My theories as to the value of medusæ as an aid to the determination of the origin of water masses were here put to the test. In many cases, my views were confirmed, both as regards the distribution and origin of the various species, and as to the significance of the composition of the fauna in different localities; in other cases, an advantageous revision of opinion was the result, and finally, I gained a great deal of altogether new information. After this cruise, and not least from my own participation in the most important section, I feel now far

more sure of my ground in regard to the whole of this question, which had occupied my mind for years previously.

As regards this particular cruise, it will be best to take the results in more or less chronological order, and not, as in the foregoing, take each water by itself.

From the 1—2 April, a few isolated hauls were made en route from Esbjerg to Copenhagen; the results are not of particular interest save as showing that *Rathkea* and *Hybocodon* were present in the eastern Kattegat, *Hybocodon* also in the Sound, at that season.

On the 17 April, the "Dana" commenced the cruise proper, under the leadership of Dr. A. C. JOHANSEN. During the first two days investigations were carried out in the south-eastern Kattegat. The medusa of most constant occurrence here was *Halitholus cirratus*, though this did not appear in any great numbers; here and there *Hybocodon prolifer* was found in great quantities, and at three stations, large specimens of *Tima bairdii* were found, probably a remainder from the imported stock of the year before (see Special Section, p. 146). At this time, there was already water of very high salinity in the deeper parts of the Kattegat, right up into the bay north of Kullen (Skelderviken) but it was not noticed at once, as there was no table on board for calculating salinity from specific gravity. When joining the vessel at Copenhagen, on the morning of the 19th April, I took with me one of these tables, and made the calculations, and from that date until the 19th May we could always keep ourselves informed as to the salinity of the water by means of the areometer determinations.

On the first day out, in Köge Bay (St. 2954, 19 April) we encountered an interesting phenomenon. The bottom water here, which despite the slight depth (14 m) showed a considerably higher salinity than that at the surface (14.3 as against 7.9 ‰) contained a great number of *Hybocodon prolifer* and a few *Sarsia tubulosa*, *Rathkea octopunctata*, *Tiaropsis multicirrata*, and *Eutonina indicans*. The occurrence of these species in Köge Bay was evidently due to a slight forward movement of the salt bottom water from the Sound across the threshold between Amager and Skåne. In Præstö Bay, all these medusæ were lacking, even at St. 2957, though the bottom salinity here was 17.1 ‰ *i. e.* higher than at the station in Köge Bay already mentioned. — South of Möen, the Baltic stock of *Sarsia tubulosa* and *Halitholus cirratus* began to appear, increasing in numbers as we moved westwards; to these were added, in Kadetrenden, *Hybocodon*, and in the Femern Belt *Rathkea* (bottom salinity here 25.4 ‰). — On the 21—23 April, several places in the waters south of Fyen were investigated. *Sarsia tubulosa* and *Halitholus cirratus*, both indigenous here, were largely predominant; they were found mainly in the lower water layers. Apart from these, we found only a few *Rathkea* (St. 2969) and, curiously enough, a couple of *Aglantha* (St. 2973).

On the way northward through the Great Belt and Samsö Bay, we met with no fewer than 8 species of Hydromedusæ, three of which in particular are interesting: *Halitholus*, which was so common in the Baltic, was found in considerable numbers

in the Great Belt, in quite shallow water east of the island of Vresen and off Kerteminde (St. 2975 and 2977), but was lacking altogether in the deeper parts; it was also taken east of Samsö in the upper water layers. *Hybocodon*, on the other hand, increased very greatly in numbers as we moved northward until we reached Samsö Bay, where it was evidently indigenous. The same was doubtless the case with *Rathkea*, but as this species was not so numerous, the position is not so clearly apparent in this case. Evidently, *Halitholus* must, just before this time, have been on its way from the Baltic out towards the Kattegat, while at the same time, part of the stock of *Hybocodon* and *Rathkea* from the Samsö Bay were carried inward towards the Baltic, reaching, about the 20 April, as far as Kadetrenden and Femern Belt respectively. As we shall presently see, the Atlantic water forced its way in along the deep channels of the Kattegat, and the inward current gained the mastery over the outward movement, so that *Halitholus* was driven over to the shallow coastal waters of the Great Belt. The salinity in the lower water layers of the Great Belt was already unusually high, 30.1 ‰ at 26 m' depth N. of Sprogö (mean abt. 24 ‰).

In and near the Samsö Bay there was a fairly rich fauna of indigenous medusæ (see Table XII).

The subsequent investigations in the eastern and northern Kattegat were extremely interesting, both as regards the hydrographical conditions and the composition of the plankton; in the case of the medusæ, the extreme paucity both of species and of individuals was a characteristic feature of the plankton here. Few as they were, however, these medusæ are most interesting from their peculiar distribution; and not less interesting in itself was this very scarcity of medusæ in a water which at this time of year generally exhibits a particularly abundant fauna.

Salinity in the Eastern Channel of the Kattegat.

	Depth m	St. 2982 37 m ‰	2 981 44 m ‰	2983 47 m ‰	2984 60 m ‰	2985 85 m ‰	2991 85 m ‰
26—29 April 1923	0	18.5	17.9	19.4	20.0	22.4	23.0
	10	32.7	30.2	26.0	33.9	30.0	32.3
	20	34.6	34.5	34.5	34.5	34.5	—
	bottom	34.8	34.7	34.8	35.0	34.9	35.0
Mean 1. May	0	18	19	19	20	21	23
	10	21	22	22	27	28	29
	20	30	31	32	32	32	31
	40	33	33	34	34	34	33

The table above shows the salinities at stations in the eastern channel, together with the approximate mean values for 1. May at the same localities (from the charts, Taf. III in Jacobsen 1909). It will be noted that the salinity at the surface was very nearly normal; this surface layer of Baltic water was, however, very thin, and at only 10 m' depth the water was already very salt, in some places abt. 14 ‰

higher than the surface value, while at 20 m, the salinity everywhere was abt. 34.5 ‰, at bottom 35 ‰ or very near this figure. It is evident that the salt, Atlantic bottom water from the Skagerrak had risen very considerably, and that a great part of it had made its way into the Kattegat, filling up the deeper portions, right up to within 20 or 10 m of the surface, with a slight admixture of Baltic water at the higher levels. In the north-western part of the Kattegat, this salt water reached far in towards the coast; in the northern part of Læsö Channel (St. 2986) a salinity of 34.5 ‰ was registered at 10 m' depth, and in quite shallow water in Aalbæk Bay (6 m, St. 2987), the salinity was 34.1 ‰ right up to the surface. — The temperature everywhere was rather low at the surface, relatively high in the lower water layers. At stations in the eastern channel, temperatures at the same depth showed but slight variation from one place to another; the position may be briefly indicated by the figures in the table below.

Temperature of the water in the Eastern Channel of the Kattegat.

Depth m	26—29 April 1923	Mean 1 May	Difference
0	abt. 5°2	abt. 7°	÷ 1.8
10	— 5°	— 6°	÷ 1
20	— 6°	4°5—5°	+ 1—1.5
bottom	— 6°3	4°5—5°	+ 1.5—2

The bottom water was thus not only salter, but also considerably warmer than is normal.

With the aid of the daily observations recorded in the Nautisk-Meteorologisk Aarbog, we can follow the progress of the salt bottom water as it flowed into the Kattegat. The movement began in February, at Skagens Rev, where, on the 16th, the salinity rose to 35 ‰ at the bottom (38 m) and at the same time to 34.5 ‰ at 30 m' depth. The inflowing salt water, in the form of a thin layer at the bottom, reached Læsö Trindel on the 19th of February, when the salinity suddenly rose from 29.7 to 34.5 ‰. In the course of March, the salt water rose slowly and steadily up towards the surface, so that at Skagens Rev, towards the end of the month, we find 34.5 ‰ at 15 m' depth. At Læsö Trindel, the salt water still kept to the bottom; at Anholt Knob a rise of salinity at the bottom (28 m) was observed about the middle of the month. In April, the upper limit of the salt water at Skagens Rev was abt. 20 m' depth; at Anholt Knob, the rise continued very slowly, and by the end of the month, the salinity here was 35.4 ‰ at bottom, 34.4 ‰ at 20 m' depth. About the same time, the salt bottom water reached Læsö Rende Lightship (maximum 34 ‰) and Schultz's Grund (35 ‰, 30 April). Early in May, the Atlan-

tic water began to fall back, and we notice a drop in the salinity, first at Skagens Rev, later at the more southerly stations.

It is very interesting to note that this rise of the salt bottom water was everywhere accompanied by a sudden drop in the salinity of the upper water layers. The minimum surface salinities at the lightship stations were as follows:

Skagens Rev	23 March	12.4 ‰	normal	28.6 ‰
Læsö Trindel	10 —	14.6 -	—	abt. 25 -
Læsö Rende	22 —	11.5 -	—	abt. 25 -
Anholt Knob	20 —	13.7 -	—	20.4 -
Schultz's Grund	15 —	11.3 -	—	17.9 -

We see then, that the inflow of salt water was at once followed by a strong outward movement of the Baltic water. But from the end of March and on through the whole of April, the surface salinity rose once more, very slowly; by the end of April it was, as we have seen from the "Dana" observations, very nearly normal throughout the eastern Kattegat, and continued to rise until some way on in May. When the bottom water began to rise in earnest in the Kattegat, the outflowing Baltic water was thus largely held up and confined to a thin surface layer. — We shall see later on how the entire situation was changed in the course of May.

Some of the salt bottom water which advanced, as above described, into the Kattegat must have come directly from the Atlantic. This is evident from the plankton fauna, which contained, in addition to several species indigenous in the depths of the Skagerrak, also such typical Gulf Stream forms as the siphonophores *Physophora hydrostatica* and *Galeolaria truncata*, both of which were found in the northern Kattegat at the end of April.

One of the questions which particularly interests us here is the fate of the "bank water". Since the advance and rise of the Atlantic water in the channels of the Kattegat took place gradually in the course of abt. 2 months, it might well be imagined that for a great part of this time, there would have been room between the Atlantic water and the Baltic surface water for some of the North Sea bank water which at this time of year generally constitutes the bulk of the undercurrent in the Kattegat. It is not easy to determine, from temperature and salinity alone, whether the intermediate layer consisted of such bank water or of a mixture of Atlantic and Baltic water; if these two were in direct contact, they would of course mix to a certain extent and produce an intermediate layer of mixed water. — And it is here that I think the medusa fauna can help us.

The medusa fauna of the eastern and northern Kattegat at the end of April. — I will first point out that at this time of year, there is usually a rich medusa fauna at Anholt Knob lightship, *Hybocodon* and *Rathkea* being particularly numerous, and undoubtedly brought thither by the bank water; this also doubtless brings with it a great number of *Eutonina*, which, however, are less frequently taken in the vertical hauls from this station. Also, in normal years, we find

here *Obelia* (the origin of which is unknown) together with *Sarsia tubulosa* and *Aglantha*, these being as a rule mainly indigenous in the eastern Kattegat. — Compared with this normal state of things, the medusa fauna of the eastern and northern Kattegat was remarkably poor at the end of April 1923. True, *Aglantha* occurred almost everywhere, though in small numbers; of other indigenous species, the lower water layers (near bottom) yielded a few small *Sarsia tubulosa* and a very few *Halitholus*, *Tiaropsis*, and *Eutonina* (this last only in the southern part of the eastern channel). *Rathkea* and *Hybocodon* had, as we have seen, a native stock in the southern Kattegat, *Hybocodon* indeed being very common there. Still at St. 2982 (off Great Middelgrund), a few specimens of these two species were taken in the lower water layers; north of here, however, *Rathkea* was altogether lacking, and *Hybocodon* represented only by isolated specimens in the upper water layers as far north as St. 2985 E. of Læsö, not north of here. The upper water layers also yielded a number of large *Sarsia tubulosa*, evidently belonging to the stock from the southern Kattegat or Belt Sea, and now on their way northward with the Baltic current. Apart from the species here noted, the only find was that of a *Laodicea undulata* at St. 2981 (E. of Anholt); this is one of the few medusa species indigenous in the depth of the Skagerrak, and the specimen in question had doubtless been carried thence by the Atlantic water. The hauls in the upper water layers were made with 20, 30, or 40 m wire, *i. e.* at depths to abt. 20 m below surface. — This distribution of the medusæ distinctly shows that all those found in the area in question (with the exception of *Laodicea*) were either of local origin or brought up from the south with the Baltic Current, while of the customary bank water fauna there is no trace whatever to be found. Had there, at any time during the previous month or so, been any inflow of northern bank water into the Kattegat, we should expect now to find a stock originating from that source, at any rate of the gemmiferous species *Hybocodon* and *Rathkea*; we should also look for a form such as *Tima bairdii*; this medusa, however, was only met with right down at the entrance to the Sound, and the specimens from there undoubtedly formed part of a previously imported stock. — As already noted, the Atlantic water in the Kattegat was restricted to a rather thin bottom layer until well on in April, before it rose to such a degree as to bring the boundary layer up to abt. 20 m, where it was sharply defined; in the Skagerrak however, the rise had already commenced early in the winter (see the observations from Skagens Rev for February) and then, presumably, with such force as to check at once the advance of the North Sea bank water into the Kattegat. The bottom layer (and later the intermediate layer) in the Kattegat during February —April thus consisted, not of North Sea bank water, but probably, in part, of water from the Skagerrak, at any rate from its eastern portion. This is very interesting, for since this water did not bring with it the usual spring fauna to the Kattegat, we must conclude that the fauna in question, in normal years, does not originate from the northern Kattegat or eastern Skagerrak, but actually comes all the way from the North Sea, or at least from the western part of the Skagerrak.

Skagerrak. — On the way out towards the North Sea, a number of hauls were made in rather shallow water off the coast of Jutland. In Tannis Bay, the water was still very salt, 34.4 ‰ right up to the surface, and the medusa fauna was poor; in Jammer Bay and Vigsö Bay on the other hand (St. 2997—3000), we at last encountered the "bank water", thrust aside by the advancing Atlantic water. The salinity here did not exceed 33.8 ‰, and the medusa fauna was extraordinarily rich. *Hybocodon* was not found, but *Rathkea* was fairly common, and *Eutonina indicans* extremely numerous; in addition, we find such species as *Bougainvillia britannica* and *superciliaris*, *Tiaropsis multicirrata*, *Obelia nigra*, and *Staurophora mertensii*, with of course *Aglantha*. In Vigsö Bay we encountered for the first time the "red" and the "brown" *Sarsia tubulosa*. Most of these medusæ were doubtless indigenous on the coastal banks near the entrance to the Skagerrak (not, however, the brown Sarsia, vide infra).

North Sea. — From the 2—7 May we were working off the west coast of Jutland. The results of our investigations here are highly interesting, and afford several eloquent examples of the manner in which medusæ may serve to indicate the origin of water masses and the course of currents. — Hydrographical conditions. The surface temperature was in the main increasing towards the south, the bottom temperature apparently chiefly dependent on depth and distances from shore. The most striking feature is the rather low bottom temperature at the outer stations 3010 and 3012. Salinity at the inner stations decreased somewhat towards the south; at the bottom, we have at Hanstholm 33.8 ‰, N. of Horns Rev 32.7 ‰, and the same S. of Horns Rev. The surface salinities recorded in the same areas were respectively 33.6, 32.6, and 31.3 ‰. This might seem to suggest the presence of a north-going current along the coast. The medusa fauna, however, tells a different story.

The medusæ *red Sarsia*, *Bougainvillia britannica*, *Rathkea octopunctata*, *Tiaropsis multicirrata*, and *Eutonina indicans* were represented in Vigsö Bay by a stock indigenous round the mouth of the Skagerrak; all these species decreased noticeable in frequency to the southward, at the inner stations along the west coast of Jutland. The same species were, however, also indigenous and, in some cases, very common in the area S. of Horns Rev. If there had been any north-going movement of the water across Horns Rev, then we should expect to find at least partly the same fauna north of the reef as south of it. This, however, was not the case; on the contrary, there was a conspicuous difference. Of the twelve species composing the medusa fauna at St. 3006 and 3007, only three were found at St. 3004, and the slight traces of this fauna met with farther north at St. 3003 had evidently come from the north, and belonged to the same stock as the fauna in Vigsö Bay. On the other hand, the distribution of *Bougainvillia britannica*, and perhaps also *Rathkea*, at some of the outer stations might suggest that there had been a slight northward current out here at some distance from the coast, but we can say nothing for certain as to this. Again, it is evident that no water had recently been flowing from

the northward across Horns Rev, the occurrence of masses of *brown Sarsia* north of the reef and its complete absence south of the same being proof of this. The distribution of the brown Sarsia is extremely interesting; it is given in detail in the Special Section (p. 32 ff.). We can, I think, from this distribution, in conjunction with the salinity of the water, conclude that a water mass from the west coast of Norway had, shortly before the "Dana" commenced operations here, been driven southward, and thrust a narrow, well-defined tongue eastward round the Jutland Bank and down along the west coast of Jutland as far as the northern edge of Horns Rev, where the great host of Sarsia in this water accumulated.

As already noted above, a rich medusa fauna was located south and south-west of Horns Rev, under conditions indicating that the fauna in question was indigenous. Several of the species noted, however, will hardly be ordinarily indigenous in the area. This applies doubtless to *Bougainvillia britannica, Staurophora mertensii,* and *Tiaropsis multicirrata.* The two last-named are northern forms, and when Bougainvillia occurs in our waters, it doubtless also comes from the north. True, we do not know much about the medusa fauna off the west coast of Jutland apart from what is shown by the three years' collections from Horns Rev lightship, and none of these three species has ever been taken there. But if the species in question were ordinarily indigenous here, they would certainly have been taken by the "Thor" during the cruise in June 1911, and on that occasion, only *Bougainvillia britannica* was noted, this also having evidently been brought down from the north. If it be true that these three species are not ordinarily indigenous south of Horns Rev, then their presence there in May 1923 must be due to the introduction of a previous medusa generation, which propagated in the vicinity, the subsequent hydroid generation then hibernating and sending forth a fresh generation of medusæ. Presuming that it was the medusa generation immediately preceding which was so imported, we can date the event approximately from our knowledge of the biology of the species concerned. All three begin to appear in the plankton in March or April; *Staurophora* lives nearly all the summer, *Bougainvillia* until June—July, but *Tiaropsis* disappears in June at latest. The importation must then have taken place between March and June 1922. — The presence of *Aglantha digitale* and *Tima bairdii* south of Horns Rev (and at the outer stations) likewise suggests an inflow of water from some northern source. It is not likely, however, that these two cold water forms, especially *Tima,* should have been capable of surviving a whole summer south of Horns Rev; still, even though they were not imported at the same time as the three spring forms, their presence might well be supposed to be due to the same current conditions. Now the hydrographical observations from Horns Rev give, as a matter of fact, no indication whatever of any particular inflow of water from the north at any time during 1922. It would be expected that a water mass bringing with it such visitors from the north would reveal its presence by a lowering of the temperature in the deeper levels, as noted in 1911; nothing of the sort was observed, however, from the lightship station. There is, however, also the possibility that

the medusæ in question may have reached the area south of Horns Rev by some other route.

We know from English sources that in 1921, and to some extent also in 1922, extraordinary current conditions prevailed in the North Sea. HARDY (1923) mentions a host of Atlantic Pteropoda off the east coast of England in the autumn of 1921, undoubtedly brought in from the Atlantic round the north of Scotland. STORROW (1922 p. 104) notes that great masses of *Tima bairdii* were washed ashore on the coast of Northumberland in November and December 1921, showing that there was at that time a considerable inflow of water from the northern part of the North Sea, or rather from the Norwegian Channel; even in May 1922, there were still some *Tima* off the Northumberland coast (HARDY p. 8), suggesting that the inflow of northern water towards the east coast of England had continued throughout the winter of 1921—22. It is likely that these water masses moved eastward over towards the west coast of Jutland; that is so say, that they constituted part of the Jutland Current at that time. There is thus no reason why there should not have been a number of northern medusæ brought from the west to the southern parts of the west coast of Jutland in the spring of 1922, favoured, moreover, by the unusually low temperature that spring. Whether the large specimens of *Tima* (at least 7, at most abt. 12 months old) taken near Horns Rev came the same way or were of different origin is another question altogether. In this connection, I would again refer to what I have previously stated as to the position off the west coast of Jutland in the autumn of 1922: in the first place, water from the intermediate depths at the mouth of the Skagerrak extended more or less towards the south along that coast, and further, a cold water mass had thrust itself down towards the north or north-west corner of the Little Fisher Bank and the Jutland Bank; possibly, this cold water may have been of greater extent towards the southward farther west, and have brought with it *Tima bairdii*. We know nothing as to this, however, as no pelagic investigations were made in the Horns Rev area in 1922.

Skagerrak 7—9 and 15—16 May. — The two stations at the mouth of the Skagerrak, 3014 and 1315, exhibited a rather poor fauna; they were particularly interesting from the low salinity right down to the bottom (see Special Section, *Sarsia tubulosa* p. 34). — At the three easterly stations, 3022, 3023 (9 May) and 3042 (15 May), it was noted that the bank water was now in motion towards the east, with all its abundant fauna of medusæ. Particularly common were *Aglantha*, *Eutonina*, and (at St. 3023) *Bougainvillia britannica*, but as a matter of fact, the fauna as found here comprised practically all those forms recorded from the Hanstholm area about 1 May. As regards the hydrographical conditions, we encountered here the remarkable phenomenon of salinity in the lower water layers increasing towards the east, in towards the Kattegat; it was conspicuously low at St. 3022 and 3023, where the lower water layers evidently consisted for the most part of the same Norwegian coastal water which we had met with at the mouth of the Skagerrak; this water, on its eastward way, must then have picked up and carried

off a number of the medusæ which had accumulated in the south-western Skagerrak; the water in question did not reach as far as St. 3042. At the same time, there was a rapid outflow of Baltic surface water; from the ship we could often see violent surface rips, this violent outward movement not extending right in to the coast itself. At St. 3042 and 3044, north of the Skaw, a native stock of *Mitrocoma polydiademata* was found.

Kattegat 13—15 and 17—19 May. In Læsö Channel and Aalborg Bay (13, 14, and 18 May) a fairly abundant fauna of indigenous medusæ was found; *Eutonina* was particularly numerous, but in the case of this species also, it was doubtless only a native stock (see Special Section, *Eutonina* p. 133). At Herthas Flak (St. 3040), on the other hand, the occurrence of a *Bougainvillia britannica* and of some very large *Eutonina* showed that the inflowing bank water had reached here.

Extremely interesting are the two stations 3047 and 3048 in the eastern channel of the Kattegat 17 May. At the deeper and more southerly of these two stations, the bottom water was still very salt (34.7 ‰), but in the intermediate water layers, the salinity was lower than in April. This might well be supposed to be due to a continued mixing of the Atlantic water with the Baltic surface water. But the medusa fauna shows that a very essential part of the water masses here consisted of the advancing North Sea bank water. Disregarding the blue Sarsia, I found in the plankton at these two stations the same fauna as that noted in Vigsö Bay about 1 May. Some of the numerous *Eutonina* were very likely indigenous in the Kattegat, but the many very large specimens had doubtless come from outside; the same applies to *Aglantha*. In addition, *Staurophora* and some *Bougainvillia britannica* were found; a specimen of *Mitrocoma* also, which was indigenous in the neighbourhood of the Skaw, had been carried down as far as Læsö Trindel. *Rathkea* and the *red Sarsia* on the other hand, did not penetrate into the Kattegat.

The investigations on the return voyage through the Skagerrak and Kattegat distinctly show that 1) the Atlantic water was now moving back, and 2) the North Sea bank water, which had been thrust aside out in the western part of the Skagerrak, was forcing its way forward at a violent pace, and had now, by the middle of May, already reached far down in the eastern channel of the Kattegat; 3) that the Baltic surface water, which had been held up in our inner waters, was at the same time flowing speedily outwards. The fact that this Baltic water was not of very low salinity is presumably due to previous mixing with the salter water masses.

This section of the cruise of the "Dana" terminated on the 19 May at a station in the northern part of the Sound (St. 3054), where a native fauna remarkably rich in number of species was found.

28 May—24 June. On the 28 May, the "Dana" again left Copenhagen and proceeded round the north of Sealand and down through the Great Belt to the Baltic, which was closely investigated right from the Little Belt to far east of Bornholm.

At the first two stations, a fairly rich native fauna was observed; as a curiosity

may be noted the finding of two young specimens of *Tima bairdii* east of Kullen (St. 3056), undoubtedly the offspring of that isolated stock of large *Tima* which had been observed in the same water in April. *Tima* is doubtless not otherwise indigenous so far south in the Kattegat; and the same may be said of *Bougainvillia britannica*, two young specimens of which were taken off Hellebæk on the 19 May. Some unusual circumstances must have arisen to enable these two species to develop a small local stock in the south-eastern corner of the Kattegat. In any case, this small local occurrence can hardly have any connection with the occurrence of the same species in the south-western Kattegat a few days later.

The medusa fauna of the lower water layers at stations 3058—3068 from south of Anholt to the southern part of the Langelandsbelt, serves to show the continued rapid inflow of the bank water from the Skagerrak. — Among the indigenous spring fauna of the Kattegat were still found some remains of *Hybocodon* and *Sarsia tubulosa*; *Rathkea* and *Halitholus* on the other hand, had everywhere disappeared. Some of the *Eutonina* found undoubtedly belonged to the Kattegat stock, and the same may perhaps be true of a few *Tiaropsis*. But there can be no doubt that an essential part of the medusa fauna in the southern Kattegat, Bay of Samsö, and Great Belt originated from the Skagerrak. This applies almost certainly to some of the large *Eutonina* taken far down in the Great Belt, the young *Tima* at St. 3061 SE. of Samsö (young, yet old enough to have covered the distance from the Skaw to Samsö at the rate of speed with which the bank water advanced), and finally, to *Bougainvillia britannica*, which was taken at nearly all stations from Anholt to the southern part of the Langelandsbelt, and must have come all the way from the Skagerrak. The size and appearance of the *Aglantha* also show that some of them must have belonged to the stock from the Skagerrak or the North Sea. This fauna could not be traced beyond the southern outflow of the Langelandsbelt. The first inward movement of the North Sea bank water must have taken place about 10 May, or at any rate not many days earlier; by the 1 June, it had reached at least as far as the Langelandsbelt, thus covering a distance of abt. 220 miles in the course of abt. 22 days, *i. e.* moving at an average rate of 10 miles in the twenty four hours (= 0.42 nautical miles per hour = 21.4 $^{cm}/_{sec}$). At certain places, it is true, as in the Langelandsbelt and at Schultz's Grund, much greater velocities have often been recorded at the lower levels; nevertheless, 21.4 $^{cm}/_{sec}$ must be reckoned a considerable rate of speed, when taken as the average for the whole distance covered, in the broader parts of which the undercurrent, as far as we know, generally moves rather slowly. The bank water which flowed into the Kattegat in May 1923, however, did not keep to the bottom in the deeper parts, but forced its way in as an intermediate layer between the Baltic surface water and the Atlantic water still remaining. — A very interesting feature is the finding, at St. 3065, in the Great Belt, of a specimen of *Leuckartiara nobilis*, a Gulf Stream form never before seen in Danish waters.

The results of the investigations in the western Baltic are likewise very inter-

esting. A number of Kattegat forms were carried eastward from the Langelandsbelt (south of Laaland and Falster) and a similar fauna (*Eutonina*, *Aglantha*, *Sarsia*, and *Hybocodon*) was found to have come down through the Little Belt, but not beyond the neighbourhood of Als. South of Fyen, no hydromedusæ were found at all. It seems then, as if no portion of the water flowing in through the Great Belt can have turned westward round the southern extremity of Langeland, as is doubtless generally the case; this may perhaps be due, on this occasion, to the counter-pressure from the simultaneous inflow through the Little Belt.

A fauna consisting more particularly of *Eutonina* and *Aglantha* etc. was found in hauls near the bottom from the southern point of Langeland along the south of Laaland, through Kadetrenden and on into the Baltic proper as far as the eastern side of Möen. There can hardly be any doubt but that this was a fauna originating from the Kattegat, its presence here being due to the fact that the rapidly inflowing North Sea bank water thrust on ahead of it considerable masses of Kattegat water, which were thus driven down through the Great Belt and even through Kadetrenden, this water being also recognisable from the very high salinity at the bottom. East of Gjedser, the salt water layer was, however, very thin, at St. 3082, depth 18 m, the following values were noted:

0 m	8.3 ‰
12 m	8.5 ‰
18 m	21.4 ‰

Even at St. 3089, S. of Möen, where *Eutonina* was still met with, the bottom salinity was 20.3 ‰ (normally 8—9 ‰); farther east, however, no remarkably high salinities were observed.

Investigations in the deeper parts of the Baltic, between 13° E. (the Arkona Deep) and 16½° E. (N. of Stolpebanke) yielded in nearly all the numerous hauls in deeper water layers, *Halitholus cirratus*, which is indeed characteristic of this water; at two localities (St. 3098 N. of Rügen and St. 3103 N. of Bornholm) *Sarsia tubulosa* was also found, this last undoubtedly forming part of a stock indigenous in these deep waters. No hydromedusæ whatever were found in the surface water. For the rest, there is nothing particular to note regarding these investigations.

I cannot but consider that the medusæ are a great aid to the understanding of the peculiar current conditions in Danish waters in the spring of 1923. In the winter (by February at latest) the Atlantic bottom water in the Skagerrak was increased so greatly by inflow from without that it rose to an altogether unusual level, barred the usual inflow of North Sea bank water into the Kattegat, and in the course of March and April forced its way in to the deeper parts of the Kattegat, which gradually became filled almost entirely with this salt water. At first, the inflow of Atlantic water was accompanied by a very marked outflow of Baltic surface water, but in April, when the salt water attained its greatest volume in the Kattegat, the Baltic water was largely checked. The North Sea bank water was

found, about 1 May, to have been forced over into the south-western part of the Skagerrak. Early in May, the Atlantic water began to fall back, yielding place to the bank water, which now, with its abundance of medusæ poured into the Kattegat, flowing through at an average rate of abt. 10 miles in the twentyfour hours, reaching the southern outflow of the Great Belt abt. 1 June. On its way, this bank water picked up a quantity of the organisms previously brought in by the Atlantic water, and in its hurried advance, thrust before it a mass of water from the Kattegat, partly down into the Little Belt, and also through the Great Belt and Kadetrenden some way on into the Baltic proper, where, at the beginning of June, a fauna probably unique for this locality was found.

Chapter II. The Medusa Fauna in different Sections of the Danish Waters.

Table XIV.

There are now 40 species of Hydromedusæ: 21 Anthomedusæ, 18 Leptomedusæ (including the three Obelia species) and 1 Trachymedusa known from Danish waters. Of these 40 species, *Sarsia tubulosa* appears in three varieties (blue, brown, and red), *Aglantha digitale* in two (forma *typica* and var. *rosea*). Since these varieties differ altogether as regards their distribution, it will be best, in this Section, to take them separately, as distinct forms. They are therefore included in the Summary given below as species, thus making the total number of species 43. Of these 43 species, no fewer than 37 are ordinarily indigenous in one or several sections of our waters. Of the remaining 6, there are 2 of which only a single specimen has been found in each case: *Eucodonium brownei* has been taken once in the Kattegat; it is a very small and inconspicuous medusa and was doubtless indigenous on that occasion; it is uncertain, however, whether it is ordinarily so. *Podocoryne areolata*, which was taken in the North Sea during the spring of 1923, was probably a visitor from the north, and is entered in Table XIV as such. Of *Cyclocanna welshi* also, only a single specimen is known, but the species may doubtless be considered indigenous in the depths of the Skagerrak. *Leuckartiara nobilis* again, has only been found once (Great Belt, 1923) and this we can certainly put down as a visitor from the Atlantic. Of the remaining "visitors" two at least (*Staurophora mertensii* and *Melicertum octocostatum*) can sometimes, though probably only exceptionally, be indigenous. — From this it appears that the very great majority of our medusa fauna is indigenous in our own waters, though in the case of some species there may also be some importation from other regions.

We will first go through the medusa fauna of each individual area in detail, and then proceed to consider the results as a whole. As to the limitation of the areas, see Chart 24, p. 248.

The North Sea. The west coast of Jutland is barren and sandy, largely devoid of vegetation; the littoral area therefore offers no favourable conditions for the

hydroids. To the south, off Blaavandshuk, Horns Rev extends some 20 miles out from the coast in a westerly direction; the reef consists mainly of sand without vegetation. South of Horns Rev, the bottom is often rather clayey or stony; algæ are rare, but there are not a few hydroids and bryozoa. — Off the northern part of the coast, abt. 25 miles out, lies the Jutland Bank (minimum depth 17 m) and farther out again the Little Fisher Bank (minimum depth 27 m); on these banks, there are in several places great numbers of small, sharp-edged stones, with a rather scanty growth of algæ, bryozoa, and hydroids. — Farther north again, on the southern slope of the Norwegian Channel and at the entrance to the Skagerrak, we find, especially at depths between 50 and 100 m, the richest growth of hydroids and bryozoa known to exist anywhere in Danish waters. — The hydroids off the western coast of Jutland thus occur for the most part in two separate areas: south of Horns Rev and north of Jutland Bank, the intervening waters being very poor in these forms, until some distance out from shore, in rather deep water, where the wave action does not disturb the bottom material to any great extent. What the hydroids lack on the west coast is first and foremost a supply of objects on which to attach themselves; there are hardly any large stones, and pebbles, gravel and shells are only suitable for the purpose when they can be suffered to lie more or less undisturbed on the bottom. *Sertularia cupressina* and *Hydrallmania falcata* seem to be the forms which manage best; the smaller species occur practically speaking only epizoically on these and on *Flustra*.

Of known medusa-producing hydroids, the following have been found up to the present off the west coast of Jutland: *Laomedea longissima* (medusa probably *Obelia nigra*), *L. geniculata* and *dichotoma* (*Obelia* spp.), *Campanularia johnstoni* (*Phialidium hemisphæricum*), *Perigonimus repens* (*Leuckartiara octona*), *Bougainvillia ramosa* (medusa of that name), *Corymorpha nutans* (*Steenstrupia nutans*), and *Podocoryne carnea* (medusa of that name); the two last-named were taken by Hartlaub NW. of Horns Rev, Podocoryne also NW. of Hanstholm ("Dana"); the others are known only from the northern or southern areas as described above. From the occurrence of the medusæ we may conclude that the North Sea also shelters the hydroids of a whole series of other medusæ. Both in this respect, however, and also in regard to the importation of medusæ from other regions, the northern and southern parts of the area are so unlike that it will be best to take them separately.

Apart from the above mentioned species, the following medusæ are indigenous in the area South of Horns Rev: *Red Sarsia*, *Bougainvillia superciliaris* (rare), *Rathkea octopunctata*, and *Eutonina indicans*; the last-named species is very numerous. All these species occur more or less regularly in the plankton at Horns Rev lightship at the seasons characteristic of each. In certain years also, the hydroids of some few other species may settle provisionally, thus (in 1922—23) *Bougainvillia britannica*, *Staurophora mertensii*, and *Tiaropsis multicirrata*. — In hydrographical respects, the area is marked by comparatively low winter temperature (average minimum abt. 3°) and high summer temperature (average maximum abt. 15°) as

also by the strong tidal currents; there is, however, probably as a rule no great transport of water across Horns Rev. The Jutland Current forms almost constantly a sinistrorse eddy in the German Bight (BÖHNEKE 1922); at Vyl lightship, the surface current flows almost without fluctuation backwards and forwards in SE. and NW. directions, with a resulting mean current averaging 8 $^{cm}/_{sec}$ towards the NW. (magnetic) *i. e.* a very slight displacement of the water mass and also mainly longitudinally along the southern slope of Horns Rev. Round the outermost point of the reef, where the Horns Rev lightship lies, the direction of the current approaches more the N.—S. (main composants N. 21 W. and S. 22 E., magnetic), and the resulting mean current is essentially stronger than at Vyl (19 $^{cm}/_{sec}$). Some of the medusæ hatched south of the reef are doubtless carried westward round the point and thence to the northward, at some considerable distance from the shore. Passing Horns Rev lightship also, there is a more directly moving portion of the Jutland Current, bringing with it various medusæ from the southern part of the North Sea, especially towards the autumn, when the current increases in volume. We find then especially the larger Leptomedusæ: *Eutima gegenbauri* and *insignis*, *Eucheilota maculata*, *Mitrocoma polydiademata*, and *Laodicea undulata*; specimens of *Phialidium hemisphæricum* are also brought up by this current, and the importation of this medusa continues throughout the winter. As a rule, it would seem that none, or at any rate very few, of these medusæ reach as far as the mouth of the Skagerrak. Owing to the eddy above mentioned, Horns Rev and the west coast of Jutland receive practically no supply of medusæ from the Bay of Helgoland, for if so, several of the species indigenous there would have been found; any medusæ brought by the Jutland Current to the west coast of Jutland will not have passed the Bay of Helgoland. Occasionally, there is also some importation to Horns Rev from the north, a cold water mass moving southward along the bottom, below the warmer water of the Jutland Current. We have instances of this in 1911 and 1913; in the latter year indeed, the importation was so considerable, and of such duration, that some of the medusæ taken at Horns Rev had evidently come from the area north of the Jutland Bank. Unfortunately, our medusa material covers only a few years, but in both the cases mentioned, the occurrence of the northern medusæ was accompanied by conspicuously low bottom temperatures, which we know, from hydrographical observations, to be unusual.

In the area between Horns Rev and Jutland Bank, the indigenous fauna is, as mentioned, very poor; true, we may, at some distance out from land, always reckon with numbers of *Eutonina indicans* in the spring. Also the holoplanktonic Trachymedusa *Aglantha digitale* var. *rosea* is indigenous, and extremely numerous, in this area, whence it is carried down to Horns Rev when south-going currents prevail. Presumably, numbers of medusæ occasionally come down from the north along this part of the coast of Jutland; this was the case for instance in the spring of 1923, when great numbers of *Sarsia tubulosa* in particular (brown and green) were carried down to the northern edge of Horns Rev.

In the area North of the Jutland Bank, and at intermediate depths at the mouth of the Skagerrak, there live, not only the above-mentioned species of medusa-producing hydroids, but also the hydroids (mostly unknown) of the following species of medusæ: *red Sarsia, Euphysa aurata, Bougainvillia superciliaris, B. britannica, Lizzia blondina, Rathkea octopunctata, Laodicea undulata, Staurophora mertensii* (probably only in exceptional cases), *Cosmetira pilosella, Tiaropsis multicirrata, Eucheilota maculata, Eutonina indicans, Saphenia gracilis, Eutima insignis, Eutima gegenbauri, Eirene viridula,* and *Tima bairdii.* In this area, the annual changes in temperature are not so great as at Horns Rev, the average minimum at surface is abt. 4°, at bottom 4—5°; average maximum at surface abt. 14°, at bottom abt. 8—11° (according to depth, rising in towards land). Also, the salinity is somewhat higher than in the Horns Rev area (mean value at bottom 34.6—35.0 ‰). The rich medusa fauna is, however, probably due chiefly to the fact that the sea floor offers far more favourable conditions for the hydroids; a very great majority of the medusæ found here are doubtless indigenous on the spot. The Jutland Current runs close inshore, and probably reaches as a rule down to the bottom, both on the banks and on the coastal plateau. This current of course brings a number of medusæ from the coastal bank along the west coast of Jutland, but probably very rarely from more distant parts of the North Sea. Water from the Norwegian Channel often wells up from the north along the northern slope of the banks; this water, however, is doubtless very poor in medusæ. Now and again, the surface water from the coast of Norway may spread southward to north-west Jutland, bringing with it various medusæ such as the large *brown Sarsia, Bougainvillia britannica* and *principis, Podocoryne areolata* etc.; this happened, for instance, in the spring of 1923, but it is doubtless a phenomenon of rare occurrence.

Skagerrak. In the deep channel of the Skagerrak, the depths run to as much as 700 m; the bottom consists, as far as we know, of soft clay and ooze in all parts, and is very poor in hydroids. It is highly probable that several interesting medusæ live in the depths, but we know very little about them. HARTLAUB found *Bythotiara murrayi* off Lindesnes; and on the cruise of the "Dana" in 1922, I found *Tiaranna rotunda* and the remarkable *Cyclocanna welshi* near the bottom at 450 and 650 m' depth. Higher up in the water we find *Aglantha digitale* forma *typica,* and in the upper parts of the Atlantic water, where it meets the bank water, *Tima bairdii* may be taken. Finally, there seems to be an indigenous stock of *Laodicea undulata* in the depths of the Skagerrak.

The coastal region from Hanstholm to the Skaw offers very unsuitable conditions for hydroids; we find, however, in the harbour now in course of construction at Hirtshals, *Campanularia johnstoni* and *Laomedea dichotoma* and *geniculata,* the hydroids of which, as well as the medusæ, I observed in great numbers in the harhour basin during the summer of 1925; in this harbour, I also found the hydroid *Bougainvillia ramosa.*

Outside the coastal area proper, conditions differ greatly from one part to

another. In the western waters we find no clay bottom until some 30 miles from shore, where the water is 100 m deep. There is a large area here where the bottom abounds in gravel, small stones, and shells, an excellent type of bottom for all attached forms, and we find also a very rich fauna of these, in direct continuation of that above noted as living in the area north of the Jutland Bank and up towards the southern slope of the Norwegian Channel. Farther east, the ooze reaches considerably farther in towards land. The medusæ indigenous in the area round Hanstholm, both within and beyond the boundary between the North Sea and the Skagerrak, have been mentioned above. Farther east again, the Danish coastal area hardly contains any other species beyond *Phialidium hemisphæricum* and the *Obelia* forms, which are indigenous; possibly also *Lizzia blondina*. The hydroid of *Mitrocoma polydiademata* probably lives in rather deep water outside Tannis Bay, and at intermediate depths N. and E. of the Skaw, *Neoturris pileata* is indigenous. We can also say for certain that the hydroid of *Tima bairdii* must live at intermediate depths throughout the whole of the Skagerrak. — Off the rocky coasts of Norway and Sweden, several neritic species naturally have their habitat, among them *Hybocodon prolifer* and *Steenstrupia nutans*, which have not hitherto been found on the Danish shores of the Skagerrak. Off the south coast of Norway, the surface water moves outward, towards the North Sea (the Baltic Current); some of the medusæ indigenous here can, however, get out into the eastward flowing bank water, and there is every reason to believe that such forms as *Hybocodon prolifer*, *Rathkea octopunctata*, and *Melicertum octocostatum* can make their way into the Kattegat by this route. Probably, however, any such importation from the northern side of the Skagerrak only takes place in the spring, with the "northern" bank water. I am inclined to believe that most of the medusæ imported into the Kattegat follow the Danish coast, and originate from the rich area N. and NW. of Hanstholm; in the first place, the eastward movement of the bank water is strongest along the coast of Jutland, and further, there is a considerable similarity between the indigenous fauna of the Hanstholm area and the bank water fauna of the Kattegat. Importation of medusæ by this route might take place both in spring and autumn. The Jutland Current contributes to the formation of the bank water in the Skagerrak, chiefly in the autumn. This current runs close inshore at Hanstholm and Hirtshals, but in Vigsö Bay and Jammer Bay it keeps some distance out; the coastal currents here are of a purely local character, and depend on the wind; the same holds good to some extent as regards Tannis Bay. — The Skagerrak itself may occasionally receive supplies of medusæ from without; save for the inflow round Hanstholm, however, this importation is of but slight extent and doubtless only takes place occasionally. Given certain combinations of wind and current, the brown *Sarsia tubulosa*, *Bougainvillia principis*, *Staurophora mertensii*, *Melicertum octocostatum* and perhaps other species may be carried from the west coast of Norway into the Skagerrak. A case such as that of 1923, when purely Atlantic water was carried into the Skagerrak is doubtless almost unique. — In the eastern part of the Skagerrak, off the coast of Bohuslän,

we find two medusæ which do not occur in the other parts of the Skagerrak *viz.* the *blue Sarsia* (very common) and *Halitholus cirratus* (rare). As already noted, the eastward current in the Skagerrak continues over towards the Swedish coast, where it divides, part of it uniting with the Baltic Current and flowing northward, part flowing south as an undercurrent in the Kattegat. The indigenous medusa fauna off the coast of Bohuslän is more likely to be carried northward, but now and again some organisms may be picked up by the south-going current and carried into the Kattegat (as for instance in the spring of 1909).

The Kattegat (not including Bay of Samsö) falls naturally into two distinct areas: the extensive shallows of the western part, and the deep channel which occupies most of the eastern and southern portions. It will be natural first to deal with the Eastern Channel, which forms a direct continuation of the depths of the Skagerrak. — Depths. From the rocky western shores of Sweden, the bottom falls away rather steeply down towards the broad, deep channel, but for some way along the western side of the channel, the declivity is even steeper, to wit, on the eastern edge of the Aalborg plateau. We find here the deepest part of the channel, often with depths of abt. 100 m. There are several grounds in the eastern channel, and the deep channels wind in and out between them. In the southern Kattegat, the bottom is more uniform, with depths about 25—35 m. In the south-western portion again we have a great number of banks or shallow grounds (Lysegrund, Hesselö, Schultz's Grund etc.) with intervening channels of 30—40 m; this part of the water forms the transition to the Bay of Samsö.

In by far the greater part of the eastern channel the bottom is composed of clay and ooze, more or less mixed with sand in the shallower waters. The banks consist as a rule of gravel and stones, with laminaria and other algæ; there are however some stony banks devoid of vegetation here and there in deeper water. The eastern and southern Kattegat thus constitute, as regards form and character of the bottom, a highly complex and heterogeneous water, and afford, in consequence, the possibility for development of a rich fauna. As regards the attached forms (epifauna) very little is known, unfortunately, about this interesting area. Of medusa-producing hydroids, we know from the cruises of the "Hauch" only *Perigonimus repens* and *Laomedea dichotoma*; I have myself, on the cruises of the "Dana" in 1922 and 1923 found these two species, and in addition, *Campanularia johnstoni* at 25 m' depth on Groves Flak. Dredgings from the "Dana" were made chiefly at intermediate depths; I was somewhat surprised at the small number of hydroids brought up. It is possible, however, that operations at other depths may prove more satisfactory, though this is not certain. The soft clay bottom at the greater depths does not afford good conditions for the ordinary hydroid forms (we find here mainly such species as can thrive when attached to live molluscs, *Perigonimus* species, *Merona cornucopiæ*); the stony parts with a growth of algæ on the other hand, are often so near the surface as to be exposed, at any rate occasionally, to the action of the Baltic Current. It will also be seen, when we come to consider

the occurrence of the medusæ in the eastern and southern Kattegat, that the species derived from littoral hydroids are remarkably rare. On the rocky coast of Sweden, there are doubtless several such hydroids, but we know very little about them, and the medusæ they produce are doubtless carried northward with the coastal current, never moving far out to sea; they are therefore of little interest to us in this connection.

Aglantha digitale var. *rosea* is indigenous throughout the deeper part of the Kattegat, and forma *typica* may occasionally come down into the channels from the Skagerrak. Apart from this holoplanktonic species, there are 31 species of Hydromedusæ known from the Kattegat as a whole; only 2 of these have not yet been found pelagically in the area here dealt with (eastern and southern Kattegat), *viz.* the littoral forms *Podocoryne carnea* and *Bougainvillia ramosa*; the hydroid forms of these, however, are found on the north coast of Sealand, and presumably also on the coast of Sweden, and the two medusæ must therefore be reckoned as belonging to the fauna of the area. In the accompanying table, I have endeavoured to arrange faunistically the 31 species in question. The arrangement is based on such conclusions as I considered might be drawn from the occurrence of the medusæ as noted in the Special Section; it should be borne in mind, however, that in the case of some species, our material is not sufficient for positive and definite results. The arrangement must therefore be taken with some reserve; it affords, however, a fairly good idea as to the character of the fauna. — The two last-noted species in the table are so rare that they must be omitted from any calculation. Of the remaining 29 species, no fewer than 22 or 23 are presumably indigenous, some, however, only in the northern or in the southern part of the area, not in both. — The hydroids of the first 8 species are probably found only in rather shallow water. *Euphysa tentaculata* is only indigenous in the southern Kattegat, and the same probably holds good of *Bougainvillia ramosa*, *Podocoryne carnea*, and *Steenstrupia nutans*. The *Obelia* medusæ can, it is true, occur in considerable numbers in the eastern channel; we cannot distinguish one from another of the three, but in all probability it is chiefly the medusa of *Laomedea dichotoma* which is found, this hydroid being the commonest species in the eastern channel, and extending out into deeper water than the other two. Native specimens of *Phialidium hemisphæricum* are rare in the eastern channel, but there is a regular supply from the autumn stock of the Skagerrak. Both *Obelia* and *Phialidium* are considerably more numerous in the south-western part of the Kattegat. — As already noted, not a single medusa-producing hydroid has yet been found in deeper water in the eastern and southern Kattegat; nevertheless, we must presume that at least 14 species live here; 9 of these hydroids are unknown to science. The undercurrent from the Skagerrak brings into the Kattegat a considerable supply of medusæ; the number of species thus brought in from without may be put at 21; in the great majority of cases, however, the eastern channel has also its own indigenous stock of the species in question, mainly from deeper water. Only 6 or 7 species it would seem,

Medusæ of the Eastern and Southern Kattegat.

Species	Indigenous in		Introduced from N.	Only as Visitors	Remarks
	shallow water	deep water			
Bougainvillia ramosa	s	..	..	..	
Obelia geniculata	×	..	..	..	
Phialidium hemisphæricum	×	..	×	..	Only the autumn form is brought from the north.
Podocoryne carnea	s	..	..	..	
Steenstrupia nutans	×	..	..	..	Perhaps only in the southern part.
Obelia longissima	×	..	..	..	
— dichotoma	×	..	..	..	
Euphysa tentaculata	s	?	..	..	
Sarsia tubulosa	×	(×)	×	..	
Leuckartiara octona	×	×	(×)	..	
Halitholus cirratus	..	×	..	..	
Purena gemmifera	..	×	(×)	..	
Euphysa aurata	..	×	(×)	..	
Lizzia blondina	..	×	×	..	
Eutonina indicans	?	s	×	..	
Tima bairdii	..	(×)	×	..	As a rule only indigenous in the northern part.
Hybocodon prolifer	..	s	×	..	
Rathkea octopunctata	..	s	×	..	
Eucheilota maculata	..	(×)	(×)	..	Only occasionally indigenous.
Tiaropsis multicirrata	..	(×)	×	..	do.
Saphenia gracilis	..	(×)	×	..	do.
Neoturris pileata	..	(N)	×	..	
Eutima insignis	..	?	×	?	Perhaps indigenous in northern part.
Bougainvillia britannica	..	..	(×)	×	
Laodicea undulata	..	..	(×)	×	
Staurophora mertensii	..	..	(×)	×	
Melicertum octocostatum	..	..	(×)	×	
Mitrocoma polydiademata	..	..	(×)	×	
Cosmetira pilosella	..	..	×	×	
Bougainvillia superciliaris	..	(?)	..	..	Probably indigenous, but rare.
Eucodonium brownei	(?)	(?)	..	..	Only one specimen known; from the southern part.
No. of species	10	14	21	6	Total 31 species.
Total no. of indigenous species	22				

N = Only in the northern part of the area.
S = Only in the southern part of the area
( ) = rare.

occur solely as visitors from without; and even with regard to these it is highly possible that future investigations may reveal some of them as indigenous, though rare. — The indigenous species form a more or less equable mixture of northern and southern species; the visitors are predominantly forms with a northerly area of distribution. It is characteristic that the 4 species from deep water indigenous in the southern part of the area are all northerly forms; this is undoubtedly connected with the fact that the temperature of the lower water layers is lower in the southern than in the northern waters of the Kattegat, especially in summer. Altogether, the "southern" Kattegat is, hydrographically as well as regards its fauna, so unlike the "eastern" and "northern" Kattegat that it would be desirable to deal with it separately; with our inadequate knowledge as to the distribution of the species concerned, however, such distinction cannot be made here, and I have therefore, in the table above, merely indicated by the letters S and N such species as are only indigenous in one part — southern or northern — in the total area involved.

From the foregoing, we see that the eastern channel and the southern basin of the Kattegat constitute an area with abundant fauna, among the medusa-producing hydroids of which, however, the littoral forms are of quite subordinate importance compared with the more abyssal.

We may then proceed to consider the western Kattegat, the coast of Jutland from the Skaw to Hasenöre and the shore grounds with the shallows outside. Save for the deep Læsö Channel, which is a direct continuation of the deep eastern channel itself, the western Kattegat is, both as regards physical conditions and fauna, very unlike the eastern part. Aalbæk Bay has a fine sandy beach almost throughout; large stones with a rich growth of algæ are found near Frederikshavn, and in the stone breakwaters of the harbour at the Skaw. On the algæ we may find *Laomedea geniculata* and *Campanularia johnstoni*, more rarely *Laomedea dichotoma* and *Bougainvillia ramosa*; on the whole, however, hydroids are rather rare on algæ in this region. The sandy bottom inside Hirtsholmene has an abundant growth of *Zostera*, but farther north, up towards the Skaw, this vegetation becomes more and more scanty; in and inside the Zostera belt, *Nassa reticulata* creeps about on the sandy floor, often with *Podocoryne carnea* attached to its shell. In the greater part of Aalbæk Bay, the sandy bottom extends far out, though with some admixture of clay in the outer parts; in many places, shells abound, often with large colonies of *Laomedea dichotoma* and *longissima*, especially up near the Skaw. Bivalves and gastropods are often, especially in rather deeper water, overgrown with *Perigonimus repens*. Outside the middle of Aalbæk Bay, some 10 miles from the nearest land (the Skaw) there lies a solitary shoal with gravelly bottom (minimum depth 9.2 m) called Hertha's Flak; the name is generally used, as a matter of fact, for the whole extent of level ground extending out eastward from Aalbæk Bay; it falls away on the north to the deeps of the Skagerrak, on the south to the deep Læsö Channel; everywhere outside the 20 m curve, the bottom consists of clay and ooze;

Podocoryne carnea and *Perigonimus repens* have been found here, but the fauna is otherwise very little known.

The hydroid fauna of the large, shallow Aalborg plateau which comprises the shore grounds round the islands of Læsö and Anholt, is likewise very little known. From a little south of Frederikshavn to about Fornæs in Djursland, the coast is flat and sandy, with an extensive and luxuriant growth of *Zostera*. I have made a number of excursions along this stretch of coast, but have never myself found any of the medusa-producing hydroids; at the mouth of Randers Fjord *Podocoryne carnea* and *Laomedea geniculata* have been found, the latter also in one or two localities on the east coast of Djursland. On the north side of Læsö, there are several considerable stony banks with a growth of algæ, but they have no rich hydroid fauna; I have found *Campanularia johnstoni* and *Laomedea geniculata* on Læsö Trindel and adjacent grounds, where also *Laomedea dichotoma* may be met with on shells etc. The sandy bank south of Læsö, which is covered with *Zostera* and *Fucus*, and has only few stones, is probably poor in hydroids. The Aalborg plateau outside the shore grounds consists mainly of sand, with a few stony banks here and there, these having a growth of *Laminaria* and other algæ. The only medusa-producing hydroids found are *Campanularia johnstoni*, *Laomedea dichotoma*, and *Corymorpha nutans*, and, at a single locality north of Anholt, *Laomedea longissima*. In Læsö Channel, which cuts through north and west of Læsö with decreasing depth and a bottom of soft clay, the only form found is *Perigonimus repens* (on bivalves).

The plateaux of the western Kattegat thus yield the hydroids of the following medusæ: *Steenstrupia nutans*, *Leuckartiara octona*, *Podocoryne carnea*, *Bougainvillia ramosa*, *Phialidium hemisphæricum*, and all three *Obelia* species. The two first-named occur mainly in somewhat deeper water, the remainder are chiefly littoral forms. The hydroid of *Bougainvillia ramosa* is rather rare, the other species, however, are common near Frederikshavn and the Skaw, but seem to be scarce in the other parts of the area.

It is evident, however, from the occurrence of the medusæ, that the hydroids of the following species must also exist in this part of the Kattegat: *Sarsia tubulosa*, *Hybocodon prolifer*, *Rathkea octopunctata*, and *Eutonina indicans*. Possibly also, the hydroid of *Euphysa aurata* may be indigenous on the deeper parts of the plateaux. The number of species whose hydroids live on the plateaux of the western Kattegat is thus 12 or 13 (including the three *Obelia* species), *i. e.* something over half the total of 22 or 24 indigenous in the Kattegat as a whole. These are for the most part the same species as found in Samsö Bay, but constant experience shows that the number of specimens of these species is as a rule less in the bays of Aalborg and Aalbæk than in the Bay of Samsö (*vide infra*).

As regards importation from without, nearly all the species here referred to are recruited by supplies coming probably as a rule from the Skagerrak eastward

round Hertha's Flak and down through Læsö Channel; this, however, doubtless does not apply to *Boungainvillia ramosa* and *Podocoryne carnea*; perhaps not to all of the *Obelia* species. — Species presumably not indigenous in the area but often imported are *Tima bairdii*, *Halitholus cirratus*, and *Lizzia blondina* (the last-named occasionally from the eastern Kattegat round the north of Anholt); more rarely, *Bougainvillia superciliaris*, *Bougainvillia britannica*, *Melicertum octocostatum*, *Tiaropsis multicirrata*, *Eucheilota maculata*, and *Saphenia gracilis*, 9 species in all, 6 of which are indigenous (though some are rare) in other parts of the Kattegat. Of medusæ known as visitors in the Kattegat, there are thus only 3 which have been found up to now in the western part. True, the western Kattegat is not one of our best investigated areas; nevertheless, there can be no doubt but that the fauna, both indigenous and imported, is comparatively poor.

The Sound. Before proceeding to consider the Bay of Samsö, which as regards its fauna constitutes a part of the Belt Sea, it will be as well to say a little about the Sound, which is in many respects a peculiar water. — The narrow northern end of the Sound is deep; the southern part, on the other hand, is characterised by the shallows which, with Amager and Saltholm, join Sealand to Skåne and prevent the regular passage of that salt water which flows down from the Kattegat into the deep channels of the Sound. Owing to the low salinity, the fauna of the shore grounds is poor; the only medusa-producing hydroids hitherto found are *Podocoryne carnea* and *Corymorpha nutans*; this latter form I found in 1916 a little south of Elsinore. The channels, which in places attain a depth of abt. 40 m, constitute, as regards their fauna, a continuation of the eastern channel of the Kattegat; the bottom is clay, the salinity nearly as high as in the deep parts of the Kattegat itself. A very remarkable feature is the low temperature of the lower, salter water layers. The fauna of the Sound, both pelagic and bottom fauna, is very inadequately known. Apart from the two above mentioned forms taken in shallow water, no medusa-producing hydroids have hitherto been recorded from the Sound. A considerable number of medusæ, however, have been found, considering the paucity of the plankton material available, and most of the species are doubtless indigenous in the Sound. No definite distinction between natives and visitors can be made, as the material is not sufficient. *Podocoryne carnea* has not been taken pelagically in the Sound; *Steenstrupia nutans* has been found off Hellebæk, but not south of Elsinore; we know, however, that these two species are indigenous in the Sound, as their hydroids have been found. The following species also are probably or possibly indigenous: *Sarsia tubulosa*, *Purena gemmifera*, *Euphysa aurata*, *Euphysa tentaculata*, *Hybocodon prolifer*, *Rathkea octopunctata*, *Halitholus cirratus*, *Leuckartiara octona*, and *Eutonina indicans*; I consider it very doubtful whether *Phialidium hemisphæricum* and the *Obelia* species are indigenous in the Sound (their hydroids have been found off Hellebæk, but not below Elsinore). The following species occur probably only as visitors: *Lizzia blondina*, *Tiaropsis multicirrata*, *Tima bairdii*, and *Aglantha digitale*.

Assuming that the *Obelia* specimens found represent all three species, we have then a list of 19 species in all, found in the Sound either as hydroids (the two species above noted) or as medusæ.

Bay of Samsö. I use this term for the south-western part of the Kattegat within a line from Gniben—Hasenöre (not, as does JACOBSEN 1908, only within the line Fyens Hoved—Samsö—Hasenöre). It is a very complex area, surrounded by deeply indented coasts and abounding in islets and shoals with deep narrow channels in between, where the depths as a rule are from 30—40 m. The most pronounced of these channels is that between Sealand and Samsö; depths here run up to 59 m, and the channel itself forms a direct line of communication between the southern Kattegat (round the south of Schultz's Grund) and the Great Belt. Another important channel runs north and west of Samsö; there are holes here of considerable depth (up to 64 m, N of Samsö), but the bottom is far more uneven than that of the eastern channel. Between Samsö and Fyens Hoved there are a number of small shoals and several deep holes, but no pronounced deep channel; the salt bottom water of the Kattegat can therefore only penetrate into the Little Belt by a complicated and circuitous route. Hydrographically, the area is characterised firstly by the low summer temperature of the bottom water, and further, by the considerable extent to which the water layers are mixed, giving a comparatively salt surface water, especially near the coast of Jutland. In winter, the mixing is strongest, and the difference between bottom and surface salinity therefore least.

As regards the hydroid fauna, Samsö Bay is the best investigated of the larger areas in the Danish waters, thanks to the excellent collections made by G. Winther (WINTHER 1880); this writer not only collected a considerable amount of material, but also labelled his preparations with very precise indications as to locality. — There is a rich vegetation in this water. Along the coasts, especially in the indentations, there are considerable growths of *Zostera*, and on the stony banks a number of algæ, including large *Laminaria*, are found; the leaves of these last have a considerable span of life, which is favourable for the development of hydroids which are often found growing on them (see Special Section, under *Bougainvillia ramosa*). On the algæ, we find great numbers of *Bougainvillia ramosa*, *Campanularia johnstoni*, and *Laomedea geniculata*; less numerous, sometimes on algæ, also on small stones and shells, are *Laomedea dichotoma* and *longissima*. *Podocoryne carnea* is, like *Nassa reticulata*, on the shell of which it is most frequently found, particularly common in the shallower parts of this area; on the edges of the channels, where there is sandy bottom, *Corymorpha nutans* may at times be found in great numbers. On the shells of live molluscs from clay bottom in the deeper parts we may find *Perigonimus repens*; this species, however, is not so common here as it is farther out in the Kattegat. — In addition to the 8 species above noted, the following 9 must also be regarded as probably indigenous (at any rate occasionally), chiefly in deeper water: *Sarsia tubulosa* (very common, hydroid taken in the northern part of the Little Belt), *Euphysa aurata* (not constant), *Euphysa tentaculata*, *Hybocodon prolifer*

(common), *Lizzia blondina* (not constant), *Rathkea octopunctata*, *Halitholus cirratus* (rare), *Tiaropsis multicirrata* (not constant), *Eutonina indicans*. With the exception perhaps of *Podocoryne carnea* and *Bougainvillia ramosa*, all the indigenous species are doubtless further supplemented by importations from the southern Kattegat. The following species occur only as visitors from outside: *Purena gemmifera*, *Bougainvillia britannica* (very rare), *Tima bairdii*, and *Aglantha digitale*. — Altogether, 21 species of hydromedusæ have been found in the Bay of Samsö up to now, including the three *Obelia* species. The littoral forms are more numerous here than in any other part of our waters, not on account of specially favourable temperature or salinity, but because the nature of the bottom, and the vegetation, with the strong, brisk current flowing between the numerous islets and shoals afford favourable conditions for the development of the hydroids. The littoral species are for the most part cosmopolitan, or have their main area of distribution in the boreal but not extreme arctic regions. Those species, however, whose hydroids, most of them unkown, must be presumed to live in the deeper waters of the area, are mainly northern forms; in particular, it should be noted that the indigenous Kattegat stock of the three northern medusæ: *Hybocodon prolifer*, *Rathkea octopunctata*, and *Eutonina indicans* is, as far as we can judge, much more numerously represented here than in other parts of the Kattegat. There can be little doubt but that this is due to the low summer temperature in the deeper water layers (cf. western Kattegat).

The medusæ brought in to the Samsö Bay from outside by the undercurrent are nearly all forms indigenous in the southern Kattegat. Exceptions are *Bougainvillia britannica*, which was only found in Samsö Bay in one year (1923), under abnormal hydrographical conditions, and *Tima bairdii*, the longevity of which enables it to reach here from its distant habitat in the Skagerrak or northernmost waters of the Kattegat. Nevertheless, it is almost certain that a very essential portion of the import supply of the gemmiferous medusæ *Hybocodon*, *Rathkea*, and perhaps also *Lizzia* does come all the way from the Skagerrak; the specimens found in Samsö Bay, however, are hatched out in the Kattegat as a gemmation product of the stock from the Skagerrak. Possibly also some of the *Eutonina indicans* in Samsö Bay may have come from afar. — It will be observed that the imported medusæ which may be supposed to come from the Skagerrak are all such as occur in spring or summer; none of those forms which come in to the eastern channel of the Kattegat in late summer and autumn ever seems to reach as far down as the Bay of Samsö.

Little Belt. Northern boundary: Strib—Fredericia; southern boundary: a line drawn from the north-west extremity of Ærö (Skjoldnæs) to the south-eastern corner of Als (Pöls Huk). In the broader parts, the depth is comparatively slight (abt. 20—25 m, increasing on the whole from north to south); in the narrows, however, the current has cut channels of considerable depth, 40—50 m; west of Fænö as much as 81 m. In the deeper parts, the bottom consists as a rule of clay and ooze. The laminaria- and sponge regions of the coasts shelter numerous hydroids

and bryozoa etc.; save for the western part of the Skagerrak, there is probably no other part of our waters with so rich and luxuriant an epifauna of all kinds.

In hydrographical respects, the Little Belt is characterised primarily by the strong current, which at times can race back and forth through the narrows at a furious pace, the water layers in consequence becoming so thoroughly intermixed that we have practically uniform temperature and salinity from bottom to surface. The current often changes its direction, and inshore, in the bays and creeks, a powerful backwash is often formed. The salinity decreases somewhat from north to south, varying considerably at any given spot according to the direction of the current; in Middelfart Sound, with a north-going current, it is as a rule 15—16 ‰ with a south-going current abt. 20—21 ‰.

The medusa-producing hydroids found in the Little Belt up to the present are as follows: *Bougainvillia ramosa* (numerous on Laminaria), *Podocoryne carnea* (common on Nassa), *Corymorpha nutans* (sometimes very numerous on sand or gravel bottom), *Coryne sarsii* (common on Halidrys, red algæ, Flustra etc.), *Campanularia johnstoni* (numerous, especially on red algæ), *Laomedea geniculata* (very numerous on Laminaria, Halidrys etc.), *L. longissima* (rare; I found it on a single occasion west of Fænö). All these species are found in the northernmost part of the Belt (off Strib, Middelfart, Fænö). The hydroid fauna farther south is practically unknown, so that we cannot say how far down through the belt the species extend. *Laomedea geniculata*, however, must presumably live also in the southern part of the Belt as it has been taken in the waters south of Fyen. — Apart from the 7 species here mentioned, the hydroids of the following medusæ must live either in the southern part of the Little Belt or in the waters of the Baltic immediately adjoining: *Bougainvillia superciliaris* (rare), *Hybocodon prolifer*, *Rathkea octopunctata*, and *Halitholus cirratus*. — As visitors from the north, the following have been found: *Eutonina indicans* (regularly in May—June, sometimes in great hosts), *Euphysa aurata* (July 1909, July—Sept. 1915), *Purena gemmifera* (Sept. 1893), *Lizzia blondina* (July—Sept. 1915), *Tiaropsis multicirrata* (April 1915), *Tima bairdii* (Jan. 1914), and *Aglantha digitale* (Jan. 1916). — There are thus 18 species in all of hydromedusæ hitherto found in the Little Belt. — Great numbers of the following are imported from the north: *Sarsia tubulosa*, *Hybocodon prolifer*, *Rathkea octopunctata*, *Obelia* spp., and *Eutonina indicans*, all forms wich are indigenous and common in the Bay of Samsö; on rare occasions, when *Euphysa aurata* has an indigenous stock in that same water, this medusa also can appear in the Little Belt in considerable numbers (1915). The other species occurring as visitors in the Little Belt are all rare, coming only occasionally and in small numbers though most of them are indigenous at any rate in the outer portion of Samsö Bay; true Kattegat forms occur very rarely (*Tima bairdii*, *Aglantha digitale*, *Purena gemmifera*). From this we may conclude that the Little Belt as a rule obtains supplies of imported medusæ only from the waters immediately adjacent, both north and south, though occasionally, one or another form from the Kattegat proper may

appear, these being either long-lived species such as *Tima*, gemmiferous as *Purena* and *Lizzia*, or holoplanktonic (*Aglantha*).

Great Belt. Northern boundary: Fyens Hoved—Revsnæs: southern boundary: southernmost extremity of Langeland (Gulstav)—south-western corner of Laaland (Albuen); the southern part is called the Langelandsbelt. — Depths. Throughout the whole length of the Great Belt there runs a deep, narrow channel, 30—40 m for the greater part, but in places nearly 60 m deep. This channel runs round the east of Sprogö, and continues through the Langelandsbelt; west of Langeland on the other hand, the water is rather shallow. Outside the channel, the depth in the Great Belt proper is abt. 20—25 m; in the Langelandsbelt only abt. 15 m; the channel is here particularly marked. Shoals and islets occur here and there. On the banks, large stones with algæ are often found; the bottom is, however, mainly clay throughout the Belt. Hydrographically, the characteristic feature of the Great Belt is the free passage of Kattegat water, mainly as a salt undercurrent in the deep channel, flowing almost constantly southward. The surface currents are rather complex; they can be very strong at times, forming a powerful backwash close inshore. Generally speaking, the surface currents are directed northward, with a heavy pressure over towards the eastern side, the salinity here being consequently much lower than on the western side. The surface salinity fluctuates a great deal according to direction of current (10—20 ‰). At 20 m' depth, the average salinity is abt. 19—24 ‰, increasing from south to north; there is as a rule a well defined boundary between the salt bottom water and the less salt surface water, the distinction being more pronounced in summer. The temperature of the lower water layers is in winter somewhat lower, in summer somewhat higher than in Samsö Bay.

The medusa-producing hydroids known from the Great Belt are: *Coryne sarsii* (hitherto only found at Nyborg), *Perigonimus repens* (only in the northern part), *Podocoryne carnea* (still found west of Langeland), *Corymorpha nutans*, *Laomedea geniculata*, *dichotoma*, and *longissima*. Neither *Campanularia johnstoni* nor *Bougainvillia ramosa* have been met with in the Great Belt, nor have their medusæ been found there. Apart from the 7 noted above, the following 6 species must be presumed to be indigenous in the Great Belt: *Euphysa tentaculata*, *Hybocodon prolifer* (common), *Bougainvillia superciliaris* (rare), *Rathkea octopunctata* (fairly common), *Halitholus cirratus* (somewhat rare), *Eutonina indicans* (scarce); in addition, there may occasionally be a native stock of *Euphysa aurata*. The undercurrent from the Kattegat brings every year a considerable additional supply of *Sarsia tubulosa*, *Hybocodon prolifer*, *Rathkea octopunctata*, and *Eutonina indicans;* there may also be some importation of the three first-named species from the south. It is possible that *Purena gemmifera* and *Lizzia blondina*, which have only once been found in the Belt (Aug. 1916) may likewise be regular annual visitors, but we have very little plankton material from the season at which these two species occur. *Aglantha* appears fairly frequently, though not regularly, as a visitor. *Bougainvillia britannica* and *Tiaropsis*

multicirrata rarely visit the Great Belt; they were found there in 1923, when a specimen of the Atlantic medusa *Leuckartiara nobilis* was also taken. The occurrence of *Halitholus cirratus* in great numbers is doubtless due to importation from the south. Up to now, the total number of medusæ found in the Great Belt is 20, of which 14 are indigenous. There can be little doubt but that the Great Belt receives a considerable supply of medusæ from the Kattegat in spring; hardly any of the late summer and autumn forms, however, have been found in the Belt. This can scarcely be due to insufficient inflow of water from the Kattegat; it is possible that the lower salinity of the Belt water kills off the organisms in question; on the other hand it is quite as likely that the cause may be purely and simply lack of sufficient material from these seasons. Plankton investigations in the Great Belt have been almost exclusively directed towards the finding of fish eggs, and were therefore carried out in the spring; as to the pelagic fauna of these waters later in the year we know, unfortunately, very little indeed.

The western Baltic comprises the waters south of the Danish islands from the southern mouths of the Belts to a line Gedser-Darserort. The water is divided by the Femern Belt into an eastern and a western Basin. — As regards depth, the bottom is for the most part very level, the shore ground narrow on the whole, and banks in open water very few. The depth increases gradually from the coasts to abt. 20—25 m. South of Ærö, there is a channel some 30 m deep, connecting the channels of the Little Belt and Great Belt. That of the Great Belt also has a continuation to the eastward through the Femern Belt, buth with decreasing depth, and in the eastern basin, no very pronounced channel is distinguishable until the entrance to the Baltic proper is reached; here, the narrow cut known as Kadetrenden, 20—30 m deep, runs through between Gjedser Rev and the shallows off Darserort. — Nature of bottom: In the western Baltic, the bottom consists for the greater part of sand and small stones at depths to abt. 20 m, ooze and mud beyond that depth. — Hydrography: The surface salinity decreases rather sharply from west to east, and is higher in winter than in summer (mean for February 17—11 ‰, for August 15—9 ‰); in the lower water layers, however, there is little difference in salinity between west and east, and the higher values are noted in summer (at 20 m: 18—19 ‰ for February, abt. 20 ‰ for August). The difference between surface and bottom salinity is thus least in winter, the mixing of the water layers being greater at that season. The temperature of the bottom water is rather low; in summer a little higher, in winter a little lower than in Samsö Bay and the south-western Kattegat. — The current at the surface is variable, but mainly directed outwards, carrying, especially in spring, a considerable volume of water from the Baltic proper to the Belts and on into the Kattegat. The water at the lower levels is doubtless only to a slight extent renewed through the Little Belt; the salt, inward undercurrent of the Great Belt on the other hand continues down into the western Baltic. As a rule, one branch turns southward round Langeland, follows the channel south of Ærö, and flows back along the German coast to join

the other branch running directly eastward from the Great Belt through the Femern Belt to the eastern basin and via Kadetrenden to the Baltic proper. The inflow through Kadetrenden, however, takes place irregularly in sudden movements of short duration, and the greater part of the salt bottom water coming in through the Great Belt stagnates in the deeper portions of the western Baltic, mixing, in course of time, with the surface layers.

The hydroid fauna of the western Baltic is but little known, though a fair number of species have been found. Only three are, however, medusa-producing forms, viz: *Laomedea geniculata*, which I found in 1923 off the mouth of the Sli, *Coryne sarsii*, which has been taken outside Kiel and Warnemünde, and *Podocoryne carnea*, from Kiel and Wismar; the medusa corresponding to *Coryne sarsii*, (*Sarsia tubulosa*) is common throughout the western Baltic. *Halitholus cirratus* is likewise indigenous both in the eastern and in the western basin; it is fairly common, and its hydroid must doubtless live in the deepest, cold parts of the area. — *Euphysa tentaculata*, *Hybocodon prolifer*, and *Rathkea octopunctata* must likewise be presumed to be indigenous, but only in the western basin, and not in great numbers. *Bougainvillia superciliaris* may possibly be indigenous here, though rare. — The western Baltic receives via the Great Belt considerable supplies of *Sarsia tubulosa*, *Hybocodon prolifer*, *Rathkea octopunctata*, and *Obelia*, as also of *Eutonina indicans*, which only occurs as a visitor. It has been found, however, on several occasions, that even though great hosts of these medusæ may have been on their way through the Great Belt, only small numbers were found at the same time in the western Baltic; it seems as if the imported specimens died on entering this water (*vide infra*). Visitors less frequently met with are *Euphysa aurata*, *Steenstrupia nutans*, *Phialidium hemisphæricum*, and *Aglantha digitale*. Altogether, 13 species of hydromedusæ have been found up to now in the western Baltic (*Obelia* here reckoned as one species only, *geniculata*, though the two other forms may possibly appear as visitors). Of these 13 species, 7 or 8 are indigenous, all being species of northerly or cosmopolitan distribution. All are indigenous in the western basin, but only 3 of them in the eastern. The remaining 5 species appear only as visitors, and have only been met with in small numbers; it is possible that they may come in through the Great Belt in considerable numbers, most of them, however, dying off as soon as they enter the Baltic, as would also appear to be the case with the imported stocks of indigenous species above noted. This is remarkable inasmuch as the salinity at the levels inhabited by the organisms in question (lower water layers, and probably fairly close up to the boundary layer) is not much lower in the western Baltic than in the Great Belt, at any rate, in its southern part, the Langelandsbelt. Possibly the 19—20 ‰ at the southern mouth of the Great Belt just represents the lower limit of endurance for several of these species. As, however, several of them have been found in excellent condition at even lower salinities, it is more likely that other factors are responsible (oxygen content; concentration

of hydrogen ions?); the striking difference between the fauna of the western and that of the eastern basin seems also to point in this direction.

The biological boundaries of the Baltic proper on the outward side consist partly of a line Gjedser—Darserort, and partly of a line from the south-eastern point of Amager (Dragör) across the southern extremity of Saltholm to Limhamn in Skåne. Inside both these entrances there are rather shallow waters. Various banks and shallows occur also farther up in the Baltic; it will here suffice to mention the grounds between Bornholm and Rügen, where the minimum depth is 5.8 m (Adler Grund, abt. midway between the two islands). The basin west of Bornholm shows depths of abt. 50 m (the Arkona Deep); east of Bornholm lies the Bornholm Deep, with abt. 80—100 metres of water. The bottom in these deeps is of soft mud. The mean salinity of the surface water is, from Bornholm to near the entrances, abt. 8—9 ‰, varying only slightly, and with a very gradual increase towards the bottom. In the deeps, we may find on the bottom a salter water, of 15—20, or up to 23 ‰ salinity. This salt bottom water varies greatly in quantity, extent and salinity. The temperature in the deeps is as a rule low, 3°—5°, but may at times, in the Arkona Deep in summer, in the Bornholm Deep not until autumn, rise to a figure considerably higher. The surface current carries a considerable volume of water out through the Sound and Kadetrenden. The salt bottom water is renewed rather frequently, though irregularly and by sudden movements, via Kadetrenden, rarely through the Sound.

Only two species of hydromedusæ can be regarded as indigenous in the Baltic proper. *Halitholus cirratus* lives in the cold deep portions, being very numerous in the Bornholm Deep, rarer in the Arkona Deep. *Sarsia tubulosa* is probably indigenous in the south-western part, though hardly beyond Rügen and not north of Möen; it may at times be carried by the salt undercurrent far up into the Baltic, but keeps then to the lower salterer levels; it has been met with as far as 17° E. *Hybocodon prolifer* sometimes comes in through Kadetrenden; in 1908, is was carried by the undercurrent nearly as far as Bornholm, but this is probably exceptional. *Rathkea octopunctata* also may possibly come in through Kadetrenden, but has not been observed here up to now. Occasionally, when the bottom water from the Sound overflows the threshold between Sealand and Skåne, it may carry some medusæ with it; on the 19 April 1923 for instance, the following species were found in Köge Bay; *Sarsia tubulosa*, *Hybocodon prolifer*, *Rathkea octopunctata*, *Tiaropsis multicirrata*, and *Eutonina indicans*, the salinity being 14 ‰. Medusæ coming in by this route do not in all probability penetrate very far, as the water pouring in through the narrow and not very deep channels between Sealand and Skåne soon flows out into a broad open expanse where it is mixed with the masses of the Baltic water and lost in it, the salinity then being too low for the medusæ. — Altogether exceptional is the occurrence, at the beginning of June 1923, of *Euphysa tentaculata*, *Obelia sp.*, *Eutonina indicans*, and *Aglantha digitale* in the passage south of Möen (but not farther east), the water being forced in through Kadetrenden

owing to the heavy inflow of bank water from the Skagerrak into the Kattegat. — In the Baltic proper, 9 species of hydromedusæ have hitherto been found; of these, 2 are indigenous, 2 may be regarded as fairly frequent visitors, the remaining 5 as visitors of very rare occurrence.

Discussion. — Table XIV shows the distribution of the species throughout the different sections of the Danish waters. In each section, the species found there are divided into two columns, that on the left containing those known or presumed to be indigenous in the section concerned, that on the right species imported from other waters (one and the same species may occur in both columns). Where a species is indigenous only in a certain portion of a section, this is indicated by a special sign; the direction whence imported stocks are derived is also noted. Further, in the case of indigenous species, I have noted in parentheses: species which are rare, but presumably normally occurring ( ) and species only occasionally indigenous [ ]. In several instances, these indications cannot claim to represent more than my own more or less confident opinion, based on the grounds already put forward in the Special Section. The table does not pretend to give a completely certain and reliable survey, but affords a fairly good idea as to the distribution of the species.

At the bottom of the table is noted the number of species in each section of the waters, divided into 1) those normally indigenous, and 2) those which only appear occasionally, as visitors, or only exceptionally as indigenous. These figures show, roughly speaking, the following state of things: The Skagerrak has the largest number of species, and the Kattegat has more than the North Sea. The proportion of "visitors" as compared with ordinarily indigenous species shows a marked increase from the North Sea and the Skagerrak towards the Baltic. This at once suggests that the salinity of the water must be the most important factor in the delimitation of the respective areas of distribution. The general survey here given will not, however, suffice as it stands to give a clear understanding of the distribution of species and character of the fauna; as with statistics generally, it requires to be analysed. In the first place, we have to distinguish between species with littoral and those with abyssal hydroids; then again, the geographical range of the species has also to be considered. Both features have also to be regarded in the light of hydrographical conditions in the separate sections. We are here doubly at a disadvantage, as our knowledge is insufficient for certain classification. Only a few of the hydroids are known, and we must therefore, in most cases, make do with what we can venture to assume from the occurrence of the medusæ. Zoogeographical classification again, though possible in most cases, is out of the question in others. The following rare forms, or species only occasionally met with, must be omitted altogether from our considerations: *Eucodonium brownei, Bougainvillia principis, B. superciliaris, Podocoryne areolata, Leuckartiara nobilis, Staurophora mertensii, Melicertum octocostatum, Tiaropsis multicirrata.*

Medusæ with littoral hydroids. — Among these I include the 9 species noted in the table below. It is possible that a few other species should also come

	North Sea	Skagerrak	E. & S. Kattegat	W. Kattegat	The Sound	Samsö Bay	Little Belt	Great Belt	W. Baltic	Baltic proper	Geographical distribution
Bougainvillia ramosa	×	×	×	×	..	×	×	..	..	..	southern
Obelia geniculata	×	×	×	×	..	×	×	×	×	..	cosmopolitan
Phialidium hemisphæricum	×	×	×	×	..	×	×	..	..	..	temperate
Podocoryne carnea	×	×	×	×	×	×	×	×	×	..	cosmopolitan
Sarsia tubulosa	×	×	×	×	×	×	×	×	×	×	northern
Steenstrupia nutans	×	×	×	×	×	×	×	×	..	..	temperate
Obelia longissima	×	×	×	×	..	×	(×)	×	..	..	cosmopolitan
Obelia dichotoma	×	×	×	×	..	×	..	×	..	..	cosmopolitan
Leuckartiara octona	×	×	×	×	×	×	..	×	..	..	cosmopolitan
Number of indigenous species	9	9	9	9	4	9	7	7	3	1	

under this head, but the 9 here given are the only ones as to which we can say anything for certain (I am here disregarding *Cladonema radiatum*, as its occurrence and mode of life are unique). Some of the 9 species are more decidedly littoral than others, and this evidently affects their distribution to a great extent; they are arranged in the table more or less in order of vertical occurrence, the most decidedly littoral forms uppermost. — We notice first of all that all 9 species are found in the North Sea, the Skagerak, the Kattegat, and Bay of Samsö; 2 species are lacking in the Little Belt but met with in the Great Belt; two others are lacking in the Great Belt but occur in the Little Belt; the Sound and the Baltic contain but a few of the species. — What, then, are the causes which determine the distribution of these species in our waters? We must here first of all bear in mind that the Temperature of the upper water layers does not differ very greatly as between one and another part of our shores; moreover, the species here in question are nearly all widely distributed in temperate regions, or even cosmopolitan; an exception is *Sarsia tubulosa*, which is of rather northerly occurrence, but this species is represented in our inner waters by a particular variety. The temperature can thus hardly be of any importance in this connection. — It is otherwise with the Salinity. In the 5 areas in which all the species are indigenous, the salinity is sufficiently high for them throughout; in the Baltic, on the other hand, it is too low for most. The most interesting point is, however, the distinct relationship discernible between the fauna of the three channels leading to the Baltic, and the salinity of the water layers. We will first take the 4 species from the Sound: the hydroid of *Steenstrupia nutans* has only been found in the northernmost part of

the Sound; that of *Leuckartiara octona* (*Perigonimus repens*) can live in rather deep water, and therefore thrives in the deep salt channels of the Sound; the two remaining species are both able, as their occurrence in the Baltic shows, to endure a rather low salinity. It is not impossible that *Obelia dichotoma* and *longissima* may actually be living in the channels of the Sound; it is certain, on the other hand, that the most littoral species are lacking. In the Little Belt, the water layers become so mixed that the salinity at bottom, even in the deepest parts, is insufficient for *Perigonimus repens*, *Laomedea dichotoma*, and *Laomedea longissima* (which has only been found once), whereas these three species, all of which can go out into deeper water, live in the channels of the Great Belt, where the bottom water remains salt. On the other hand, the same features enable the more decidedly littoral hydroids of *Bougainvillia ramosa* and *Phialidium hemisphæricum* (*Campanularia johnstoni*) to thrive in the northern part of the Little Belt, whereas they are to all appearances both lacking in the Great Belt, where the surface salinity, owing to the slighter degree of mixing, is lower than in the Little Belt. — Everything thus suggests that the distribution of the littoral species in towards the Baltic is restricted by the salinity of the water. Within limits of adequate salinity, however, the occurrence of the hydroids depends on the presence of plants, animals, or other objects on which they can grow, together with a supply of suitable food in sufficient quantity; given otherwise favourable conditions of life, these hydroid forms will attain their most luxuriant development where there is a fairly strong current.

Medusæ whose hydroids are known or presumed to live in deep water. — These can be divided into 4 groups, according to their distribution as indigenous forms in the Danish waters:

a) Indigenous only in the deep channel of the Skagerrak: *Tiaranna rotunda* and *Cyclocanna welshi.*

b) Indigenous round the mouth of the Skagerrak on the slopes north of the Jutland Bank and Hanstholm, but not farther inward in the Skagerrak, and not as a rule in the other parts of our waters: *Bougainvillia britannica*, *Cosmetira pilosella*, *Eucheilota maculata*, *Saphenia gracilis*, *Eutima insignis*, *Eutima gegenbauri*, and *Eirene viridula.* (An intermediate position between groups *a* and *b* is occupied by *Laodicea undulata*, see Special Section). Most of these species will at times, perhaps not infrequently, be carried by the undercurrent into the channels of the Kattegat, but only on one occasion, under exceptional circumstances, was one of them observed in the Belt Sea (*Bougainvillia britannica*, in 1923); presumably, the salinity of the water forms a barrier to their further progress in towards the Baltic. Most of them, moreover, are carried to Horns Rev by the Jutland Current, from the southern part of the North Sea. — It is not altogether easy to understand why the hydroids of these species should live, ordinarily, only in these parts of our waters. As far as the salinity is concerned, one would think they might certainly

be indigenous farther on in the Skagerrak, or even in the deepest parts of the eastern channel in the Kattegat. It is possible that such factors as nature of bottom, and the presence of suitable animal forms or other objects to which the hydroids can attach themselves, as also lively interchange of water, which is advantageous to most hydroids, are responsible for the occurrence and well being of the species in question in these waters; we have also noted that numerous known hydroids attain a more luxuriant development here than in any other part of our waters. But the fact that these species in particular should occur here, all of them being forms with mainly southerly distribution and, except for Bougainvillia britannica, occurring pelagically in the hottest season, late summer and autumn, invites consideration of the question as to whether temperature may not count for something. Let us compare the mean values of the bottom temperatures for the months of February, May, August, and November at 40—100 m' depth for three sections across the Skagerrak (Resumé de l'hydrographie, 1909, Pl. XV ff.: Section III, Thyborön—Lindesnes; Section II, north of Hirtshals; Section I, north of the Skaw) and two sections through the Kattegat (Jacobsen 1908, Taf. VIII—XI: Section I, from the Paternoster reefs towards the west; Section II, longitudinal, from the southern Kattegat to the deep east of Kobbergrund). These figures are given (approximately) in the table below. We shall here observe that in February, the lowest temperatures are found in the Hirtshals section (Sk. II) the highest in the Skaw (Sk. I) and Thyborön sections (Sk. III), the Kattegat sections being about midway between. In May, there is not much difference between the Skagerrak sections, but the temperature in the Kattegat is considerably lower. In August, the temperature is a little lower at the mouth of the Skagerrak than farther east; in the Kattegat, on the whole considerably lower but rising towards the Swedish coast. In November, the temperature is lowest in the western Skagerrak, rising gradually towards the east, and essentially higher in the Kattegat. — The winter temperature is presumably, within these limits, of no importance; the maximal temperatures evidently attain higher values in the Kattegat than in the western Skagerrak, though they may occur somewhat later. — The area in which these hydroids live has thus no particularly high winter or summer temperatures, and it does not seem as if any answer to our question could be found here. Possibly it may count for something, that in spring and summer, when the hydroids (save for Bougainvillia britannica) are presumably developing and liberating their medusæ, the temperature increases more rapidly in the Skagerrak than in the Kattegat. On the other hand, it would seem more reasonable to suppose that the period when the medusæ are propagating, and new hydroid generations are being formed, must be a critical one for the species; and at this time of year, the temperature of the Kattegat is higher than that of the western Skagerrak. In any case, the temperature affords us no clue as to why these hydroids should not extend farther into the Skagerrak. I return, then, to the suggestion that it must be the nature of the bottom, and the currents, which, directly or indirectly, favour

Bottom Temperatures in Sections Skagerrak I—III and Kattegat I—II.

	m	Sk. III	Sk. II	Sk. I	K. II	K. I
Febr.	40	4.5	3	5.5	5.2	< 4
	60	5.2	3.8	5.5	5	4.1
	80	5.4	4.5	5.5	5	> 4.2
	100	5.5	4.6	5.5	—	—
May	40	6.2	7	6	4.5	< 5.5
	60	5.9	6.1	< 6	4.8	5.2
	80	5.8	5.9	< 6	4.8	5
	100	5.8	5.7	5.6	5	—
Aug.	40	12	13	12	10	12
	60	9	11	10	7	9
	80	8	9	9	< 6.4	< 8
	100	7	8	8	—	7.5
Sept.	40	8.6	8.5	9.5	<10.5	>10
	60	8	> 8	9	<10	10
	80	7.6	8	8.5	9.5	<10
	100	7.5	8	> 8	9.4	< 9.3

the growth of these hydroids, and provide the suitable conditions of life for them in the area north of the Jutland Bank and Hanstholm. — And yet I cannot quite relinquish the idea that certain conditions of temperature must count for something in the occurrence of these southerly species. Compare, for instance, the following group:

c) Species indigenous on the slopes of the eastern Skagerrak, and to some extent also in the northernmost, deepest parts of the eastern channel in the Kattegat. We have here three species, all of a predominantly northerly distribution: *Neoturris pileata*, *Mitrocoma polydiademata*, and *Tima bairdii*. Neoturris and Tima especially are decidedly cold water forms, which, when they occur in the Kattegat, are found in water of low temperature. Tima, which has a long span of life in the medusa stage, is carried through the deep channels right down into the Sound, Bay of Samsö, and Little Belt; in winter, it may be met with in rather shallow water, but at other seasons it keeps to the cold water of the deepest channels.

d) Species whose hydroids live in deeper water inside the Skaw. There are 8 species which come under this head; their distribution in the Danish waters will be seen from the table below.

The distribution of these species, as indigenous forms, shows a very distinct correlation with the temperature of the water. In the table the species are arranged as far as possible in consecutive order according to their geographical distribution,

	North Sea	Skagerrak	E. Kattegat	W. Kattegat	Samsö Bay	Little Belt	Great Belt	W. Baltic	Baltic proper	Geographical distribution
Purena gemmifera	..	×	I	..	G	G	G	..	..	southern
Lizzia blondina	I	I	I	G	[I]	G	G	..	..	—
Eutonina indicans	I	I	I, s	I	I	G	(I)	G	(G)	northern
Euphysa aurata.....	I	I	I	I	[I]	G	[I]	(G)	..	—
Rathkea octopunctata.	I	I	I, s	I	I	I	I	I	G	—
Hybocodon prolifer...	..	I	I, s	I	I	I	I	I	G	—
Euphysa tentaculata ..	..	..	I, s	..	I	..	I	I	(G)	—
Halitholus cirratus ...	..	G	I	G	I	I	I	I	I	—

I = indigenous. G = only as a visitor. *s* = in southern part only. × = occurs. () = rare. [] = only exceptionally.

the most southerly forms coming first, the most northerly last. — *Halitholus cirratus* occupies a position apart from the rest, having its main area of distribution in the inner waters of the Baltic, and decreasing greatly in numbers out towards the Skagerrak; it is an arctic outlier in the Baltic, and is only found outside this water in the early spring. — *Purena* and *Lizzia* are southerly forms; their main area of occurrence inside the Skaw, lies in the eastern channel of the Kattegat, where the bottom water at intermediate depths shows a comparatively high temperature both winter and summer; the summer temperature especially is considerably higher than in the south-western Kattegat or the Belt Sea. In both species, the medusæ propagate by gemmation, and the stocks remain for a long time among the plankton, chiefly in the intermediate water layers, not only at the bottom in the deep channels. Neither time nor temperature could thus prevent their being carried by the currents far in towards the Baltic; the fact that they actually penetrate only in small numbers into the Belt Sea is thus doubtless due to the lower salinity, which bars the further progress of the medusæ; on the other hand, it is almost certainly the temperature, and especially the summer temperature, which restricts the hydroid generation mainly to the eastern Kattegat. Nevertheless, we must not disregard the possibility that these hydroids, which are as yet unknown to us, may be associated with certain animal forms or other objects only met with in the eastern channel of the Kattegat and farther out, the restricted occurrence of these thus also determining the inner limit of occurrence of the hydroids in question. As against this theory, we have again the fact that Lizzia at least can sometimes, in certain years, have an indigenous stock in the Bay of Samsö.

All the remaining species in this group are northerly forms. *Euphysa aurata*, penetrating but a little way into the Baltic, reveals itself as somewhat more stenohaline than the rest; and this explains why, unlike the other species, it is not constantly indigenous in the Belt Sea. It may be so at times, however, and in the

Kattegat, it is quite as common in the southern, colder parts as in the northerly, warmer waters. — As regards the 4 remaining species, all have their main area of occurrence in our waters, as indigenous forms, in the southern Kattegat and Bay of Samsö, *i. e.* in waters where the summer temperature of the lower water layers is at its lowest. *Euphysa tentaculata* has hitherto only been met with south of Anholt, and has altogether only been found in small numbers; it is, however, a decidedly northern form, and is thus very probably really only indigenous in the southern and coldest parts of our waters. The three other species are indigenous in the western Kattegat, where the summer temperature is rather low; they are, however, considerably more numerous in the still colder Bay of Samsö, where the natural conditions otherwise resemble in several respects those of the western Kattegat. All seem to be very rare as indigenous forms in the northern part of the eastern channel, but are common in the southern part, and increase in numbers as we approach the cold Bay of Samsö. In the western Baltic, the salinity is evidently too low for *Eutonina*, which appears here only as a visitor, whereas *Hybocodon* and *Rathkea* again exhibit an indigenous stock in the cold deep water south of the Fyen group of islands. We see then, as regards these 7 species, that the movement of the pelagic medusæ in towards the Baltic is restricted by the salinity of the water, but where salinity is high enough for a given species to exist at all, the areas in which that species can live through its whole life cycle will be determined by the temperature of the bottom water, especially in summer. The connection between occurrence and temperature is at any rate so pronounced that I think it may fairly be taken as one of cause and effect.

In the foregoing discussion, I have disregarded *Aglantha digitale*, our one holoplanktonic medusa. I have pointed out, in the Special Section, that its distribution as an indigenous form depends not only on the salinity of the water, but also on the depth.

The zoogeographical considerations put forward above lead, I consider, to the following results:

The limits to which pelagic medusæ can penetrate in towards the Baltic are determined first and foremost by the salinity of the water, often in conjunction with the duration of life in the individual or, in gemmiferous forms, the pelagic life of the stock, as medusæ with but a short span of life will, *cæteris paribus*, have less chance of being carried far from their source of origin than the more long-lived forms. In some rare cases also (among certain cold water forms) the temperature of the water is a factor to be considered.

In the case of the hydroids also, the salinity at the depths where they live determines the absolute limit of occurrence of the species in towards the Baltic. Within areas of adequate salinity, however, there are numerous other factors to be considered. Many species seem to be affected by the temperature of the water, those whose main area of distribution lies in waters south of our own thriving

best where the temperature of the water is highest; and *vice versa* in the case of the northern forms; everything seems to suggest that it is the summer temperature far more than that of winter which is of importance here. — Several species are at their best where there is a brisk current, this presumably ensuring abundant supply of food. — Apart from these considerations, which affect the various species in different ways and in different degrees, a point of decisive importance for the hydroids is the presence of suitable objects to which they can attach themselves: stones, shells, living molluscs or crustaceans, algæ of suitable shape and size etc. Hydroids growing on living animals or plants are nearly always found to be associated, not with certain particular species of host, but with those whose mode of life conforms to a certain type. A hydroid which can grown on a *Buccinum* can also grow on an *Aporrhais*; *Perigonimus repens*, which is found in the Kattegat mostly on the hinder end of live *Nucula*, can thrive equally well on the operculum of a *Turritella* or the pointed end of the shell of a *Dentalium*, forms which live partly, but not entirely buried in the oozy bottom. (For the particular occurrence on the crab *Corystes*, see Special Section).

Looking back over this discussion it will be evident, first and foremost that the question as to what factors determine the distribution of species and composition of the fauna in different waters is extremely complicated, and that tabular arrangements of numerical material (so many species found in, or common to, such and such waters etc.) are useless without the closest analysis. The only way to arrive at an understanding of the question is by the closest possible investigation of the biology of each individual species.

Chapter III. Seasonal Occurrence of the Medusæ.

Table XV.

Most of the meroplanktonic medusæ have a certain definitely restricted period of occurrence, which is, in the main, uniform year after year within a given water (this, however, does not apply to deep sea forms, whose occurrence is probably but little affected by the seasons). Table XV shows the periods of occurrence of the most important species of hydromedusæ in Danish waters. The following species have been omitted owing to lack of adequate material:

Brown *Sarsia tubulosa*, in the North Sea in spring.
Red — — — — —
Euphysa tentaculata, in the southern Kattegat and Belt Sea, May—July.
Cladonema radiatum, in the Limfjord spring to autumn.
Bougainvillia principis, found in the Skagerrak and North Sea in July and August.
Podocoryne areolata, once in the North Sea in May.
Tiaranna rotunda, found in the deeps of the Skagerrak, October.
Leuckartiara nobilis, once in the Great Belt in May.
Neoturris pileata, found in the eastern Skagerrak and northern Kattegat in May, June, and October.

Cyclocanna welshi, once in the deeps of the Skagerrak in October.

Laodicea undulata, the stock indigenous in the deeps of the Skagerrak has been found in April, May, and October; the North Sea stock in September—October.

Staurophora mertensii, in the North Sea and Skagerrak in May.

Melicertum octocostatum, found in June, July, August, and October.

The remaining Danish species are noted in the table according to their normal period of occurrence. Where a sign is placed in parentheses, this denotes that the species in question is sometimes met with in that particular month; quite exceptional occurrences are not included in the table.

Some Observations as to the normal period of Occurrence of the Medusæ. — A few species may be met with pelagically in our waters throughout the year. In the case of the *Obelia* species, this is due to the fact that the hydroids liberate medusæ at nearly all seasons, save for a very brief spell in the winter. *Phialidium* medusæ on the other hand, are liberated only during a fairly short period, as a rule from June—October, and in our inner waters the pelagic medusa is lacking in winter and early spring, whereas in the North Sea and the Skagerrak, the medusæ hatched in autumn continue to grow, live through the winter and far on into the following spring, being sometimes carried down into the Kattegat. It is this surviving stock from the winter that accounts for the finding of Phialidium all the year round. — Young *Tima bairdii* are liberated from May to October, but the longevity of the individuals is such that they may be met with at all seasons. — All our remaining meroplanktonic species have a definitely restricted season, which depends first on the length of time during which medusæ are liberated by the hydroid, and further, on the longevity of the medusæ themselves; their span of life ranges from a few days (*Podocoryne carnea*) to several months. The average length of life of the individuals can be determined when sufficient representative material is available, but this we have up to now only been able to procure in the case of a few species. As regards gemmiferous medusæ, the duration of the season depends not only on the rate of growth and longevity of the individual, but also on the number of generations which can be produced.

The time of year at which the medusæ appear in the plankton differs greatly for the different species, and is characteristic in each case. Some occur in midwinter or early spring, others in midsummer or towards autumn. When considering which species occur at the various seasons, it is natural to enquire whether there is any correlation with their geographical occurrence in general. We find, on investigation (see Table XV) that those medusæ which appear in our waters in winter and spring are very largely those with a northerly range of distribution, whereas our summer and autumn forms are predominantly southerly species (in both cases, with exception of a few cosmopolitan forms). This again naturally leads us to the question as to:

Variation in the period of occurrence in different waters. — It is a general rule that medusæ species in the warmest part of their area of distribution occur earlier in the year than in colder parts; various instances of this are noted in KRAMP & DAMAS (1925) in the case of Norwegian medusæ, and also in my "Ingolf" papers; I will not therefore go further into the question here. Some examples may, however, here be given of medusæ exhibiting a period of occurrence in Danish waters differing from that noted elsewhere. I should wish first of all to point out the difference which exists, in the case of several species, between their occurrence in the North Sea and in our inner waters. The following species appear earlier in the North Sea and Skagerrak than in the Kattegat and Belt Sea: *Steenstrupia nutans*, *Leuckartiara octona*, *Phialidium hemisphæricum*, and *Eutonina indicans*; to these may be added the holoplanktonic form *Aglantha digitale* var. *rosea*, which has its propagation maximum about a month earlier in the North Sea and Skagerrak than in the Kattegat. It is natural to suppose that this is due to the higher temperature of the water in the North Sea than in the Kattegat and Belt Sea in winter, and especially in the spring. In view of this fact, it is remarkable that the gemmiferous *Rathkea octopunctata* should develop earlier and more rapidly in our inner waters than in the North Sea. The period of occurrence for these species in our waters does not differ essentially from that noted in other temperate regions. The following southerly species, on the other hand, occur in our waters (chiefly in the North Sea) 2—4 months later than on the coasts of Britain: *Lizzia blondina*, *Laodicea undulata*, *Cosmetira pilosella*, and *Saphenia gracilis*. *Neoturris pileata* also, which is a northerly species, appears in our waters later in the year, but it is found only in the deep cold channels of the northern Kattegat and adjacent parts of the Skagerrak. *Bougainvillia superciliaris*, a pronounced northern species, which in the arctic regions is a summer form, occurs in our waters mainly in February—April, which is natural enough. — A very peculiar occurrence in Danish waters as compared with the season elsewhere is observed in the case of the two following species: *Euphysa aurata* occurs off the shores of Britain and west coast of Norway from early spring to late autumn or even winter, whereas in our waters, it does not appear until July, rarely in June. On the other hand, *Mitrocoma polydiademata* has, in British and Norwegian waters (as far as is known) a well-defined season of occurrence in spring (April to June or July); in our waters, it has been found in the Skagerrak in May—July, but at Horns Rev it appears in September—November, and in the Kattegat, where it is rare, it has been taken in May and November. This is doubtless due to the power of the species to develop, in our waters or some part of them, two sets of generations in the year. It is nevertheless remarkable that these two species, both northern forms, should in our waters differ, each in its own fashion, as regards period of occurrence from that of other waters.

Variation in period of occurrence from year to year. — Though the occurrence of individual species in our waters is mainly restricted to a certain season, there is nevertheless some variation from year to year, in many cases exhibiting

actual correlation with the temperature of the water. Only in the case of a few species is our material sufficiently representative to permit of a more or less reliable comparison between the different years; and mostly among the smaller forms, which can be taken in great numbers in the vertical hauls from the lightships; even with these species, however, there is the serious defect that the collections from Schultz's Grund lightship were not continuous. As a general rule we may say (see Special Section) that the period of occurrence of the medusæ in the plankton varies most among those species which make their first appearance in winter or early spring (*Hybocodon, Rathkea, Sarsia tubulosa*), whereas those which appear about midsummer keep very nearly to the same time every year (*Purena gemmifera, Euphysa aurata, Lizzia blondina*). As regards disappearance of the stock, all species vary considerably. In the case of the gemmiferous forms it would seem as if the stock disappeared earlier when the temperature is higher, gemmation proceeding then more briskly; and there must presumably be some limit to the number of generations which can be produced. Altogether irregular and apparently inexplicable variations may sometimes occur, as for instance the unusually early appearance of *Phialidium* in the south-western Kattegat in 1911. But it must be borne in mind that the time when a given species of medusa first appears in any given water may depend on the horizontal distribution of the hydroid generation for that year, e. g. the early appearance of *Euphysa aurata* in the Great Belt in 1909. — The whole question as to time of occurrence of the medusæ, both normally and in its variations, with their causes is, as will be apparent from the foregoing, highly complicated, and careful study of every individual species is necessary in order to arrive at a true understanding.

Medusa fauna of the Danish waters throughout the year. — In Winter, our medusa fauna is poor. Young and medium-sized *Aglantha* are, however, numerous in the North Sea and Skagerrak as also in the deeper parts of the Kattegat; large *Tima bairdii* are common in the intermediate water layers of the Skagerrak, whence they are often carried in to the coasts at this season, or far down into the Kattegat. In the North Sea, we find specimens of *Phialidium* and *Obelia* which have survived the winter; during mild winters also at times *Leuckartiara octona* and *Cosmetira*. In our inner waters, *Hybocodon* and *Rathkea* begin to appear, sometimes as early as December, as a rule in January or February, followed soon after by young *Sarsia tubulosa*.

With the approach of Spring, the number of medusæ shows a considerable increase, both as regards species and individuals. The stocks of *Hybocodon* and *Rathkea* are rapidly augmented by active gemmation, and in the Kattegat, the numbers of these are further increased by importation from the Skagerrak. *Sarsia tubulosa* also increases rapidly in the Kattegat and Belt Sea. In the deeper parts of the Belt Sea and Kattegat, *Halitholus cirratus* appears, disappearing for the most part before May; crowds of young *Obelia* appear everywhere. In April we encounter the young *Eutonina, Tiaropsis*, and in the North Sea, *Bougainvillia britannica*. By the

end of April or early May *Hybocodon* and *Rathkea* enter on the mature stage, and a month later disappear from the plankton. In May, *Euphysa tentaculata, Leuckartiara octona* and, in the Skagerrak, *Mitrocoma* appear, followed shortly after by the fresh stock of *Phialidium. Aglantha* is now at the height of its propagation period, and full-grown specimens of this species make up a very large part of the plankton in open waters.

Summer and Autumn. — A notable feature in the month of July is the presence in our waters of a considerable number of medusa species, nearly all however, so poorly represented as regards number of individuals that very little is seen of them. Most of the spring forms are now disappearing, while the numerous summer and autumn forms have only just begun to arrive. The medusa fauna in July consists for the most part of *Obelia, Phialidium,* and young *Leuckartiara,* the hydroids of which continue to liberate medusæ in increasing numbers. On the other hand, we lose, often as early as June, all the most characteristic spring forms: *Sarsia tubulosa, Hybocodon, Rathkea, Eutonina,* and *Bougainvillia britannica*; most of the large *Aglantha* likewise disappear, after having propagated and left behind them an innumerable host of almost microscopic offspring. — The moribund spring fauna is rapidly replaced, however, by an entirely different assortment, comprising, especially as regards the North Sea and western Skagerrak, a very large number of species. In our inner waters, we find first *Steenstrupia nutans* and *Euphysa aurata,* then *Bougainvillia ramosa* and the two gemmiferous medusæ *Purena gemmifera* and *Lizzia blondina*; all these small Anthomedusæ are numerous in August, most of them also in September, constituting then, together with *Obelia, Phialidium,* and *Leuckartiara,* the greater part of the medusa plankton in our inner waters (as far in as the species in question go; see previous chapter). Save for *Steenstrupia,* all remain till late in the autumn, thinning out in October, but still found, as a rule, in November or even December. In the North Sea and western Skagerrak, the summer and autumn fauna consists predominantly of Leptomedusæ, only one Anthomedusa being of any importance, to wit, *Leuckartiara octona,* this species, however, being very numerous. Unfortunately, we know very little as to the first appearance and ultimate disappearance of this fauna, but it seems likely that most of the species live for a long time in the plankton. Off the north west coast of Jutland we find, in September—October, both fullgrown and younger specimens of: *Leuckartiara octona* (numerous), *Laodicea undulata, Cosmetira pilosella, Phialidium hemisphæricum, Eucheilota maculata, Obelia, Saphenia gracilis, Eutima insignis* (numerous), *Eutima gegenbauri,* and *Eirene viridula,* all of which are indigenous in this area, several being also carried thence with the southern bank water into the Skagerrak or even to the Kattegat; several also appear at Horns Rev, chiefly as visitors brought by the Jutland Current from the southern part of the North Sea. — Inside the Skaw, December is the poorest month as regards the medusa fauna; now and again one may find a few stragglers from the autumn forms, or early arrivals of *Hybocodon* and *Rathkea*; the native stock of *Phialidium* in the Kattegat has disappeared, though

Obelia may still be present in great numbers, and, with hosts of small *Aglantha*, constitute an essential part of the plankton.

Table XV below shows how many of the 26 species noted are found in each month (exceptional occurrences omitted). It will be observed that the number of species increases gradually from midwinter to midsummer, remaining then fairly constant for some months, and decreasing somewhat abruptly about November. From the figures in the table it would seem as if our medusa fauna were quite exceptionally abundant in July, whereas in reality, save in the case of some few species, there are very few medusæ in our plankton during that month; the cause of this has been discussed in the foregoing; and we have here a further instructive instance of the great need for caution and critical consideration in dealing with numerical material.

Discussion.

Main Lines of Plankton Research, illustrated by investigation of the Medusa fauna.

Morphology and classification form the basis of all biological research. This is plainly apparent in the history of nature study; not until a great number of species had been described and classified, and could be determined, was it possible to proceed further to biological, faunistic (floristic), and oecological studies. As regards plankton research, there was a time when progress was extremely rapid, a period marked by a whole series of names of distinguished authorities, whose important works I need hardly quote here. I will merely give a brief survey of the main features, pointing out where to my mind, development proceeded at too swift a pace, and where it seems to me to have taken unsuccessful directions.

Various pelagic animal and plant forms were already known and described before the invention of the plankton net, but it was not until JOHANNES MÜLLER, in the 1840's, constructed the first silk net for capture of pelagic organisms, that any rapid advance was made; during the succeeding decades, not only were a host of new species brought to light, but a new idea was formed as to the importance of pelagic organisms in the economy of Nature. If now marine plankton research had been suffered to develop calmly and naturally, we should have had first, in conjunction with description of the new species, a study of the biology of plankton species, their food, propagation and growth, their requirements or adaptation as regards physical environment, their horizontal and vertical distribution; this would have been followed gradually by development of faunistic (and floristic) studies, description of the pelagic fauna and flora in different waters, and demonstration of the manner in which the elements of both drift with the currents; and finally, on the basis of facts thus obtained, would have come oecological investigations as

to the importance of the plankton in the metabolism of the sea. Actually, however, to the detriment of plankton research, HENSEN came forward before CLEVE, and CLEVE before GRAN.

Plankton research proper dates from the time when VICTOR HENSEN constructed the implement for quantitative determination of plankton which now bears his name; and in his epoch-making work, "Ueber die Bestimmung des Planktons", 1887, he introduced the system of oecological plankton research without the requisite biological and faunistic-floristic foundation. And so great was Hensen's authority, so distinguished were his pupils and collaborators (BRANDT, LOHMANN, APSTEIN) that the German school has now for forty years set its mark on the plankton research of northern Europe. — Not many years after the appearance of Hensen's great work, an altogether new system was introduced by the Swedish writer P. T. CLEVE; the first suggestion appeared in 1894, and was followed by a long series of works, notably "Planktonundersökninger" 1896, and his principal work, "A Treatise on the Phytoplankton of the Atlantic and its Tributaries and on the periodical Changes of the Plankton of the Skagerak" 1897. Cleve set up, as we know, a series of "plankton types" or "communities", named after their principal species, and each characteristic of its own area of sea or current; and he considered it possible, with the aid of these plankton types, to determine the origin of the water masses found in any given area. The chief fault in Cleve's theories is his assumption that the organisms are transported by the currents for enormous distances, so that for instance, the occurrence of a certain type of plankton in the Skagerrak is made to prove the transport of water from the Arctic regions, or from the western Atlantic. This error is due to lack of knowledge of the biology of plankton forms, and an insufficient recognition of the importance of biology itself. — Cleve's compatriot and contemporary, C. W. S. AURIVILLIUS, was, in contrast to Cleve, more of a zoologist than a botanist; though accepting Cleve's theories on the whole, he revised and improved them considerably in his two great works of 1898, partly by introducing the distinction between "endogenetic" and "allogenetic" organisms (in "Vergleichende thiergeographische Untersuchungen über die Planktonfauna des Skageraks in den Jahren 1893—97"), and further by his studies of the life history of the organisms ("Om hafsevertebraternas utvecklingstider och periodiciteten i larvformernas uppträdande vid Sveriges vestkust"). Aurivillius was thus well acquainted with the biological principle; unfortunately, however, he died prematurely in 1899, before he could complete that modification of Cleve's theories which might have brought out the element of truth that was in them, and saved them from a neglect beyond their deserts. — Cleve's methods were soon much criticised, notably by the Norwegian H. H. GRAN, in a series of works which followed in rapid succession: HJORT & GRAN: Hydrographic-biological Investigations of the Skagerrak and the Christiania Fiord (1900); GRAN: Hydrographic-biological Studies of the North-Atlantic Ocean and the Coast of Nordland (1900); GRAN: Das Plankton des Norwegischen Nordmeeres von biologischen und hydrographischen Gesichtspunkten

behandelt (1902). Gran accepts in the main Cleve's "plankton types", but prefers to call them "plankton elements" and modifies their definition to some extent; he is strongly opposed, however, to the idea of transportation for long distances, and severely critical as to the use of plankton organisms for determination of currents. The fundamental point in Gran's research, which is put forward very clearly in the first of the works above mentioned, and further developed in the later ones, is his demonstration of the necessity of knowing the life cycle of the different species and their distribution at different seasons. — The Danish writer C. H. OSTENFELD, whose first works on plankton appeared about the same time as those of Gran, took up a similar position, though not, perhaps, so sharply opposed to Cleve.

The general tendency of human nature to arrange and classify material obtained has also made itself apparent in plankton research. HAECKEL, who, in his "Plankton-Studien" (1890) violently attacked Hensen, calling his method "völlig nutzlos", introduced an extravagantly detailed terminology in his classification of organic life, but only a few of his terms have been since applied. The point of principal interest to us here is the division of the plankton into neritic and oceanic, and of the plankton organisms into holoplanktonic and meroplanktonic. The former of these pairs of categories was extensively employed by Cleve, but not by Aurivillius, who, on the other hand, distinguishes between endogenetic and allogenetic organisms. Gran combined these principles by further dividing the plankton according to the geographical areas in which the species were indigenous (atlantic, boreal, and temperate-atlantic species); Ostenfeld further divided according to season. All these divisions are entirely justifiable, and indeed of the utmost importance, but in practice, the arrangement is apt to become too schematic, and not sufficiently in accordance with actual conditions, as the boundaries are not sharply defined. Nature is too varied to be cramped within the narrow limits of a system. The most exact distinction is that between meroplanktonic and holoplanktonic organisms, which is based on a fundamental difference in the life cycle itself; and it is unfortunate that Gran should have defined the terms neritic and oceanic as synonymous with meroplanktonic and holoplanktonic, which he does without reserve in his great work of 1902 (p. 75—76), though in 1900 (p. 27—28) he had expressly pointed out that the two modes of division do not exactly coincide. As regards the phytoplankton, neritic may perhaps be made synonymous with meroplanktonic, and oceanic with holoplanktonic; as regards animal forms, however, the two pairs of categories certainly do not coincide.

Altogether, it seems that plankton research has suffered somewhat from the fact that most planktologists, and these the most distinguished, at any rate in northern Europe, have been botanists. The phytoplankton is largely dependent upon light, and keeps therefore to the upper water layers (*vide* OSTENFELD 1913, p. 149 ff). Knowledge of the vertical distribution of the organisms is therefore less important

to the botanical than to the zoological planktologists. And we have here perhaps the explanation of the fact that the international plankton collections have been made predominantly by the Hensen method, with vertical hauls from bottom to surface, even in those countries where the leading authorities work from a biological point of view. The great amount of material which has been collected since the commencement of the International Investigation of the Sea has thus lost considerably in value.

All the great planktologists, representing all the main branches of the science, appeared in the course of a very brief period (principal works: HENSEN 1887, CLEVE 1897, GRAN 1902) at a time when empirical knowledge both of plankton and of hydrography was still very inadequate. Consequently, the work developed at first far too rapidly to give clear results. Points of view individually of the greatest value for what was right in them, and which, given calm collaboration, might have led to excellent and important results, were sharply opposed, and the long period that followed was one of confusion, dominated by the thorough and persevering, though one-sided methods of the German school. American writers (CH. A. KOFOID on the west coast, H. B. BIGELOW on the east) started afresh on the basis of European studies, but working from the first on sound and natural lines, which promise valuable results. English investigators also have followed more or less their own methods, studying the plankton organisms mainly from physiological and biological points of view (ALLEN, HERDMAN, JOHNSTON, RUSSELL etc.).

The study of the medusæ in Danish waters illustrates in many ways the value of the three main principles of plankton research. I will here mention a few of the most characteristic examples, referring for details to the general contents of the present work.

a) HENSEN. — The plankton collections made off the east coast of Langeland in the spring of 1909 would, from the Hensen point of view, be regarded as of great value, samples being taken every day throughout a period of abt. $2^1/_2$ months. The material is, however, not less valuable for the criticism of the Hensen principle which it involves. To provide a reliable foundation for calculation of the quantity and production of plankton the collections should have been made at several places simultaneously, and for an even longer period of time; the material thus obtained would obviously be so enormous as to be impossible to deal with; nor, indeed, has any such undertaking ever been attempted. Generally, collections on the Hensen principle have been made at intervals of a week or month or more; the accidental elements thus introduced, and the manner in which such sources of error can upset the numerical results, are plainly apparent in the results from the Langelandsbelt (pub. KRAMP 1915). A glance at the Table p. 4—6 is in itself sufficient to show how greatly the number of specimens varies from day to day; I will, however, endeavour to illustrate the position further. Taking only those hauls made in the morning, from bottom to surface, and considering a medusa such as *Obelia*, which was found throughout the entire period, we find that the 66 hauls yielded on an

average 64 specimens per sq. m of surface. Let us now suppose that hauls had been made only on the even dates, we get an average of 48, and for the odd, 81 — a considerable difference. Proceeding further, and supposing that hauls were made, as at the lightship stations, only once a week, we find, taking two weekdays chosen a will, 25 and 88 specimens respectively per sq. m surface within the same period. This shows how little value can be attached to the precise numbers of specimens in a series of plankton samples taken once a week, not to speak of collections made at even longer intervals.

The collections at Anholt Knob lightship 1911—1914 were made only twice a month; it is therefore unlikely to begin with that precise enumeration of the specimens of species taken should be of any value; a couple of days' difference in the current might alter the numerical values altogether. The medusa material from these samples exhibits several instances of this; as in the rarity of *Rathkea octopunctata* 15 April 1913 on a day when the salinity of the water was particularly low, below the mean value for the month; also the occurrence of *Lizzia blondina* in July 1911 (see Special Section, p. 67). Then again we have the complete absence of *Phialidium hemisphæricum* in all three hauls at Schultz's Grund on the 3 Oct. 1911. — The collections from Schultz's Grund had at least the advantage of being made weekly, with three hauls from different depths, thus affording some information as to the vertical distribution. The otherwise very valuable material from the cruise of the "Thor" in 1911 was procured mainly by vertical hauls from bottom to surface; hydrographical observations showed that there was a decidedly cold water layer on the bottom in the southern and south-western Kattegat; would it not then have been interesting to have known whether the medusæ in this area were living in the cold water or in the warmer layers above? It would at least have been more useful than to know the precise number of specimens per sq. m of surface. — The medusa *Halitholus cirratus*, whose main area of occurrence in our waters lies in the inner parts of the Baltic, is a fine example of the sources of error involved by the Hensen method of collecting and investigation; if we knew only the occurrence of the species in the Kattegat, as expressed in number of specimens per sq. m of surface at different localities, we might form the impression that the medusæ were carried out from the Baltic by the current, as the frequency decreases greatly from the Belt Sea northwards; knowing the vertical distribution and the size of the specimens on the other hand, we are able to demonstrate that the species is indigenous throughout the Kattegat. A case where quantitative determination is of great value is afforded by the notes regarding *Halitholus* in the different water layers of the Bornholm Deep in 1907, from which it was possible to determine how the occurrence of the medusa depends on the temperature of the water, far more than on the salinity; and even in this case, an exact count of the specimens would not have been any more valuable than the approximate figures actually obtained.

b) Cleve and Aurivillius. — How far it may be justifiable to divide the

phytoplankton into "communities" (Cleve's "Plankton types") of species found together, naming the communities after their most characteristic species, I cannot say; in the case of the medusæ, any such arrangement would be impossible; or would at any rate be artificial. The distribution of a medusa species is determined by a number of different causes (*vide supra* pp. 219—220) as for instance the site of growth of the hydroid form, season for liberation of the medusæ and duration of that process, longevity of the medusa, and its requirements and power of resistance as regards physical environment. Medusæ having their source of origin within one and the same area can therefore, in the course of their pelagic life, be very differently distributed, while on the other hand, a number of medusa species commonly occurring together within a restricted area may well be of altogether different origin. These considerations apply in a still higher degree if we extend the "community" idea so as to embrace not only the medusæ, but also the remaining plankton organisms, irrespective of whether their biological features are alike or fundamentally dissimilar. In the Special Section, pp. 120—121, it is pointed out that the fluctuations in the number of *Phialidium* at Horns Rev in the autumn, especially in 1913, follow very conspicuously those of *Rhizosolenia styliformis*; in the first place, this does not prove that either of the two organisms is dependent on the other in any way whatsoever; and further, even though their parallel occurrence within a brief period may perhaps indicate a common source of origin, we cannot take them as character forms of a certain type of plankton, for at a certain season, varying moreover from year to year, the diatom disappears, whereas the medusa remains in the plankton long after.

Cleve held that the origin of water masses could be determined by means of plankton types; Aurivillius on the other hand was more concerned with the separate species as indicative forms having regard to their biological features; and if his results were in several cases incorrect, this was due rather to the inadequate knowledge of biology and distribution of species at the time than to any error of principle in his ideas, which would doubtless have led to valuable results had he lived long enough to put them into practice. My studies of the medusæ have in this respect led me to a position intermediate between Cleve and Aurivillius; a single species may, if it can be proved to have travelled far from its normal area of distribution, serve as a proof of the movement of water from distant parts (as Gran also points out); within restricted areas, however, the value of a single species as a guide is reduced, partly because the limits of distribution are not altogether definite, partly because there will in many cases be two or more possible alternatives for origin and route; in such cases, it will often only be of value when taken in conjunction with other species. The Jutland Current, increasing in volume in the autumn, carries with it then, as a rule, a host of Leptomedusæ to the Horns Rev lightship, including *Eutima gegenbauri* and large *Phialidium hemisphæricum*; the same species are, however, indigenous at the entrance to the Skagerrak, and in September—October 1913, they came from there to Horns Rev; but

their northern origin was in this case indicated by the fact that the plankton at the same time contained *Aglantha digitale* and *Euphysa aurata* (see General Section, p. 175). Among other instance, I will note the local accumulation of medusæ off Hals in May 1911, with *Sarsia*, *Hybocodon*, and *Rathkea*, together with *Aglantha*; the three first-named species might well have come from Aalborg Bay (though for various reasons it was not very probable), but their being taken in company with Aglantha plainly shows that an importation from the north, via Læsö Channel, had taken place. A notable example of the use which can be made of plankton material — composition and numerical proportions — is afforded by the investigations off the northern part of the west coast of Jutland in the autumn of 1922. The occurrence of *Sarsia*, *Hybocodon*, *Rathkea*, *Tiaropsis*, and *Eutonina* in the Bay of Köge on the 19 April 1923 showed that there had been a forward movement of the water from the deeper layers of the Sound; the species in question could, for that matter, individually be taken as proof, but the finding of all together at the same place, while all were lacking at more southerly localities, was valuable confirmation. A particularly valuable instance of the use of pelagic fauna for determination of the movements of a water mass was seen in the spring of 1923; a whole series of medusa species properly belonging to the bank water of the northern North Sea and the Skagerrak, were found in Jammer Bay and Vigsö Bay on the 1 May; a few days earlier, these species were almost entirely lacking in the eastern channel of the Kattegat, but on the 17 May they were nearly all present, some in considerable numbers, thus showing that the bank water was now flowing in through the Kattegat (see General Section, pp. 188, 189, 192). So also, in May 1923, the fauna north and south of Horns Rev showed that no movement of water of any importance in either direction across the reef had taken place for some time previously (General Section, p. 189). In these cases, it was not so much the individual species, but far more the general aspect of the fauna in its composition that was convincing; on the other hand, a closer analysis of the impression thus formed had to be based on the knowledge of the biology of the different species. The fauna was here of greater importance from the fact that it would have been difficult to arrive at the same conclusions from hydrographical observations alone.

It is not only positive finds, however, of this or that species or group of species which can serve as an aid to hydrography; investigations with negative result are sometimes no less valuable; and here in truth we find that the presence or absence of a single species is only of value when taken in conjunction with others. The absence or unusual scarcity of a given species may be due to circumstances affecting that species alone; but when we find the same state of things applying to all those species generally constituting an essential part of the plankton at a given time and place, we may take it that the current which ordinarily carries the fauna in question to the locality must on this occasion have failed or taken another course. Thus the medusæ serve to show that the Kattegat, in the spring of

1912 and of 1923 received no supply, or practically none, of bank water from the Skagerrak (see General Section, pp. 173 and 188).

There can, I think, be no doubt but that the plankton, both as regards single species and also the composition of the fauna (and doubtless also flora) can, in an enormous number of cases, be of great help in determining the compositions and origins of a given mass of water. But it must be most distinctly and emphatically pointed out that in any such use of plankton material, it is absolutely essential, first of all to know, and further, constantly to bear in mind, the distribution and biology of the individual species.

c) Gran. — No one has been more emphatic than H. H. Gran in maintaining the necessity of knowing the life cycle of the individual species and their distribution at the different seasons; nevertheless, there are one or two points where his views might, in my opinion, be somewhat modified. Gran admits, it is true, that the plankton organisms, both single species and "communities", can in certain cases be made to serve as indicators of the currents, but in general, he is sceptical as to the importance attached to this by Cleve and Aurivillius. One of Gran's leading principles is perhaps the view that currents act for the most part indirectly, by modifying the conditions of life to which the plankton organisms are subjected. The botanical point of view is here apparent and may be entirely correct as regards most forms of phytoplankton; pelagic resting-spores and single individuals of diatoms and peridineans lead for some time a more or less latent existence in the plankton, but when a current alters the surrounding conditions in their favour, the organisms may suddenly begin to "flourish", and rapidly become enormously abundant in some locality where their presence was previously hardly noticed at all, thus giving the impression that they had been brought to the spot by the current[1]). Something similar may be said as to certain animal forms, e. g. the tintinnids and perhaps also to some extent the rotatoria and cladocera with resting-eggs; also for a single category of medusæ, to wit the gemmiferous species, whose gemmation is furthered by optimal conditions of temperature (in Danish waters, *Purena gemmifera*, *Hybocodon prolifer*, *Rathkea octopunctata*, and *Lizzia blondina*). Both as regards the phytoplankton and the animal forms above noted, however, the "flourishing" period is doubtless often due to their being carried by the currents to places where favourable conditions prevail. There can be little doubt, for instance, but that the Kattegat receives, as a rule, each spring, a supply of *Hybocodon* and *Rathkea* from the Skagerrak, these species then after their arrival in the Kattegat, propagating at a more rapid rate; in the spring of 1923, the heavy inflow of atlantic water into the Kattegat raised the temperature of the lower water layers, but certainly did not occasion any great abundance of Hybocodon and Rathkea in the eastern channel; rather indeed the reverse; for this water did not carry with it the species

[1]) Cf. Joh. Petersen 1898.

in question; they are actually found in great numbers in the channels of the Kattegat when, in normal years, they are brought in by the colder bank water.

In a modified form, Gran's view noted above may also perhaps apply to various holoplanktonic organisms not capable of rapid propagation by division, gemmation, or resting-eggs. The occurrence of such organisms outside their customary range of distribution does not necessarily imply that they have been recently brought to the spot by a current; they may have arrived there long before, and have been enabled, by indirect action of the currents since that time (in modifying the conditions of their environment) to maintain their existence in a region where they would otherwise have perished. As regards Danish medusæ, this applies only to *Aglantha digitale*; and I consider, also, that the occurrence of an isolated stock of Aglantha in the western Baltic south of Ærö in April 1923 was due to importation at an earlier date, the imported stock being then enabled, by unusual hydrographical conditions, to live for a long time in these waters, where the species is not ordinarily found.

In the case of meroplanktonic organisms, lacking the particular means of propagation above referred to, Gran's principle will not hold good. Only long-continued alteration of the conditions of life can alter to any essential degree the distribution of such a species in its indigenous character; and it must further be noted that the distribution of the bottom stages will depend not only on hydrographical conditions but also on several other circumstances largely unconnected therewith, as for instance the composition of the sea floor, and, in the case of attached forms the presence of suitable objects for substrata (See General Section, pp. 215—220). The distribution of the bottom stage may doubtless vary somewhat from time to time (*vide infra*) but when the pelagic stage (or the pelagic generation) is met with outside the limits of distribution for the bottom stage, it must be due to transportation by some current the origin of which can be ascertained when the distribution of the species as indigenous is known; given also the rate of growth and length of life of the pelagic stage, it will even be possible to calculate how long the individuals in question have been on the way from their source of origin; this, however, only approximately, as we have to take into consideration that the rate of growth may be affected by change of temperature. Even gemmiferous medusæ can indeed be used in this manner as an aid to hydrographical research, merely setting, in this case, the length of life of the stock in place of that of the individual; a non-gemmiferous species, however, whose rate of growth is more or less known, has the great advantage that the size of the specimens tells us much as to the length of time they have been carried by the current. The question becomes more difficult if we are seeking to ascertain the distance travelled; not only the route followed by the current, but also from how far off it has come. Here also, however, the plankton may be helpful. By taking a single species whose indigenous range is known, we can obtain a minimum value, and consideration of the composition of the plankton gives us several such. With precise know-

ledge as to the life cycle of meroplanktonic organisms and their indigenous range it is thus possible to use them extensively in hydrographical research, as an aid to the determination of the source and route of currents! As an instance of the way in which medusæ can be so used, I will mention that the composition of the medusa fauna in the northern part of the Little Belt shows, when the distribution of the species in question as indigenous forms is known, that the inflow of Kattegat water is slight and proceeds very slowly; for as a rule, only species indigenous in the waters immediately adjacent (Samsö Bay) are carried thither; when true Kattegat forms of more or less rapidly growing species do appear, it indicates a swifter inflow than usual.

In connection with Gran's division of the plankton organisms into biogeographical groups (atlantic, boreal, temperate-atlantic) I should like to observe that however useful such an arrangement may be for preliminary studies, it should only be employed subject to the reservation that the areas of distribution of the different species differ greatly in extent, and more or less overlap; in all the groups of organisms I have had to deal with I have found that there are practically speaking, no two species with the same geographical distribution, and any biogeographical arrangement must therefore be more or less artificial. In a previous chapter of the present work (General Section, Chapter II) I have, instead of schematic division into groups, arranged the species in progressive series according to their horizontal or vertical distribution, from the most southerly to the most northerly forms, or from the most littoral to the more abyssal. This method I have found well suited to the purpose, as it gives a good general view without cramping the species into schematic divisions which do not correspond to the reality.

It will be understood from the foregoing that my studies of the hydromedusæ of the Danish waters have lead me to adopt an intermediate standpoint between that of Gran and that of Cleve-Aurivillius, as Ostenfeld has done, only in my own case, more on zoological lines. I am entirely in agreement with Gran's emphatic insistence on the great importance of biological plankton studies, but consider that we can, on the basis of these, make use of the plankton extensively as an aid to hydrographical investigations.

Conclusions.

The material on which the present work is based was procured by collections made on two entirely different principles: partly by continuous collections at intervals of a week or two for a long period from a few permanent stations (the lightships), and partly by collections made over a large extent of water within shorter periods (cruises of the "Thor", "Havörnen", and "Dana"). These two principles supplement each other admirably, and the combination would be even more valuable were the situation of the localities more suited to the purpose. Frequent regular collections from a number of permanent stations carried on throughout a number of years constitute the only means of learning to know the life cycle of the different species,

while collections covering a wide area are essential to the study of the geographical distribution. A knowledge of these two factors is, or should be, the foundation of all plankton research. — Continuous collections from a permanent station, however, give reliable information only as to the life cycle of those species which are indigenous in the immediate vicinity, and the stations should therefore, as far as possible, be situated in localities with a rich indigenous fauna[1]).

The continuous collections of metazoic plankton hitherto made were confined to the three lightships at Horns Rev, Anholt Knob, and Schultz's Grund; and only in the case of the last-named have we any information as to vertical distribution of the plankton; moreover, there have been breaks of some duration in the work at Schultz's Grund. In most cases, therefore, I was unable to determine the length of life and rate of growth of the medusæ as exactly as I should have wished; the task is by no means difficult when the requisite material is available.

The various cruises, on the other hand, have yielded extremely good if not yet altogether sufficient data as to the distribution of the species in our waters; in a very great number of cases it has been possible to state in what parts of the waters a species is indigenous, and how far it can be carried from its home by the currents. Here, however, I have encountered a circumstance of great importance, which I have not yet touched upon in this chapter, as it has not, so far as I can see, been noticed by any of the writers above mentioned. The distribution of a species as indigenous is not always the same from year to year, and cannot therefore be defined once and for all; I would call to mind for instance, the fact that *Euphysa aurata* was evidently indigenous in the Belt Sea in 1909, that *Bougainvillia britannica* was indigenous south of Horns Rev in 1923, and that in the same year there was an isolated indigenous stock of this species, as also of *Tima bairdii* at the northern entrance to the Sound. If then the medusæ are to serve as indicators of the currents, their distribution as indigenous must be determined every year. In the case of the meroplanktonic medusæ, this can usually be done without great

[1]) In the case of medusæ, as probably also with many other animal forms, it would be desirable in this connection to have continuous collections made in the following localities in the Danish waters: 1) South of Horns Rev; the indigenous fauna from here would probably be better investigated with material from Vyl than from Horns Rev lightship. 2) North of Jutland Bank; there is no lightship in this very important and interesting area, but it should hardly be impossible to let the life-saving steamer from Thyborön for instance, run out there once a week and make a couple of plankton hauls. 3) Aalborg Bay; collections from Östre Flak lightship might perhaps afford useful information as to the indigenous fauna in this area. 4) Eastern channel of the Kattegat; the two lightships at Læsö Trindel and Anholt Knob both lie on the edge of the coastal ground; the rich and interesting fauna indigenous in the eastern channel, from which also a great part of the allogenetic fauna in the Belt Sea is recruited, should be investigated at short intervals, both by horizontal and by vertical hauls from a vessel somewhere in the deep part of the channel. 5) South-western Kattegat; the collections from Schultz's Grund lightship may be considered as giving very good material as far as the indigenous fauna is concerned. 6) Western Baltic; the western basin especially, south of the Fyen islands, holds a rather poor but interesting fauna, which might well be worth continuous investigations from a vessel. 7) The Bornholm Deep.

difficulty, from the geographical distribution of the medusæ found according to size and numbers, only bearing in mind that gemmiferous forms, as long as favourable conditions prevail, increase in numbers the farther they are carried from their source of origin, whereas the reverse is the case with non-gemmiferous organisms. Even this rule, however, must, like all others be applied with caution. The influence of the coastal ground on the course of the current, or the interaction between two currents in collision, may occasion an accumulation of the medusæ at some spot far from their source of origin; I would in this connection cite what I have written as to the occurrence of the brown *Sarsia tubulosa* off the west coast of Jutland in the spring of 1923 (Special Section, p. 32). The example noted also shows how we can form reliable conclusions from a comparatively small number of samples, as long as the stations are evenly distributed throughout a wide area. Any cruise with pelagic stations so distributed can yield very sound information as to the species then occurring, both as to their source of origin and the limits for their transportation by current. Given the knowledge of seasonal occurrence for the different species afforded by the continuous collections from permanent stations, one can then ascertain what seasons will be favourable for regional investigations.

As regards the hydrographical value of plankton collected according to the two principles here noted, the present material of medusæ affords a number of illustrative examples. Material derived solely from continuous collections at a few permanent stations is only valuable to a limited extend as an aid to hydrographical investigation. The occurrence of an allogenetic meroplanktonic organism, whose source of origin is known for certain, proves that importation has taken place from there; and by observation of several species with known distribution and rate of growth, it is possible in some degree to determine the origin of the water mass in question, and perhaps make sure whether it is of mixed origin; owing to the above mentioned variation in the distribution of the species as indigenous, however, care is needed in forming such conclusions. It must also be borne in mind that nothing is known with certainty as to the route followed by the current between two distant stations; and the same reservation applies in regard to determination of velocity from the successive occurrence of an allogenetic species at two or more stations (cf. *Biddulphia sinensis*, Ostenfeld 1908). Where current measurements show a continuous current of uniform direction passing a permanent plankton station, while at the same time a plankton organism is appearing in increasing numbers, we may take it as extremely likely that the species has been brought by this current; should the species again disappear (or show a sudden decrease in numbers) before the uniform current ceases, this may indicate that the stock has come from no great distance (cf. *Euphysa aurata* at Schultz's Grund in 1910, General Section, p. 163) but the fact may also be due to biological causes; in certain cases it may be possible to determine which is the right explanation, and this can be done with certainty where the distribution of the species at the time in adjacent waters is known.

On a cruise with pelagic stations evenly distributed throughout a wide area, we can, using the knowledge procured by other means as to the life cycle of the species, map out the distribution of the species as indigenous, and at the same time ascertain how far and in what directions they have moved from their source of origin; taking these data together with simultaneous hydrographical observations, the distribution of the currents then prevailing, their origin and direction, and to some extent also their velocity, can be determined with a high degree of certainty. A whole series of such instances will be found in the first chapter of the General Section. My studies of the present medusa material from Danish waters have drawn my attention to two points of importance in this connection. It is a great advantage to have a preliminary examination of the material made on board the vessel; this demands not only that one should be able to identify on the spot the most important of the species taken, but also that the operator should throughout have the needful hydrographical information up to date; it would therefore be desirable always to have a hydrographer on such cruises. I have noticed, however, that hydrographers do not like using the areometer for determinations of salinity. True, such determinations are perhaps hardly accurate enough for purely scientific hydrographic purposes, but the information they afford, and that on the spot, is quite sufficient for biologists, and should not be undervalued; titration results are often not available until so long after that the immediate value of the determinations is lost. — The second point I wish to note is this: On the cruises in the Danish waters, the position of the stations was for the most part determined beforehand; it is of course necessary to make some such plan for a series of investigations, but the leader of the cruise should have a wide margin for acting at his own discretion, so that he can alter the arrangements on encountering any unexpected phenomenon which he considers should be investigated.

International plankton research in northern Europe was originally planned as an auxiliary to the biological fishery investigations, and its great importance in this connection cannot be denied. A great number of plankton organisms serve, directly or indirectly, as food for economically valuable fishes; this, however, hardly applies to the medusæ, whose nutritive value is slight. On the other hand, Marie Lebour, of Plymouth, has in her interesting works (1922 and 1923) shown that the medusæ are of considerable economical importance in that they devour a quantity of pelagic fish larvæ. Plankton organisms however, can also be of great practical importance in their capacity as indicators of currents, giving us thus the key to understanding of the distribution of pelagic fish larvæ and their drift with the currents. — As an aid to hydrographical study, the medusæ are perhaps the most valuable of the pelagic organisms, most medusæ being meroplanktonic, with marked seasonal occurrence, and sufficiently long-lived to be carried by currents some distance from their source of origin. I would like here to note an interesting instance of parallelism between a medusa and a species of fish. On the cruise of the "Dana" in the spring

of 1923, when hydrographical conditions in the Danish waters were abnormal, both hydrographical observations and the occurrence of principal pelagic organisms, especially medusæ and fish larvæ, were noted daily on a chart; it was then found that there was a striking similarity in the distribution of *Rathkea octopunctata* and that of the cod larvæ, and that both differed from the normal in precisely the same respects. A close co-operation between planktologists and fishery biologists would doubtless bring to light several such cases, which might prove of value in the practical work of investigation.

I have in the foregoing strongly emphasised the importance of plankton organisms, especially the medusæ, as hydrographical aids; but I have also pointed out that the organisms cannot be so used without knowledge of the biology of the different species, which knowledge, moreover, must be constantly applied. As already noted in the Introduction, this principle is not a new one, but it seems to be that it needs a new recognition of its justification. The biological principle has not been generally accepted in the international plankton investigations, and I cannot but consider that there are a great many problems here awaiting solution.

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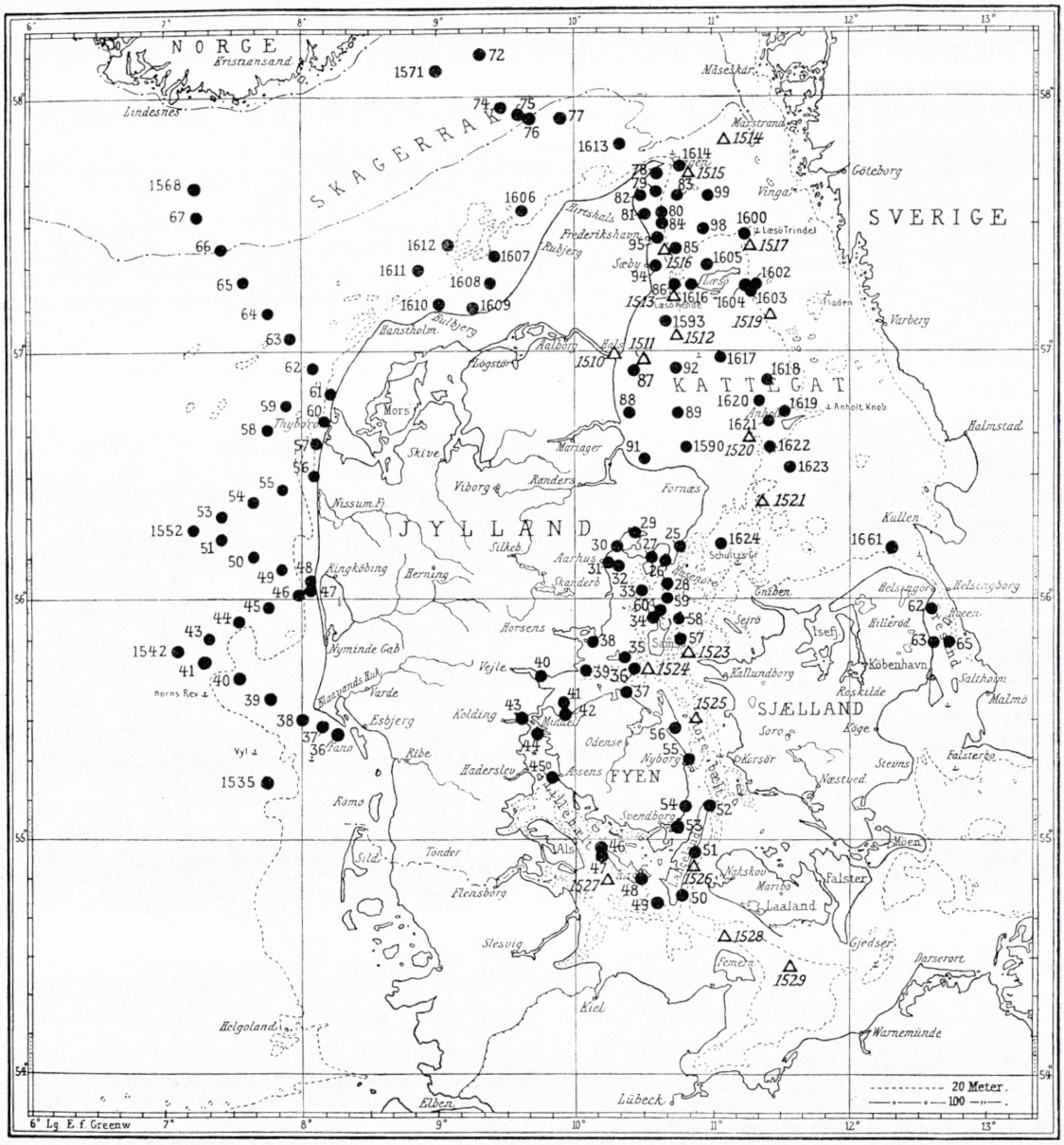

Chart 20. △ Pelagic stations, "Havörnen" May 1911, St. 1510—1529. ● Pelagic stations, "Thor" June—July 1911, St. 1535—1665. Station nos. of the "Thor" below 1600 in the North Sea, Skagerrak, and Kattegat are indicated only by the last two figures; so also with those above 1624 in the Belt Sea.

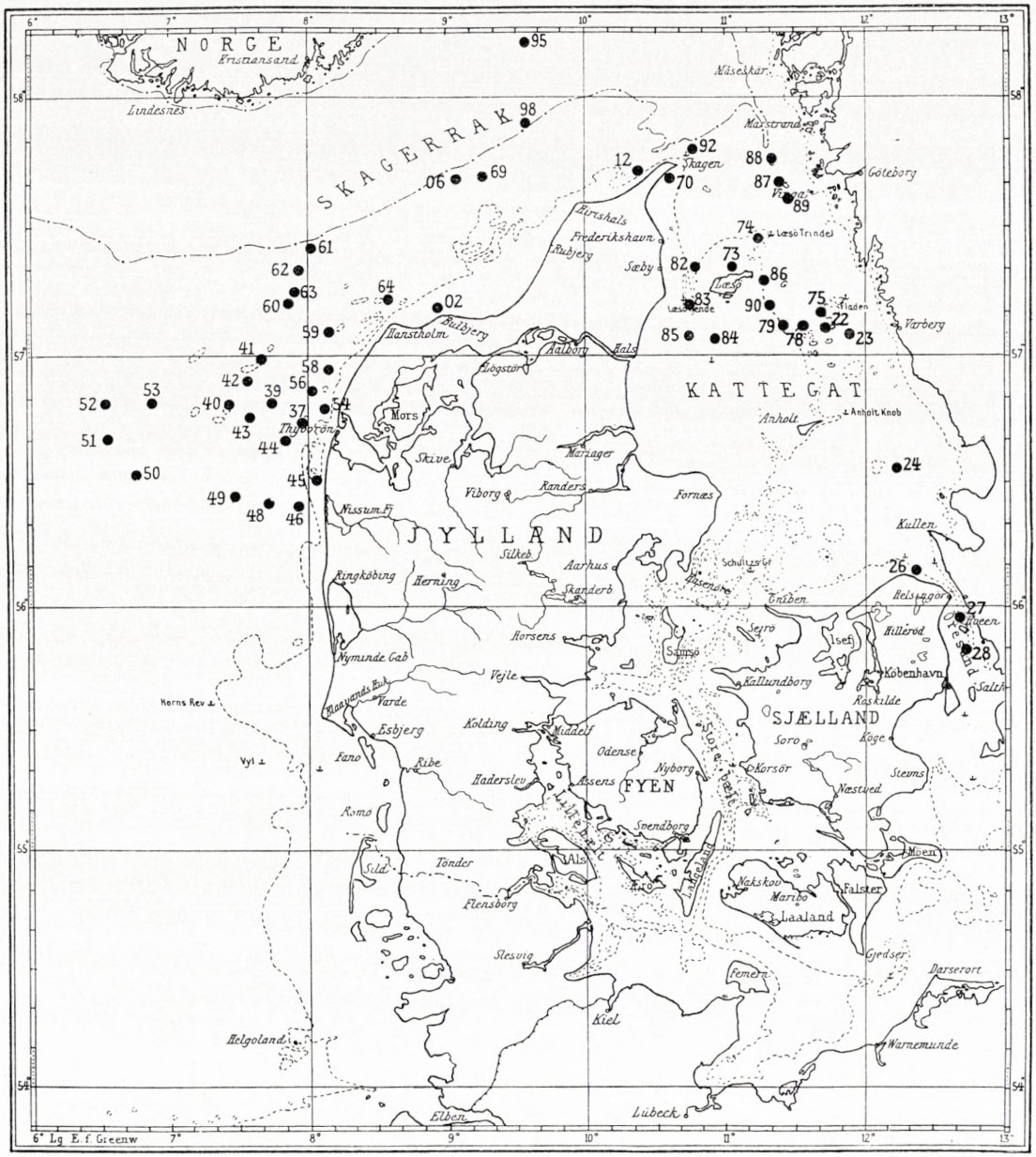

Chart 21. Pelagic stations of the "Dana", September—October 1922, St. 2837—2928. Only the last two figures of the station number are noted on the chart.

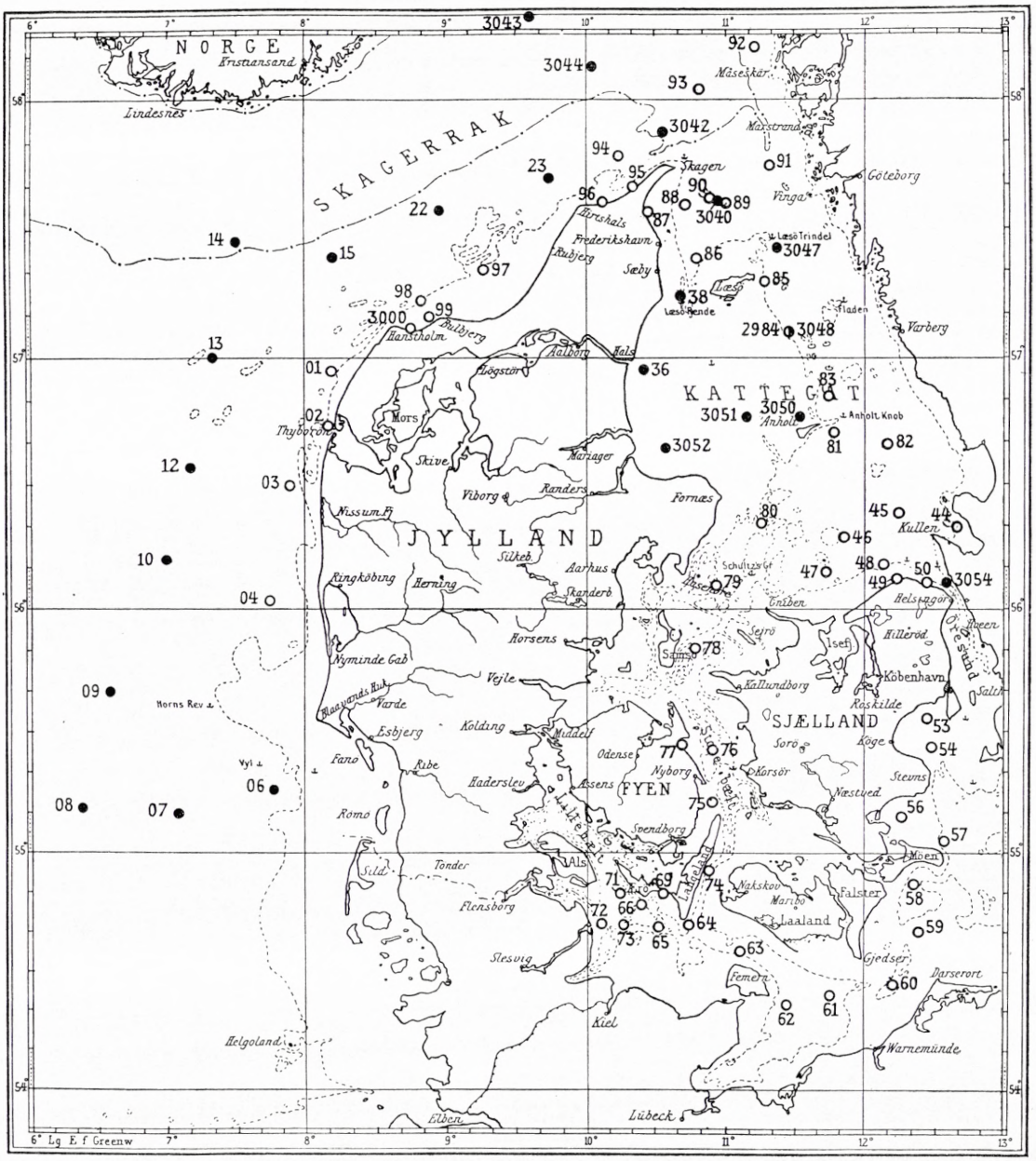

Chart 22. Pelagic stations of the "Dana" 1923, I. 16 April—19 May, St. 2944—3054. — For St. 2944—3038, only the last two figures of the station number are noted on the chart.

○ = Stations on the outward voyage from Copenhagen to Esbjerg, 16 April—2 May, St. 2944—3004.

● = Stations on the homeward voyage, Esbjerg to Copenhagen, 6—19 May, St. 3006—3054.

Chart 23. Pelagic stations of the "Dana" 1923, II. 28 May—24 June, St. 3055—3145. Only the last two figures of the station numbers are noted on the chart.

Chart 24. Chart showing place names and boundaries of the different waters.

Tables.[1]

Table I. Horns Rev Lightship.

Position: Lat. 55°34′1 N. Long. 7°19′8 E. Decl. 10° W. Depth 32 m.
In-going Current, mean direction at the surface: towards N 22 W magn.
Out-going — — — — — — S 21 E —
Limit between in- and out-going currents: S 79 W—N 79 E magn.

Year	Depth m	Resulting mean current per month, cm/sec.											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1911	0	**16.1**	**23.8**	**16.6**	**11.4**	**11.4**	**4.3**	**5.1**	**2.7**	**12.4**	**13.1**	**24.2**	**19.9**
1912	0	**13.4**	**8.1**	**19.4**	**14.1**	**7.9**	**13.3**	**10.7**	**36.4**	**4.6**	**23.6**	**20.1**	**27.8**
1913	0	**24.0**	**9.6**	**35.2**	0.3	**0.2**	0.3	**0.1**	5.5	**4.7**	**4.5**	**25.8**	**11.3**
1914	0	**10.0**	**20.6**	**20.4**	..	..	..	..	..	..	..	..	..
		Average Temperature °C. 8 a.m. 1901—1923											
..	0	4.2	2.7	3.0	4.8	8.4	11.9	14.8	15.6	14.8	12.6	9.2	6.3
..	30	4.6	3.2	3.3	4.7	7.1	9.6	12.1	14.4	14.8	12.9	9.7	6.7
		Average Salinity $^0/_{00}$ 8 a. m. 1901—1923											
..	0	33.3	33.2	32.9	32.8	32.7	32.6	32.9	33.0	33.1	32.8	32.9	33.2
..	30	33.7	33.6	33.5	33.5	33.6	33.7	33.6	33.5	33.5	33.2	33.3	33.6

[1]) In the figures representing the *Current*, the darker type denotes in-going currents, ordinary type out-going currents.

Table II. Skagens Rev Lightship.

Position: Lat. 57°46′0 N. Long. 10°43′3 E. Decl. 9° W. Depth 38 m.
In-going Current, mean direction at the surface: towards S 76 E magn.
Out-going — — — — — — N 19 E —
Limit between in- and out-going currents: N 68 E—S 68 W magn.

Year	Depth m	Resulting mean current per month, cm/sec.											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1911	0	**25.1**	**25.4**	23.2	5.4	42.2	16.5	**9.5**	16.6	3.1	33.8	1.4	16.9
1912	0	34.5	11.5	**2.1**	**7.3**	**29.5**	**6.0**	22.9	**17.4**	18.8	21.9	**9.8**	**38.0**
1913	0	42.5	**18.9**	**24.8**	35.0	19.3	**12.8**	12.4	25.9	54.1	18.6	**34.5**	**26.2**
1914	0	**10.3**	**22.6**	12.6	..	..	..	..	..	..	..	..	..
		Average Temperature °C. 8 a.m. 1901—1923											
..	0	3.2	2.4	2.4	4.7	8.9	13.2	15.7	15.8	13.9	11.0	7.6	5.0
..	10	3.9	3.0	3.1	4.5	7.6	11.6	14.5	15.4	13.8	11.3	8.1	5.7
..	20	4.4	3.4	3.6	4.6	7.2	10.7	13.6	15.0	13.6	11.3	8.5	6.1
..	38	5.0	3.8	4.0	4.7	6.8	9.3	11.9	13.7	12.7	10.8	8.5	6.5
		Average Salinity $^0/_{00}$ 8 a.m. 1901—1923											
..	0	30.8	30.9	28.6	27.8	28.0	27.9	28.5	30.2	29.7	29.1	29.9	30.7
..	10	32.2	32.5	32.0	32.3	32.7	32.1	31.6	32.0	32.0	31.9	31.8	32.1
..	20	33.2	33.4	33.4	33.5	33.5	33.1	32.6	32.6	32.9	33.2	33.0	33.1
..	38	33.9	33.9	34.1	34.0	34.1	33.8	33.6	33.3	33.5	33.8	33.8	33.8

Table III. Anholt Knob Lightship.

Position: Lat. 56°46′0 N. Long. 11°51′8 E. Decl. 8° W. Depth 28 m.
In-going Current, mean direction at the surface: towards S 37 E magn.
Out-going — — — — — — N 41 E —
Limit between in- and out-going currents: E—W magn.

Year	Depth m	Resulting mean current per month, cm/sec.											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1911	0	5.6	**9.9**	9.6	**15.6**	10.6	**9.0**	**25.4**	**17.1**	**28.6**	14.6	14.6	**4.0**
1912	0	19.1	..	2.8	6.6	**21.3**	**7.5**	**5.1**	**20.1**	4.9	8.2	**8.9**	**5.1**
1913	0	29.4	**7.2**	**8.2**	0.3	**5.6**	**27.1**	**10.2**	**10.7**	15.5	**12.6**	**5.4**	**1.7**
1914	0	**1.8**	**14.9**	4.5	..	..	..	..	..	..	..	..	..
		Average Temperature °C. 8 a.m. 1901—1923											
..	0	2.1	1.3	1.9	4.5	9.4	14.1	16.7	16.6	14.3	10.9	7.0	4.1
..	10	2.8	1.8	2.1	4.2	8.5	12.8	16.0	16.5	14.5	11.3	7.5	4.7
..	15	3.9	2.8	3.1	4.1	6.2	9.8	14.1	15.8	14.6	12.3	8.8	6.1
..	20	4.8	3.7	3.7	4.0	5.2	8.0	12.5	14.8	14.1	12.4	9.7	7.1
..	28	6.1	4.6	4.2	4.3	4.6	6.6	9.6	12.7	12.8	11.9	10.1	8.0
		Average Salinity $^0/_{00}$ 8 a.m. 1901—1923											
..	0	23.8	23.4	20.4	19.1	18.2	18.8	19.5	20.4	20.6	20.2	21.7	23.2
..	10	25.0	25.8	22.2	21.6	20.8	21.6	21.8	22.3	22.1	21.5	22.9	24.5
..	15	27.1	26.9	27.1	27.9	27.6	28.1	27.3	26.7	25.6	26.2	26.3	27.2
..	20	29.5	30.1	30.9	31.7	31.9	31.7	30.8	30.1	29.8	30.5	30.1	30.1
..	28	32.0	32.1	32.6	33.1	33.2	33.0	32.5	31.9	31.9	32.4	32.5	32.2

Table IV. Schultz's-Grund Lightship.

Position: Lat. 56°08′9 N. Long. 11°11′2 E. Decl. 8° W. Depth 26 m.
In-going Current, mean direction at the surface: towards N 84 W magn.
Out-going — — — — — — N 44 E —
Limit between in- and out-going currents: S 11 E—N 11 W magn.

Year	Depth m	Resulting mean current per month, cm/sec.											
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1911	2½	2.1	**3.5**	21.7	**9.5**	24.0	6.4	1.3	**6.8**	**7.9**	0.8	2.4	6.6
	5	1.8	**7.6**	18.6	**12.8**	20.0	2.7	1.5	**10.0**	**10.9**	**0.5**	**0.5**	0.9
	10	**4.5**	**13.2**	6.9	**19.3**	6.0	**12.0**	**2.5**	**13.1**	**16.3**	**7.2**	**10.3**	**22.8**
	15	**13.5**	**20.1**	**5.7**	**24.1**	**8.2**	**19.4**	**0.2**	**16.7**	**23.9**	**11.2**	**20.7**	**38.9**
	20	**16.3**	**19.7**	**12.1**	**21.8**	**8.3**	**18.0**	**0.0**	**15.4**	**23.8**	**14.1**	**21.7**	**33.4**
	25	**14.0**	**17.5**	**10.7**	**16.2**	**6.6**	**13.8**	**0.9**	**11.8**	**16.7**	**14.1**	**17.8**	**24.7**
1912	2½	28.2	..	9.0	12.7	**8.1**	21.0	3.6	**15.3**	11.7	3.8	**18.3**	**8.9**
	5	28.6	..	3.6	10.8	**10.0**	16.7	0.1	**18.7**	10.1	1.4	**20.9**	**11.3**
	10	20.2	..	**17.5**	1.7	**19.8**	3.6	**14.2**	**24.8**	**0.5**	**10.8**	**27.6**	**21.6**
	15	**6.0**	..	**33.2**	**3.2**	**26.0**	**9.9**	**19.4**	**26.8**	**4.4**	**24.1**	**32.9**	**33.9**
	20	**18.6**	..	**31.3**	**8.4**	**23.9**	**14.0**	**16.8**	**20.8**	**5.7**	**28.7**	**29.0**	**34.2**
	25	**16.1**	..	**25.4**	**8.1**	**17.9**	**11.4**	**13.7**	**14.5**	**6.0**	**24.0**	**22.8**	**26.4**
1913	2½	21.9	..	**5.7**	13.5	**3.7**	**1.3**	2.9	**3.8**	13.9	**22.3**	**16.7**	1.1
	5	21.2	..	**8.1**	12.9	**2.5**	**2.7**	1.9	**4.0**	13.4	**23.2**	**17.9**	0.5
	10	6.9	..	**20.1**	0.3	**14.9**	**11.6**	**2.9**	**5.8**	**2.5**	**28.7**	**28.6**	**0.1**
	15	**8.8**	..	**30.1**	**19.1**	**26.5**	**17.0**	**9.1**	**10.3**	**14.4**	**25.1**	**36.5**	**7.0**
	20	**17.3**	..	**32.2**	**26.2**	**25.1**	**16.1**	**9.8**	**12.5**	**16.2**	**21.0**	**32.7**	**10.7**
	25	**17.2**	..	**25.4**	**24.0**	**17.9**	**12.7**	**8.2**	**9.7**	**11.2**	**16.9**	**26.2**	**11.7**
1914	2½	4.3	15.8	12.6	..	..	..	..	..	..	..	..	..
	5	1.7	11.6	8.7	..	..	..	..	..	..	..	..	..
	10	**7.2**	**7.4**	**2.7**	..	..	..	..	..	..	..	..	..
	15	**17.0**	**21.5**	**15.8**	..	..	..	..	..	..	..	..	..
	20	**22.7**	**27.5**	**20.7**	..	..	..	..	..	..	..	..	..
	25	**20.3**	**21.3**	**17.1**	..	..	..	..	..	..	..	..	..
		Average Temperature °C. 8 a.m. 1902—1921.											
	0	2.2	1.4	2.0	4.6	9.3	13.9	16.5	16.5	14.3	11.0	7.0	4.2
	5	2.4	1.5	2.1	4.6	9.2	13.9	16.5	16.6	14.5	11.2	7.3	4.4
	10	2.5	1.7	2.2	4.3	8.2	12.6	15.9	16.4	14.4	11.3	7.5	4.6
	15	3.7	2.7	3.0	4.4	6.0	8.1	11.5	14.1	13.9	11.7	8.7	5.9
	20	4.7	3.6	3.7	4.4	5.1	6.0	8.1	11.2	12.7	11.8	9.7	7.0
	26	5.1	4.0	4.1	4.4	4.9	5.7	7.4	10.2	12.1	11.7	9.9	7.2
		Average Salinity ‰ 8 a.m. 1902—1921											
	0	21.3	20.6	17.9	17.4	16.2	16.3	17.1	18.1	18.2	18.1	19.1	21.3
	5	21.7	21.1	18.4	17.9	16.9	16.9	17.7	18.6	18.7	18.6	20.4	21.8
	10	22.9	22.3	20.8	19.8	19.5	19.3	19.6	20.0	20.2	20.1	21.7	23.1
	15	25.8	25.1	25.1	26.4	27.7	27.9	26.9	25.0	23.8	24.6	25.7	26.1
	20	28.1	27.9	28.8	30.1	31.6	31.7	31.1	29.8	28.1	28.4	29.5	28.8
	26	29.2	29.1	30.1	31.3	32.4	32.4	32.0	31.0	29.8	29.8	30.4	29.9

Table V. Horns

Nansen

1911 Month	Jan.					Febr.				March				April				May				
Date	3	10	18	24	31	7	13	22	27	6	13	21	28	3	10	17	24	1	8	15	22	29
Rathkea octopunctata	..	..	..	..	..	..	..	..	..	..	..	..	rr	..	..	rr	..	..	..	..	..	..
Mitrocoma polydiademata	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Phialidium hemisphæricum	..	r	rr	..	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Eucheilota maculata	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Obelia sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr
Eutonina indicans	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	rr	rr	rr
Eutima insignis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Eutima gegenbauri	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Aglantha digitale	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

1912 Month	Jan.					Febr.				March				April					May			
Date	1	10	19	23	29	5	12	19	26	4	11	18	25	1	10	15	22	29	6	15	20	27
Rathkea octopunctata	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	r	c	rr	..	..	..
Laodicea undulata	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Phialidium hemisphæricum	?	..	..	..	..	rr	..	+	..	r	..	rr	..	rr	..	..	..	rr	..	..	..	..
Obelia sp.	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	r	r	..	..	..
Eutima gegenbauri	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Aglantha digitale	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..

1913 Month	Jan.					Febr.				March					April				May			
Date		6	13	20	27	3	10	17	24	3	10	17	24	31	7	14	21	28	5	12	19	26
Euphysa aurata	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Steenstrupia nutans	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	r	+
Rathkea octopunctata	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	r	r	rr	..	..	..	..
Phialidium hemisphæricum	—	..	..	..	..	?	?	..	?	..	..	..	..	..	..	..	..	..	..	rr	..	..
Eucheilota maculata	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Obelia sp.	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Eutima gegenbauri	—	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Aglantha digitale	—	..	..	..	rr	..	..	..	..	..	..	..	rr	..	..	..	..	..	..	..	..	..

1914 Month	Jan.					Febr.				March				
Date		5	12	19	26	2	9	16	23	2	9	16	23	30
Rathkea octopunctata	—	..	..	..	..	..	..	..	..	..	..	..	..	r
Phialidium hemisphæricum	—	..	r	r	..	rr	..	r	rr	+	rr	rr	..	..

Moreover: *Sarsia tubulosa:* 1911, $^{3}/_{4}$ rr. *Euphysa aurata:* 1911, $^{21}/_{8}$ r, $^{18}/_{9}$ rr. 1912, $^{15}/_{7}$ rr. *Bougainvillia super-Leuckartiara octona:* 1911, $^{28}/_{11}$ rr. 1912, $^{30}/_{9}$ rr, $^{7}/_{10}$ r. 1913, $^{13}/_{10}$, $^{27}/_{10}$ rr. *Eutonina indicans:* 1912, $^{22}/_{4}$ rr. 1913, $^{28}/_{4}$ rr.

Rev Lightship.
Net, 30—0 m.

June				July				August					Sept.				Oct.					Novr.				Decr.			
5	12	19	27	3	10	17	24	18	21	24	28	31	4	11	18	25	2	9	16	23	30	9	13	22	28	5	12	18	25
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
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..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	r	c	..	?	..	..
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..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	c	r	rr	rr	..	..	..	..	..	..	..
..	..	..	..	..	+	r	..	+	cc	r	+	+	..	+	r	..	..	..	..	..	..	..	..	..	..	..	..	..	..

June				July					August				Sept.					Oct.				Novr.				Decr.				
3	10	17	24	1	8	15	22	29	5	12	19	26	2	9	16	23	30	7	14	21	28	4	11	18	25	2	9	16	23	30
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	c	r	r	..	..	..	?	..	..	?	..	..	?	r	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	+	..	rr	..	..	..	..	..	..	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..

June					July				August				Sept.					Oct.				Novr.				Decr.				
2	9	16	23	30	7	14	21	28	4	11	18	25	1	8	15	22	29	6	13	20	27	3	10	17	24	1	8	15	22	29
..	..	..	..	..	rr	rr	..	rr	r	rr	rr	..	..	..	..	..	rr	..	..	..	..	..	..	..	..	..	..	..	..	..
+	..	r	+	r	+	r	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
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..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	cc	c	r	r	cc	r	rr	..	rr	..	rr	+	+	r
..	..	..	..	..	..	..	..	rr	+	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	rr	..	..	..	..	..	..	..	c	r	..	..	rr	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	rr	..	r	+	r	..	..	..	..	..	..	..
..	..	rr	..	r	+	..	rr	r	c	c	c	r	rr	..	+	r	+	+	cc	c	r	r	r	..	..	..	..	..	..	..

ciliaris: 1912, $^{15}/_{4}$, $^{22}/_{4}$ **rr**. *Bougainvillia ramosa:* 1912, $^{23}/_{9}$, $^{30}/_{9}$ **rr**. 1913, $^{6}/_{10}$ **rr**. *Lizzia blondina:* 1911, $^{27}/_{6}$ **rr**

Table VI. Anholt Knob Lightship.
Nansen Net, 28—0 m.

1911 Month	Jan.		Febr.		March		April		May		June		July		Aug.		Sept.		Oct.		Novr.		Decr.	
Date	1	15	1	16	1	16	1	15	1	15	1	15	1	15	1	16	1	15	1	16	1	15	1	15
Sarsia tubulosa	..	..	..	..	..	..	r	r	rr	r	..	..	rr	..	..	..	..	..	..	..	..	..	..	..
Euphysa aurata	..	..	..	..	..	..	..	..	..	..	..	..	r	r	+	+	..	r	..	rr	..	..	..	..
Hybocodon prolif.	..	..	rr	r	+	+	c	c	c	cc	r	rr	rr	r	..	..	..	..	..	..	..	..	..	..
Lizzia blondina	..	..	..	..	..	..	..	..	..	..	..	..	..	r	..	..	..	..	..	..	..	..	..	..
Rathkea octo-punctata	..	..	..	rr	rr	r	+	c	+	c	..	..	..	..	..	..	..	..	..	..	..	..	..	rr
Obelia spp.	rr	rr	+	+	+	c	c	cc	+	cc	cc	cc	c	r	..	rr	..	rr	+	+	rr	r	rr	+
Phialidium hemi-sphæricum	..	..	rr	rr	..	..	..	..	..	..	..	..	..	..	rr	rr	..	rr	+	r	..	..	..	..
Aglantha digitale	..	..	rr	rr	rr	rr	rr	r	r	+	rr	r	r	r	r	rr	..	..	rr	rr	..	r	..	rr

1912 Month	Jan.		Febr.			M.	April		May		June		July		Aug.		Sept.		Oct.		Novr.		Decr.	
Date	1	16	1	2	22	15	1	15	1	15	1	15	1	15	1	15	2	15	1	15	1	15	1	15
Purena gemmifera	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	+	r	c	r	..	..	..	..	..	..
Euphysa aurata	rr	..	..	..	..	..	..	..	..	..	..	..	..	r	rr	r	+	rr	r	..	..	..	..	..
Hybocodon prolif.	..	..	..	..	..	..	..	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lizzia blondina	..	..	..	..	..	..	..	..	..	..	..	..	..	c	r	..	+	r	+	..	rr	+	r	..
R. octopunctata	..	..	..	rr	..	rr	rr	+	rr	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Obelia spp.	rr	..	..	..	..	..	..	c	..	cc	+	..	..	rr	..	rr	rr	+	r	..	..	r	..	..
Ph. hemisphæric.	rr	..	..	..	..	..	..	rr	..	..	..	..	..	..	..	..	..	rr	..	..	..	rr	r	..
Eutonina indicans	..	..	..	..	..	rr	..	r	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Aglantha digitale	..	..	..	..	rr	+	..	r	r	r	r	..	..	..	..	..	..	rr	..	..	..	..	rr	..

1913 Month	Jan.		Febr.		March		April		May		June		July		Aug.		Sept.		Oct.		Novr.		Decr.	
Date	—	17	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15	1	15
Sarsia tubulosa	—	..	..	..	..	..	..	r	..	..	rr	..	..	..	..	..	..	..	..	..	..	..	..	..
Purena gemmifera	—	..	..	..	..	..	..	..	..	..	..	..	..	rr	..	rr	..	..	rr	..	..	..	..	..
Euphysa aurata	—	..	..	..	..	..	..	..	..	..	..	..	..	rr	rr	+	rr	rr	rr	..	..	..	..	..
Hybocodon prolif.	—	..	..	..	r	c	cc	cc	cc	+	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Lizzia blondina	—	..	..	..	..	..	..	..	..	..	..	..	..	c	rr	..	rr	..	+	..	..	..	..	..
R. octopunctata	—	..	..	..	rr	+	r	rr	c	cc	+	..	..	..	..	..	..	..	..	..	..	..	..	..
Obelia spp.	—	..	..	..	..	..	..	..	r	+	cc	..	..	rr	..	..	..	..	..	..	..	+	..	..
Aglantha digitale	—	rr	..	..	..	..	rr	rr	+	rr	+	c	rr	..	..	..	..	..	rr	rr	+	c	r	..

1914 Month	Jan.		Febr.		March		April
Date	1	15	1	15	1	15	1
Hybocodon prolif.	..	..	..	..	..	+	..
R. octopunctata	..	..	..	..	..	r	r
Aglantha digitale	..	rr	..	..	..	..	rr

Moreover: *Sarsia tubulosa:* 1912, $^{15}/_{4}$ rr. 1914, $^{15}/_{3}$ rr. *Steenstrupia nutans:* 1911, $^{1}/_{8}$ rr. 1912, $^{1}/_{7}$, $^{1}/_{8}$ rr. 1913, $^{15}/_{8}$ rr. *Bougainvillia ramosa:* 1912, $^{2}/_{9}$, $^{15}/_{9}$, $^{1}/_{10}$ rr. *Obelia:* 1914, $^{1}/_{1}$, $^{15}/_{1}$ rr. *Eutonina indicans:* 1913, $^{15}/_{5}$ rr.

Table VII. Schultz's Grund Lightship.

August—September 1910. Hensen Net.

Month		August																				
Date		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Purena gemmifera	10—0	+	+	rr	c	+	+	+	c	c	..	..	..	c	cc	+	rr	+	c	c	cc	..	rr
	25—0	rr	r	rr	r	r	+	+	r	r	rr	..	..	..	+	r	r	c	c	c	+	rr	+
Euphysa aurata	10—0	r	..	..	..	..	..	..	..	..	cc	rr	..	rr	r	r	..	rr	..	..	..	..	..
	25—0	c	+	+	c	+	c	c	c	cc	c	c	cc	cc	cc	cc	cc	cc	c	c	+	rr	r
Steenstrupia nutans	10—0	rr	..	..	..	..	..	..	..	..	r	..	..	..	..	..	..	..	..	..	..	..	..
	25—0	r	r	+	+	rr	rr	..	r	r	rr	r	+	r	r	rr	r	..	..	rr	..	rr	..
Hydocodon prolifer	10—0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	15—0	r	rr	..	rr	r	r	..	r	r	..	..	..	..	..	..	..	..	..	..	..	..	..
Bougainvillia ramosa	10—0	..	..	..	..	..	rr	..	..	..	..	..	..	..	rr	rr	..	rr	..	..	..	..	..
	25—0	..	..	..	..	..	..	..	..	rr	..	..	..	..	..	..	..	rr	..	..	..	..	..
Lizzia blondina	10—0	c	c	rr	r	rr	rr	r	r	r	..	..	..	rr	rr	rr	..	rr	rr	r	..	..	..
	25—0	+	+	rr	..	..	rr	r	rr	r	rr	..	..	rr	r	rr	r	r	rr	rr	rr	..	..
Phialidium hemisphæricum	10—0	..	rr	..	rr	..	..	..	..	r	rr	rr	..	..	rr	rr	rr	rr	rr	..	r	..	r
	25—0	..	rr	..	..	rr	rr	..	..	..	..	..	..	..	..	..	rr	r	rr	rr	rr	rr	r
Obelia sp.	10—0	+	r	rr	+	r	..	rr	+	c	r	..	rr	+	r	r	rr	+	r	+	r	..	rr
	25—0	c	cc	c	+	rr	+	r	r	r	rr	rr	rr	r	+	r	r	c	+	c	c	r	r
Aglantha digitale	10—0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	25—0	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	..	..	rr	rr	r	rr	rr	..

Month		August (continued)									September												
Date		23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Purena gemmifera	10—0	r	+	rr	rr	..	..	rr	..	r	r	..	..	..	..	..	..	..	..	..	..	..	..	rr
	25—0	rr	rr	rr	rr	r	..	r	rr	+	rr	+	..	..	rr	r	..	..	..	..	..	..	rr	rr
Euphysa aurata	10—0	..	..	cc	c	rr	+	rr	..	rr	r	..	..	..	..	..	r	r	r	r	r	r	c	+
	25—0	..	+	cc	c	+	r	r	+	+	r	+	r	r	r	rr	..	c	c	c	c	c	c	c
Steenstrupia nutans	10—0	..	..	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	25—0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	..	..
Hybocodon prolifer	10—0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
	25—0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bougainvillia ramosa	10—0	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	..
	25—0	..	..	..	..	..	..	..	..	..	rr	..	..	..	..	..	..	..	..	..	..	..	+	rr
Lizzia blondina	10—0	..	rr	rr	..	r	rr	..	..	..	rr	..	..	rr	..	rr	..	rr	..	..	..	..	rr	..
	25—0	..	rr	rr	rr	r	rr	..	rr	rr	rr	rr	..	..	..	..	..	rr	..	rr	..	..	rr	..
Phialidium hemisphæricum	10—0	..	+	rr	r	..	..	..	..	rr	r	..	..	rr	..	r	r	+	c	+	c	c	c	+
	25—0	r	r	rr	rr	rr	rr	rr	rr	r	r	r	r	r	r	+	..	+	+	+	c	c	c	+
Obelia sp.	10—0	r	+	r	r	+	+	r	rr	rr	+	rr	rr	+	..	+	c	+	c	c	c	c	c	+
	25—0	c	+	rr	r	+	+	r	rr	r	+	+	c	c	c	+	c	+	c	c	c	c	+	+
Aglantha digitale	10—0	..	..	rr	rr	..	+	..	..	..	..	..	..	..	rr	..	..	..	..	..	..	..	..	..
	25—0	rr	r	rr	r	rr	..	..	+	..	r	r	rr	+	r	..	rr	rr	..	..	rr	rr	rr	..

Table VIII. Schultz's
Hensen Net,

1911 Month	Depth of haul	May			June				July			
Date	m	14	23	30	6	13	21	27	4	11	18	25
Sarsia tubulosa	8—0	..	..	..	..	..	..	..	..	..	..	..
	16—0	r	+	r	..	..	..	c	..	..	..	..
	26—0	—	—	—	rr	—	..	—	..	—	—	rr
Purena gemmifera	8—0	..	..	..	..	..	..	..	..	rr	..	..
	16—0	..	..	..	..	..	..	..	..	..	r	..
	26—0	—	—	—	..	—	..	—	rr	—	—	r
Euphysa aurata	8—0	..	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	..	..	..	..	..	rr	..	+
	26—0	—	—	—	..	—	..	—	..	—	—	r
Steenstrupia nutans	8—0	..	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	..	..	..	..	..	..	rr	rr
	26—0	—	—	—	..	—	..	—	..	—	—	+
Hybocodon prolifer	8—0	..	..	..	..	..	..	..	..	..	..	..
	16—0	cc	c	+	rr	r	rr	r	rr	rr	r	..
	26—0	—	—	—	+	—	r	—	rr	—	—	..
Lizzia blondina	8—0	..	..	..	..	..	..	..	..	rr	..	..
	16—0	..	..	..	..	..	..	..	..	..	+	r
	26—0	—	—	—	..	—	..	—	..	—	—	r
Rathkea octopunctata	8—0	..	..	..	..	..	..	..	..	..	..	..
	16—0	c	+	+	r	r	..	r	rr	..	..	..
	26—0	—	—	—	r	—	rr	—	rr	—	—	..
Phialidium hemisphæricum	8—0	..	..	..	..	..	..	..	..	r	..	+
	16—0	..	..	..	..	rr	..	..	..	+	rr	+
	26—0	—	—	—	..	—	..	—	rr	—	—	r
Obelia sp.	8—0	..	..	..	..	..	rr	..	..	..	..	c
	16—0	cc	c	c	+	cc	cc	c	c	+	+	c
	26—0	—	—	—	c	—	cc	—	c	—	—	c
Aglantha digitale	8—0	..	..	..	..	..	..	..	..	..	..	..
	16—0	r	..	..	r	+	..	+	..	..	rr	r
	26—0	—	—	—	r	—	r	—	rr	—	—	r

Grund Lightship.
8—0, 16—0 and 26—0 m.

August					September				October				November					December		
1	8	15	23	29	5	12	19	26	3	10	17	24	2	7	14	21	28	7	12	26
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r	rr	r	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
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r	r	..	+	+	..	+	rr	r	..	..	+	..	rr	..	..	..	..	..	..	..
r	r	r	+	+	..	+	r	r	..	+	+	r	..	..	rr	..	rr	..	rr	..
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r	r	..	rr	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
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rr	+	..	rr	r	..	rr	r	+	..	r	..	..	..	..	..	..	..	..	..	..
r	+	..	..	rr	..	rr	r	+	rr	+	rr	..	..	..	..	..	..	..	..	..
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..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	rr	..
rr	cc	rr	r	rr	r	..	r	rr	..	rr	r	..	..	..	..	..	..	..	..	..
r	cc	..	rr	+	+	+	+	+	..	r	r	..	..	rr	..	rr	..	..	..	..
+	c	r	+	+	c	+	+	+	..	r	r	..	..	..	rr	..	..	..	..	..
..	c	+	..	rr	c	c	cc	c	+	r	+	rr	cc	+	c	c	r	..	..	..
r	c	r	+	+	c	c	cc	c	r	r	c	..	cc	c	c	c	+	+	+	r
+	+	r	+	+	c	c	cc	c	r	+	c	r	cc	c	c	c	+	+	+	r
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	rr	..	rr	..	..	..	..	..	..	..	..	..	..	rr	rr	rr	..	..	..
rr	r	r	rr	rr	..	..	rr	..	..	..	..	..	..	..	rr	..	r	..	rr	..

Table VIII. Schultz's

1912 Month / Date	Depth of haul m	January				March				April			
		2	9	23	30	3	14	19	26	2	9	16	24
Sarsia tubulosa	8—0	..	..	..	..	..	r	rr	rr	..	..	rr	..
	16—0	..	..	..	..	..	r	rr	rr	..	..	r	..
	26—0	..	..	..	..	rr	+	r	..	..	rr	r	rr
Euphysa aurata	8—0	..	..	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	..	..	..	..	..	..	..	..	..
	26—0	..	..	..	..	..	..	..	..	..	..	..	..
Steenstrupia nutans	8—0	..	..	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	..	..	..	..	..	..	..	..	..
	26—0	..	..	..	..	..	..	..	..	..	..	..	..
Hybocodon prolifer	8—0	..	..	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	rr	rr	..	..	rr	..	..	rr	..	..
	26—0	rr	..	..	rr	rr	..	rr	..	..	rr	..	..
Lizzia blondina	8—0	..	..	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	..	..	..	..	..	..	..	..	..
	26—0	..	..	..	..	..	..	..	..	..	..	..	..
Rathkea octopunctata	8—0	..	..	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	rr	..	..	..	rr	rr	..	rr	rr	rr
	26—0	rr	..	..	..	..	rr	rr	rr	..	rr	rr	..
Phialidium hemisphæricum	8—0	..	..	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	rr	rr	..	r	rr	rr	r	..	..
	26—0	..	..	..	..	rr	rr	r	rr	..	rr	..	..
Obelia sp.	8—0	rr	..	..	..	..	..	..	..	..	..	+	..
	16—0	r	rr	..	rr	..	..	rr	..	..	r	c	rr
	26—0	r	rr	rr	r	rr	rr	r	..	rr	r	cc	r
Aglantha digitale	8—0	..	..	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	..	..	..	+	rr	..	..	..	..
	26—0	..	..	..	..	..	..	+	rr	..	rr	rr	..

Grund Lightship (continued).

May			June			July				Sept.		October				Novr.
14	21	28	11	19	25	2	9	16	23	17	24	3	9	15	29	5
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	—	..	..	..	..	..	..	—
..	..	..	..	..	..	..	..	..	..	..	r	..	..	..	..	..
..	..	..	..	..	rr	..	..	rr	rr	+	+	rr	..	rr	..	..
..	..	..	..	..	r	..	rr	rr	—	c	+	r	rr	r	..	—
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	rr	..	..	..	rr	..	..	..	..	..	..	..
..	rr	..	..	..	r	..	..	rr	—	..	..	..	..	..	..	—
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	—	..	..	..	..	..	..	—
..	..	..	..	..	..	..	+	..	r	rr	+	..	rr	r	r	r
..	..	..	..	..	..	..	+	rr	+	+	r	+	rr	r	r	r
..	..	..	..	..	..	..	r	rr	—	+	r	+	+	+	r	—
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..
rr	rr	..	..	..	..	..	..	..	—	..	..	..	..	..	..	—
..	..	..	..	..	..	..	..	..	..	..	r	..	..	..	rr	rr
..	..	..	..	..	..	..	rr	..	..	r	r	..	..	rr	rr	..
rr	rr	..	..	..	..	..	..	..	—	r	rr	r	r	rr	..	—
rr	rr	rr	rr	..	..	..	rr	..	rr	rr	+	+	..	r	+	+
..	+	c	rr	cc	r	rr	rr	..	..	r	c	+	rr	r	+	+
cc	c	cc	c	cc	r	r	rr	..	—	r	+	+	r	+	+	—
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	rr
..	..	rr	rr	..	..	..	..	..	—	..	..	..	..	..	..	—

Table VIII. Schultz's

1913—1914 Month / Date	Depth of haul m	August		September				October			
		19	26	2	18	25	30	7	14	21	28
Sarsia tubulosa	8—0	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	..	..	..	..	..	..	..
	26—0	..	..	..	..	..	..	..	..	..	..
Purena gemmifera	8—0	..	..	..	..	..	..	..	..	..	rr
	16—0	..	..	..	..	..	..	..	rr	r	..
	26—0	rr	..	..	..	..	..	..	r	rr	rr
Euphysa aurata	8—0	..	..	..	..	..	..	..	..	..	..
	16—0	+	r	..	..	rr	..	rr	..	..	..
	26—0	+	+	r	..	rr	..	rr	rr	rr	..
Hybocodon prolifer	8—0	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	..	..	..	..	..	..	..
	26—0	..	..	..	..	..	..	..	..	..	..
Lizzia blondina	8—0	..	rr	..	..	..	rr	rr	+	r	+
	16—0	rr	..	..	..	..	+	r	c	+	+
	26—0	rr	..	..	..	..	+	rr	+	+	+
Rathkea octopunctata	8—0	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	..	..	..	..	..	..	..
	26—0	..	..	..	..	..	..	..	..	..	..
Phialidium hemisphæricum	8—0	r	rr	..	..	..	rr	..	..	..	..
	16—0	rr	rr	r	r	..	rr	..	rr	rr	..
	26—0	rr	rr	+	rr	..	rr	rr	rr	rr	rr
Obelia sp.	8—0	rr	rr	..	..	..	..	rr	..	rr	+
	16—0	rr	rr	rr	..	..	rr	rr	r	+	+
	26—0	rr	rr	r	..	..	r	rr	r	+	+
Aglantha digitale	8—0	..	..	..	..	..	..	..	..	..	..
	16—0	..	..	..	..	..	..	..	r	rr	rr
	26—0	..	..	..	..	..	..	..	rr	r	r

Moreover: *Euphysa tentaculata:* 1912, $^{2}/_{7}$ 26—0 m **r**, $^{16}/_{7}$ 26—0 m **rr**. *Bougainvillia ramosa:* 1911, $^{8}/_{8}$, *Purena gemmifera:* 1912, $^{9}/_{7}$ 26—0 m, $^{16}/_{7}$ 26—0 m, $^{23}/_{7}$ 16—0 m **rr**.

Grund Lightship (concluded).

November				December				January		February			March				
4	11	18	25	2	9	16	27	1	13	10	17	25	3	11	17	24	31
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	..	rr
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	rr	r
..	..	..	..	..	..	..	..	..	—	..	..	..	rr	..	rr	..	c
r	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
r	rr	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
r	rr	rr	..	..	..	..	..	..	—	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	rr	..	..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	—	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	..	rr	rr	+	..	..
..	..	..	..	..	..	..	..	..	..	..	rr	..	rr	+	c	c	c
..	..	..	..	..	..	..	..	..	—	..	r	r	+	+	c	c	cc
+	+	r	c	..	..	..	..	..	..	..	..	..	..	..	..	..	..
c	r	r	+	rr	..	..	..	..	..	..	..	..	..	..	..	..	..
c	r	r	+	rr	rr	..	..	..	—	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..	rr	..	..	rr	..	rr
..	..	..	..	..	..	..	..	..	..	..	..	r	..	rr	c	+	r
..	..	..	..	..	..	..	..	..	—	..	rr	r	rr	rr	+	c	cc
..	..	..	rr	..	..	..	..	..	..	..	..	..	..	..	..	..	..
rr	..	rr	..	r	..	rr	..	..	..	..	..	..	..	..	..	..	..
rr	rr	..	..	rr	rr	rr	..	..	—	..	..	..	..	..	..	..	..
+	c	c	c	c	+	c	rr	rr	..	..	..	..	..	..	..	..	..
+	c	c	c	c	cc	cc	rr	rr	rr	rr	..	..	rr	rr	rr	..	..
+	c	c	c	c	cc	cc	rr	rr	—	rr	rr	rr	rr	r	rr	..	r
..	rr	rr	..	..	..	rr	..	..	..	..	..	..	..	..	..	..	..
rr	r	r	+	r	rr	rr	..	..	..	..	..	..	..	..	..	..	..
r	r	r	+	rr	rr	r	..	..	—	..	..	..	rr	..	..	..	rr

$^{12}/_{9}$, $^{17}/_{10}$, 26—0 m **rr.** *Leuckartiara octona:* 1911, $^{29}/_{8}$ 26—0 m **rr.** *Melicertum octocostatum:* 1911, $^{21}/_{6}$ 26—0 m **rr.**

Table IX. "Havörnen", May 1911.
Hensen Net, vertical hauls.

Station No.	Date	Position Lat. N. Long E.	Depth m	Hydrography Depth m	Temp. °C	Sal. ‰	Depth of haul m	Sarsia tubulosa	Hybocodon prolifer	Rathkea octopunct.	Obelia sp.	Aglantha digitale
		Kattegat										
1510	11. V	56°59′4 10°18′	3.7	0	13.3	23.8	3.7—0	r	..	r	+	..
				3.7	11.5	24.0						
1511	—	56°58′ 10°30′5	9	0	11.7	23.2	9—0	cc	c	cc	cc	+
				9	6.2	27.5						
1512	—	57°03′5 10°43′	15	0	11.1	19.6	15—0	+	cc	+	c	+
				15	5.6	27.8						
1513	—	57°13′ 10°43′	16	0	11.0	17.9	16—0	r	+	r	cc	rr
				16	5.9	32.7						
1514	12. V	57°49′8 11°05′4	50	0	10.4	19.7	50—0	rr	rr	r	cc	cc
				50	6.6	34.6						
1515	—	57°42′ 10°46′	24	0	11.0	21.3	24—0	rr	r	r	cc	c
				24	6.5	33.8						
1516	—	57°25′3 10°41′2	23	0	10.2	18.8	23—0	r	cc	+	cc	rr
				5	9.5	22.1						
				23	6.0	33.7						
1517	13. V	57°24′ 11°16′4	28	0	11.7	19.3	5.5—0	..	rr	rr	cc	r
				28	6.3	34.0	28—0	+	rr	rr	cc	+
1519	—	57°08′6 11°25′6	77	0	11.3	19.0	5.5—0	..	..	..	cc	rr
				5	10.2	19.2	77—0	r	rr	r	cc	+
				7.5	7.5	23.0						
				20	5.5	32.9						
				77	5.7	34.3						
1520	14. V	56°43′1 11°16′1	19	0	10.7	15.1	10—0	..	rr	..	+	rr
				19	4.8	30.8	19—0	r	c	r	+	rr
1521	—	56°23′6 11°22′	34	0	10.7	14.8	10—0	..	+	rr	r	rr
				34	4.5	33.0	34—0	rr	+	rr	c	rr
		Samsö Bay										
1523	15. V	55°46′7 10°48′8	52	0	10.9	10.8	10—0	rr	rr	..	..	..
				10	10.4	11.6	52—0	r	c	+	+	rr
				52	4.4	31.5						
1524	—	55°42′2 10°28′	22	0	10.4	13.4	10—0	rr	rr	rr	r	..
				10	10.0	19.4	22—0	rr	c	+	r	..
				22	4.4	29.0						
		Great Belt										
1525	—	55°29′8 10°52′6	30	0	9.7	10.1	15—0	rr	..	rr	..	..
				15	6.4	22.5						
				30	4.3	31.1						
1526	16. V	54°52′5 10°50′5	45	0	9.2	7.8	15—0	..	..	..	..	..
				15	5.6	18.6	45—0	+	c	r	r	..
				45	4.4	29.7						
		Western Baltic										
1527	17. V	54°50′ 10°12′7	34	0	9.7	10.7	15—0	..	..	..	..	..
				34	4.4	22.9	34—0	..	..	..	..	..
1528	—	54°35′5 11°03′5	38	0	9.6	9.8	10—0	..	..	..	..	..
				38	4.7	25.8	38—0	..	..	..	..	..
1529	—	54°27′ 11°33′4	25	0	8.5	7.9	15—0	..	..	..	..	..
				25	5.6	17.7	25—0	r	..	..	rr	..

Moreover: *Bougainvillia britannica*, St. 1517, 28—0 m **rr**. *Tiaropsis multicirrata*, St. 1516, 23—0 m **rr**. *Phialidium hemisphæricum*, St. 1511, 9—0 m **rr**. *Eutonina indicans*, St. 1517, 28—0 m **rr**.

Table X. "Thor" 1911.
Hensen Net, vertical hauls.

Station No.	Date	Position Lat. N.	Long E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul m	Sarsia tubulosa	Purena gemmifera	Euphysa aurata	Steenstrupia nutans	Hybocodon prolifer	Bougainvillia britannica	Lizzia blondina	Rathkea octopunctata	Phialidium hemisphaericum	Obelia sp.	Aglantha digitale
		North Sea																	
1535	17.VI	55°13′8	7°44′	22	0	11.8	33.1	22—0	..	..	..	..	..	..	..	..	..	..	..
1536	18.VI	55°26′	8°14′	9	0	12.3	32.6	9—0	..	..	..	..	..	..	..	..	..	..	..
1537	—	55°28′	8°08′	20	0	12.2	32.6	20—0	..	..	..	..	..	..	..	..	..	..	..
1538	—	55°29′5	8°00′3	24	0	12.2	33.1	24—0	..	..	..	..	..	..	..	..	..	..	..
					23	11.7	33.2												
1539	—	55°35′	7°47′	21	0	12.6	32.9	21—0	..	..	..	..	..	..	..	..	..	..	..
1540	—	55°40′	7°32′	23	0	11.3	33.6	23—0	..	..	..	..	..	..	..	..	..	..	..
1541	—	55°44′	7°18′	23	0	12.7	33.3	23—0	..	..	..	..	..	..	..	..	..	..	..
1542	—	55°47′	7°05′	30	0	13.0	33.6	30—0	..	..	..	..	..	rr	..	..	rr	rr	+
					30	7.8	34.3												
1543	—	55°50′	7°20′	22	0	12.7	26.5	22—0	..	..	..	..	..	..	..	..	..	rr	rr
					22	7.0	27.1												
1544	—	55°54′	7°32′	22	0	11.5	33.5	22—0	..	..	..	..	..	..	..	..	..	+	rr
1545	19.VI	55°57′5	7°46′	26	0	12.5	32.9	26—0	..	..	..	..	..	..	..	..	rr	r	..
1546	—	56°01′	7°59′	21	0	11.8	32.7	21—0	..	..	..	..	..	..	..	..	..	rr	..
1547	—	56°02′	8°03′	11	0	11.5	32.6	11—0	..	..	..	..	..	..	..	..	..	..	..
1548	—	56°04′	8°03′	13	0	11.4	32.7	13—0	..	..	..	..	..	..	..	..	..	rr	..
1549	—	56°07′	7°51′	26	0	12.1	33.5	26—0	..	..	..	..	..	..	..	..	..	..	r
1550	—	56°10′	7°39′	31	0	12.2	33.5	31—0	..	..	..	..	..	..	..	..	..	rr	..
1551	—	56°14′	7°25′	32	0	12.5	34.2	32—0	..	..	..	..	..	..	..	..	..	..	+
					32	7.7	34.9												
1552	—	56°17′	7°12′	34	0	12.7	33.6	34—0	..	..	+	..	..	rr	rr	..	rr	r	+
					32	7.1	35.2												
1553	—	56°20′	7°25′	30	0	13.8	31.7	30—0	..	..	..	..	..	..	..	..	rr	rr	+
1554	—	56°24′	7°39′	28	0	14.0	31.1	28—0	..	..	..	..	..	..	rr	..	..	r	c
					28	8.5	34.7												
1555	—	56°27′	7°51′	25	0	13.5	32.1	25—0	..	..	..	..	..	..	..	..	rr	rr	c
					25	9.1	34.6												
1556	—	56°30′	8°05′	20	0	12.4	34.0	20—0	..	..	..	..	..	..	..	..	..	rr	..
					20	10.6	34.4												
1557	—	56°38′	8°06′	20	0	13.6	31.3	20—0	..	..	..	..	..	..	..	..	..	..	cc
1558	20.VI	56°41′	7°45′	32	0	13.9	31.7	32—0	..	..	..	..	..	..	rr	..	..	rr	c
					32	8.3	35.1												
1559	—	56°47′	7°53′	28	0	13.2	31.9	28—0	..	..	..	..	..	..	rr	..	rr	+	c
					28	8.4	34.9												
1560	—	56°43′	8°10′	16	0	13.1	31.1	16—0	..	..	..	..	..	..	rr	..	..	..	+
		Lodbjerg—Lindesnes																	
1561	20.VI	56°50′	8°12′	16	0	13.5	31.6	16—0	..	..	..	..	..	..	..	..	..	rr	+
					16	10.5	34.0												
1562	—	56°56′	8°04′	26	0	13.3	32.5	26—0	..	..	..	..	..	..	..	..	rr	..	c
					26	8.3	35.1												

Table X (continued). "Thor" 1911.

Station No.	Date	Position Lat. N.	Long E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul m	Sarsia tubulosa	Purena gemmifera	Euphysa aurata	Steenstrupia nutans	Hybocodon prolifer	Bougainvillia britannica	Lizzia blondina	Rathkea octopunctata	Phialidium hemisphaericum	Obelia sp.	Aglantha digitale
1563	20.VI	57°03′	7°55′	44	0	13.2	32.9	44—0	..	..	..	..	..	rr	..	..	..	..	+
					43	7.9	34.7												
1564	—	57°09′	7°46′	53	0	14.5	32.2	53—0	..	..	..	..	..	rr	rr	..	..	r	c
					52	6.8	34.7												
1565	—	57°16′	7°35′	65	0	12.6	28.7	65—0	..	..	..	..	..	..	..	..	..	rr	cc
					64	6.2	35.0												
1566	21.VI	57°24′	7°25′	108	0	12.7	27.8	108—0	..	..	..	..	..	..	..	..	rr	..	c
					105	6.1	35.0												
1567	—	57°32′	7°14′	254	0	13.2	26.7	230—0	..	..	..	..	..	..	..	..	..	rr	+
					210	6.6	35.3												
1568	—	57°39′	7°13′	313	0	14.7	28.4	300—0	..	..	..	..	..	..	..	..	..	..	r
					300	6.0	35.1												
		Skagerrak																	
1571	24.VI	58°06′	9°00′	ca. 650	0	13.9	25.6	550—0	..	..	..	..	..	..	..	..	..	..	r
					200	6.1	35.4												
1572	26.VI	58°10′	9°19′	658	0	14.9	24.4	650—0	..	..	..	..	..	..	..	..	..	..	r
					200	6.2	35.2												
1574	—	57°58′	9°29′	170	0	14.3	—	165—0	..	..	..	..	..	rr	..	..	..	..	c
					160	6.2	34.9												
1575	27.VI	57°56′	9°36′	140	0	13.9	—	140—0	..	..	..	..	..	rr	..	..	..	..	+
					135	6.3	35.3												
1576	—	57°55′	9°41′	ca. 100	0	13.8	27.9	90—0	..	..	..	rr	..	r	..	..	..	..	+
					80	7.8	34.7												
1577	—	57°55′	9°54′	63	0	13.3	29.8	63—0	..	..	..	..	..	r	..	..	..	rr	c
					60	9.8	34.3												
		N.W. Kattegat																	
1578	28.VI	57°42′	10°36′	11	0	13.1	32.3	11—0	r	..	r	..	..	..	r	..	..	rr	+
					11	13.0	32.5												
1579	—	57°38′	10°36′	17	0	13.5	30.7	17—0	..	..	+	r	..	..	..	..	..	r	+
					17	12.5	32.9												
1580	—	57°33′	10°38′	22	0	14.0	24.1	22—0	..	..	r	..	..	..	rr	..	..	rr	+
					22	11.0	33.3												
1581	—	57°32′5	10°31′	9	0	13.3	29.2	9—0	..	..	..	rr	..	..	..	..	..	rr	..
					9	12.6	33.2												
1582	—	57°37′	10°29′	8	0	13.6	32.7	8—0	..	..	+	rr	..	..	..	..	..	rr	rr
					8	13.5	32.7												
1583	29.VI	57°37′	10°44′	25	0	13.7	30.1	25—0	..	..	+	rr	..	..	..	..	..	..	+
					24	13.1	32.5												
1584	—	57°30′5	10°38′	16	0	13.6	26.2	14—0	..	..	..	..	..	rr	..	..	..	..	rr
					13	12.8	31.4												
1585	—	57°24′	10°43′	26	0	14.8	18.4	26—0	..	..	rr	..	..	..	..	..	..	rr	..
					26	10.4	34.1												
1586	—	57°15′	10°42′	23	0	14.4	21.5	23—0	..	..	r	+	..	..	..	..	..	..	rr
					23	11.5	33.7												

Tabel X (continued). "Thor" 1911.

Station No.	Date	Position Lat. N.	Long E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul m	Sarsia tubulosa	Purena gemmifera	Euphysa aurata	Steenstrupia nutans	Hybocodon prolifer	Bougainvillia britannica	Lizzia blondina	Rathkea octopunctata	Phialidium hemisphæricum	Obelia sp.	Aglantha digitale
		Aalborg Bay																	
1587	30.VI	56°55′	10°26′	7	0	9.4	31.3	7—0	..	..	..	rr	r	..	..	rr	rr	c	rr
					7	7.7	32.4												
1588	—	56°45′	10°23′	4	0	10.1	31.1	4—0	c	..	..	..	+	..	..	r	rr	cc	..
					4	8.5	31.8												
1589	—	56°45′	10°44′	13	0	13.1	24.2	13—0	rr	..	..	..	..	..	..	rr	..	c	..
					13	6.7	33.2												
1590	—	56°37′	10°48′	7	0	12.4	26.3	7—0	cc	..	..	..	rr	..	..	rr	..	+	..
					7	7.0	32.4												
1591	—	56°34′	10°30′	8	0	10.8	30.7	8—0	c	..	..	r	rr	..	..	rr	rr	cc	rr
					8	9.4	31.8												
1592	1.VII	56°56′	10°43′	8	0	12.5	24.6	8—0	..	..	rr	rr	..	rr	..	..	..	r	..
					8	9.2	30.3												
1593	—	57°07′	10°39′	9	0	12.0	27.4	9—0	..	..	rr	c	..	..	..	..	..	r	r
					9	11.2	31.8												
		Northern Kattegat																	
1594	—	57°20′	10°35′	5	0	13.7	26.1	5—0	rr	..	..	rr	..	..	..	..	rr	..	rr
					5	12.8	32.4												
1595	3.VII	57°27′	10°35′7	10	0	13.3	28.5	10—0	+	..	c	rr	..	..	..	..	..	rr	c
1598	—	57°29′	10°56′	41	0	14.5	25.5	41—0	..	..	+	..	..	..	..	..	..	rr	r
					41	9.2	34.5												
1599	—	57°37′	10°58′	30	0	14.3	25.3	30—0	..	..	rr	..	..	..	..	..	..	..	r
					28	13.7	31.2												
1600	—	57°28′	11°14′	14	0	14.2	30.3	14—0	..	..	r	..	..	..	..	..	..	..	+
					13	13.6	31.3												
1602	4.VII	57°16′	11°19′	26	0	14.1	23.0	26—0	..	..	rr	rr	..	..	rr	..	rr	r	r
					25	13.6	31.7												
1603	—	57°14′	11°17′	18	0	14.1	23.2	18—0	..	..	rr	..	..	..	..	..	rr	+	r
					18	14.0	29.2												
1604	—	57°15′	11°15′	6—12	0	14.3	23.2	12—0	..	rr	rr	..	..	..	rr	..	rr	+	+
					8	14.1	24.4												
1605	—	57°20′5	10°57′5	5—6	0	14.0	24.5	5—0	..	rr	rr	+	..	..	r	..	r	r	r
					6	14.0	24.7												
		Danish Skagerrak-coast																	
1606	5.VII	57°33′	9°37′	24	0	13.6	30.7	24—0	..	..	..	..	..	..	rr	..	..	rr	c
					24	13.5	33.8												
1607	—	57°22′	9°24′	14	0	13.6	33.6	14—0	..	..	..	..	..	..	..	..	..	rr	rr
					14	13.5	33.4												
1608	—	57°16′	9°22′	11	0	13.8	33.4	11—0	..	..	..	..	..	..	..	..	rr	..	rr
					10	13.6	33.5												
1609	—	57°10′	9°15′	7	0	14.3	32.8	7—0	..	..	..	..	..	..	..	..	..	..	..
1610	—	57°11′	9°01′	11	0	14.1	33.2	11—0	..	..	..	..	..	..	..	..	+	..	..

Table X (continued). "Thor" 1911.

Station No.	Date	Position Lat. N.	Long E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul m	Sarsia tubulosa	Purena gemmifera	Euphysa aurata	Steenstrupia nutans	Hybocodon prolifer	Bougainvillia britannica	Lizzia blondina	Rathkea octopunctata	Phialidium hemisphæricum	Obelia sp.	Aglantha digitale
1611	5.VII	57°19′	8°52′	25	0	14.0	30.5	24—0	..	..	..	..	..	..	..	..	..	..	..
					24	13.1	34.2												
1612	—	57°25′	9°05′	20	0	14.0	31.2	20—0	..	..	..	..	..	..	r	..	..	..	c
					19	13.2	34.0												
1613	6.VII	57°49′	10°20′	85	0	14.0	30.2	80—0	..	..	..	..	..	..	..	..	..	rr	r
					80	11.9	34.2												
1614	—	57°44′	10°46′	35	0	14.5	29.4	35—0	..	..	..	..	..	..	..	..	..	..	rr
					35	13.1	33.3												
		Læsö to South of Anholt																	
1616	7.VII	57°15′	10°50′	8	0	14.9	26.4	8—0	rr	..	..	r	..	..	..	..	..	rr	..
					8	14.7	26.6												
1617	—	56°58′5	11°03′	8	0	14.3	23.5	8—0	..	rr	..	+	..	..	rr	..	rr	+	rr
					8	13.8	23.7												
1618	—	56°53′	11°24′	12	0	15.0	19.6	12—0	..	..	rr	+	..	..	rr	..	..	r	r
					12	10.7	28.2												
1619	—	56°45′	11°32′	8	0	15.5	16.1	8—0	..	rr	..	..	..	..	..	..	+	r	rr
					8	13.4	16.2												
1620	—	56°48′	11°21′	7	0	15.2	16.2	7—0	..	rr	..	..	..	..	rr	..	r	r	..
					7	15.1	16.2												
1621	—	56°43′	11°25′	7	0	15.3	15.9	7—0	..	rr	..	..	..	..	..	..	rr	..	..
					7	15.4	16.0												
1622	—	56°37′	11°26′	15	0	15.1	16.0	15—0	..	..	rr	rr	..	..	..	..	rr	r	..
					15	12.4	30.2												
1623	—	56°32′	11°34′	30	0	15.1	16.1	30—0	rr	rr	..	r	..	..	c	..	+	cc	r
					29	6.4	33.9												
		S. W. Kattegat and Samsö Bay																	
1624	8.VII	56°13′	11°03′	23	0	15.1	17.4	23—0	..	..	..	rr	rr	..	..	..	rr	c	rr
					23	6.9	33.8												
1625	—	56°12′5	10°45′5	15	0	14.3	16.6	15—0	..	..	..	r	..	..	..	..	..	+	rr
					11	9.1	31.4												
1626	—	56°09′	10°39′	9	0	14.2	16.6	9—0	rr	..	..	r	..	..	..	..	..	rr	..
					9	10.2	28.5												
1627	—	56°10′	10°33′	6—12	0	14.5	19.6	11—0	rr	..	..	..	..	..	..	..	..	+	..
					10	8.8	31.1												
1628	—	56°03′5	10°40′	36	0	15.2	16.3	25—0	r	rr	..	rr	..	..	..	rr	..	+	..
					36	6.8	33.1												
1629	10.VII	56°16′	10°26′	9—10	0	13.3	23.4	9—0	rr	..	..	rr	..	..	..	..	..	r	..
					9	8.2	31.6												
1630	—	56°12′5	10°17′5	8—10	0	14.5	20.8	8—0	..	..	..	..	..	..	..	..	..	+	rr
					8	11.3	27.3												

Table X (continued). "Thor" 1911.

Station No.	Date	Position Lat. N.	Long E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul m	Sarsia tubulosa	Purena gemmifera	Euphysa aurata	Steenstrupia nutans	Hybocodon prolifer	Bougainvillia britannica	Lizzia blondina	Rathkea octopunctata	Phialidium hemisphæricum	Obelia sp.	Aglantha digitale
1631	10.VII	56°08′5	10°14′	6—13	0	14.5	20.2	6—0	..	..	..	..	..	..	..	..	..	rr	..
					7	12.8	25.7												
1632	—	56°08′	10°19′	15	0	15.3	18.2	15—0	rr	rr	rr	..	rr	..	..	r	rr	+	..
					15	7.4	31.9												
1633	—	56°02′	10°29′	9—15	0	16.0	16.9	9—0	..	..	rr	..	..	..	..	..	..	rr	..
					9	12.2	26.5												
1634	—	55°55′5	10°34′	4—12	0	15.0	21.3	8—0	..	..	..	..	..	..	..	..	..	rr	..
					8	14.0	23.5												
1635	11. VII	55°45′5	10°21′5	5—6	0	14.9	21.8	6—0	..	..	..	..	..	..	..	..	..	+	..
					6	14.5	22.8												
1636	—	55°42′	10°26′	25	0	15.7	17.3	25—0	r	..	..	..	..	..	..	..	..	..	..
					25	6.6	32.9												
1637	—	55°37′	10°22′	5—6	0	15.8	17.5	6—0	..	rr	rr	..	..	..	..	..	rr	rr	..
					6	15.8	19.1												
1638	—	55°49′	10°08′	5—6	0	18.6	21.6	6—0	..	..	..	..	..	..	..	..	..	+	..
					6	14.4	25.8												
1639	—	55°42′	10°04′5	7—10	0	18.5	19.6	7—0	..	..	..	..	..	..	..	..	..	+	..
					7	13.8	24.9												
1640	12.VII	55°41′	9°44′5	4—6	0	16.1	24.1	4—0	..	..	..	..	..	..	..	..	..	..	..
					3.5	15.8	24.8												
1641	—	55°34′	9°55′	15	0	15.5	22.9	15—0	rr	..	rr	..	..	..	..	..	..	+	..
					15	10.8	29.3												
1642	—	55°31′	9°56′	4—10	0	21.1	21.7	4—0	..	..	..	..	..	..	..	..	..	+	..
					4	16.2	24.3												
		W., S. and E. of Fyen																	
1643	—	55°30′5	9°37′	6—10	0	20.2	19.1	9—0	+	..	..	..	..	..	..	..	..	..	..
					9	13.3	25.1												
1644	—	55°26′5	9°43′	5—10	0	18.8	16.7	5—0	..	..	..	..	..	..	..	..	..	..	..
					4.5	17.4	17.7												
1645	13. VII	55°15′	9°50′	5—6	0	18.0	15.9	5—0	..	..	..	..	..	..	..	..	..	..	..
					5	16.4	16.3												
1646	—	54°58′	10°12′	6—14	0	16.6	15.0	9—0	..	..	..	..	..	..	..	..	..	..	..
					9	14.6	16.1												
1647	—	54°56′	10°12′	38	0	17.4	14.2	38—0	+	..	..	..	..	..	..	..	rr	rr	..
					38	9.0	28.5												
1648	14.VII	54°50′	10°28′	7—10	0	17.5	14.9	7—0	..	..	..	..	..	..	..	..	..	..	..
					7	15.4	15.2												
1649	—	54°43′5	10°36′	21	0	17.6	14.4	21—0	..	..	..	..	..	..	..	..	..	rr	..
					20	10.0	26.4												
1650	—	54°45′5	10°47′	23	0	17.3	11.2	23—0	..	..	..	..	..	..	..	..	..	..	..
					23	7.1	32.2												

Table X (concluded). "Thor" 1911.

Station No.	Date	Position Lat. N.	Long E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul m	Sarsia tubulosa	Purena gemmifera	Euphysa aurata	Steenstrupia nutans	Hybocodon prolifer	Bougainvillia britannica	Lizzia blondina	Rathkea octopunctata	Phialidium hemisphaericum	Obelia sp.	Aglantha digitale
1651	14.VII	54°57′	10°51′	7—10	0	17.0	15.4	9—0	..	..	..	..	..	..	..	..	..	..	..
					9	11.0	25.1												
1652	—	55°08′	10°57′5	7—10	0	17.9	15.2	8—0	..	..	..	..	..	..	..	..	..	..	..
					8	14.3	17.7												
1653	15.VII	55°03′	10°44′	8	0	17.1	19.2	8—0	..	..	..	..	..	..	..	..	..	..	..
					8	15.7	20.1												
1654	—	55°08′	10°48′	5—8	0	17.7	18.7	8—0	..	..	..	..	..	..	..	..	..	..	..
					8	16.3	19.4												
1655	—	55°20′	10°50′	5—8	0	16.6	18.1	5—0	..	..	..	..	..	..	..	..	..	..	..
					6	16.4	18.1												
1656	—	55°28′	10°43′	7—12	0	15.9	18.7	10—0	..	..	..	..	..	..	..	..	..	rr	..
					10	14.3	19.9												
		E. of Samsö																	
1657	16.VII	55°50′	10°46′	24	0	15.6	18.3	24—0	+	r	rr	rr	..	..	r	..	r	+	rr
					24	7.4	32.6												
1658	—	55°55′	10°45′	16	0	16.3	19.4	16—0	..	..	r	rr	..	..	..	..	r	+	..
					16	9.6	29.7												
1659	—	56°00′	10°40′	15	0	16.4	17.6	15—0	..	r	..	..	..	..	rr	..	+	+	..
					15	9.1	30.7												
1660	—	55°57′	10°37′	10—12	0	16.7	19.1	10—0	..	..	..	..	..	..	..	..	rr	+	..
					10	15.2	22.2												
		North-coast of Sealand and the Sound																	
1661	17.VII	56°12′	12°18′	24	0	16.3	16.5	24—0	..	rr	..	..	rr	..	rr	..	r	+	..
					24	7.3	33.6												
1662	—	55°57′5	12°36′	15	0	16.6	15.1	15—0	..	rr	..	..	..	..	rr	..	+	+	..
					15	16.3	15.8												
1663	—	55°49′	12°37′	8	0	16.5	14.6	7—0	..	..	..	..	..	..	..	..	..	rr	..
					7	16.6	14.6												
1665	—	55°49′	12°43′	22	0	16.6	15.2	22—0	+	r	..	..	..	..	rr	+	+	c	..
					22	5.7	33.7												

Moreover: *Euphysa tentaculata:* St. 1657, 1665 **rr**. *Bougainvillia ramosa:* St. 1638, 1639, 1642 **rr**. *Leuckartiara octona:* St. 1545 **rr**. *Eucheilota maculata:* St. 1603 **rr**.

In the young fish trawl, mostly near the bottom, were caught: *Bougainvillia britannica:* St. 1542, 1549, 1551, 1552, 1560, 1563, 1592. *Leuckartiara octona:* St. 1565, 1579, 1586. *Melicertum octocostatum:* St. 1551, 1587, 1592, 1593, 1623. *Phialidium hemisphæricum:* St. 1563, 1617. *Eutonina indicans:* St. 1537, 1542, 1551, 1552, 1563, 1575, 1576. *Tima bairdii:* St. 1563, 1567, 1575, 1657.

Table XI. "Dana" 1922.
Petersen's Young fish trawl.

Station No.	Date	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Temp. °C	Sal. ‰	Depth of haul	Leuckartiara octona	Neoturris pileata	Cosmetira pilosella	Phialidium hemisphaericum	Saphenia gracilis	Eutima insignis	Eutima gegenbauri	Eirene viridula	Tima bairdii	Aglantha digitale
		North Sea																
2837	28. IX	56°44′	7°57′	28	0	12.3	33.4	near	r	..	r	c	..	r	..	..	..	..
					28	12.5	34.1	bottom										
2839	—	56°49′	7°45′	36	0	12.0	33.7	—	+	..	r	c	..	..	..	r	..	r
					36	12.3	34.5											
2840	29. IX	56°49′	7°27′	25—28	0	12.3	33.3	—	c	..	..	..	..	..	..	..	..	r
					28	12.4	33.4											
2841	—	56°59′	7°41′	22	0	12.3	33.3	—	r	..	..	..	..	..	..	..	..	..
					22	12.45	33.8											
2842	—	56°54′	7°35′	26	0	12.0	33.1	—	+	..	..	..	..	..	..	..	..	..
					26	12.3	33.7											
2843	—	56°45′	7°36′	41	0	12.4	34.1	—	+	..	..	r	..	..	..	..	..	r
					41	12.5	34.5											
2844	—	56°40′	7°51′	26	0	12.75	34.1	—	+	..	r	c	..	c	..	r	..	..
					26	12.85	34.5											
2845	30. IX	56°31′	8°03′	18—22	0	12.5	33.5	—	+	..	r	c	..	+	..	..	..	..
					22	12.6	33.6											
2846	—	56°24′	7°57′	24	0	12.65	33.5	—	+	..	..	+	..	..	..	..	..	r
					24	12.65	33.5											
2848	—	56°25′	7°43′	27	0	13.2	33.3	—	c	..	..	..	..	..	..	..	..	..
					27	13.3	33.6											
2849	—	56°27′	7°29′	34	0	13.2	33.2	—	r	..	..	?	..	..	..	..	..	..
					34	13.4	33.8											
2850	1. X	56°32′	6°44′	37	0	13.45	34.6	—	r	..	..	r	..	+	..	r	r	..
					37	13.55	34.8											
2851	—	56°41′	6°32′	37	0	13.45	34.4	—	r	..	..	+	..	c	..	c	..	..
					37	13.55	34.8											
2852	—	56°49′	6°32′	48	0	12.6	34.5	—	+	..	..	..	..	r	..	..	..	r
					48	10.6	34.7											
2853	—	56°49′	6°51′	34	0	12.8	34.8	—	r	..	..	..	..	c	r	r	..	r
					34	11.8	35.0											
2854	2. X	56°48′	8°08′	23	0	12.4	33.6	—	r	..	..	r	..	r	..	..	..	..
					23	12.65	33.7											
2856	—	56°52′	8°02′	27	0	12.8	33.4	—	+	..	..	c	+	c	..	..	..	..
					27	12.9	33.8											
2858	—	56°57′	8°10′	25	0	13.0	33.6	—	c	..	..	c	r	+	r	..	..	..
					25	12.9	33.9											
2859	—	57°05′5	8°09′	34	0	13.0	34.3	—	r	..	+	c	r	+	r	..	+	..
					34	13.0	34.6											
2860	—	57°12′	7°52′	50	0	12.0	34.3	—	..	..	..	r	..	..	r	..	r	r
					50	12.3	34.7											

Tabel XI (continued). "Dana" 1922.

Station No.	Date	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Temp. °C	Sal. ‰	Depth of haul	Leuckartiara octona	Neoturris pileata	Cosmetira pilosella	Phialidium hemisphæricum	Saphenia gracilis	Eutima insignis	Eutima gegenbauri	Eirene viridula	Tima bairdii	Aglantha digitale
2861	2. X	57°25′	8°01′	ca. 80	..	..	..	130 m wire	+	..	+	c	r	..	r	..	r	r
2862	3. X	57°20′	7°57′	ca. 60	..	..	..	70 m wire	+	..	r	+	r	..	..	..	..	..
2863	—	57°15′	7°54′	ca. 50	..	..	..	40 —	+	..	+	c	..	c	+	c	..	r
		Skagerrak																
2864	—	57°13′	8°36′	22	0	12.5	33.3	near	+	..	..	r	r	..	r	r	r	..
					22	12.85	33.9	bottom										
2869	4. X	57°42′	9°15′	47	0	11.8	34.3	—	+	..	..	..	..	..	..	..	r	..
					47	12.0	34.8											
		North. Kattegat																
2870	—	57°41′5	10°35′5	15	0	12.0	31.8	—	c	..	..	r	..	..	..	..	..	..
					15	12.8	33.5											
2873	6. X	57°21′	11°03′	8	0	11.8	22.9	—	r	..	..	..	..	..	..	..	..	..
					8	11.5	26.6											
2874	—	57°28′	11°15′	15	0	11.0	22.9	—	+	..	..	r	r	..	..	..	..	..
					15	11.9	32.0											
		Eastern Kattegat																
2875	—	57°10′	11°41′	39	0	10.8	19.9	—	..	..	..	..	..	..	..	..	..	..
					39	11.0	33.0											
2878	—	57°07′	11°34′	26	0	10.5	19.1	surface	+	..	..	r	..	..	..	..	..	..
					26	11.0	33.8											
—	—	—	—	—	..	..	..	near bottom	c	..	r	r	r	r	..	..	..	r
2879	7. X	57°07′5	11°26′5	77	0	10.2	23.2	100 m	c	..	..	r	..	..	..	..	..	..
					77	10.2	34.6	wire										
		Læsö Channel																
2882	8. X	57°21′	10°46′5	37	0	10.8	26.0	70 m wire	c	..	..	+	..	..	..	..	..	..
					37	12.0	34.3											
2883	—	57°12′	10°45′	23	0	11.8	25.8	45 —	c	..	..	+	r	..	..	..	..	..
					23	12.3	33.4											
2884	—	57°04′	10°55′5	9	0	11.4	21.6	near	c	..	..	r	..	..	..	..	..	..
					9	11.2	25.6	bottom										
2885	—	57°05′	10°43′	14	0	11.5	21.3	—	c	..	..	r	..	..	..	..	..	..
					14	11.2	25.7											
		Eastern Kattegat																
2886	9. X	57°18′	11°18′	70—45	0	10.9	22.2	—	+	..	r	r	..	..	..	..	..	r
					bot-tom	10.8	33.8											
2887	—	57°41′	11°24′5	90	0	10.2	21.4	200 m	..	+	..	r	..	r	..	..	..	..
					90	9.6	34.2	wire										

Table XI (concluded). "Dana" 1922.

Station No.	Date	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Temp. °C	Sal. ‰	Depth of haul	Leuckartiara octona	Neoturris pileata	Cosmetira pilosella	Phialidium hemisphæricum	Saphenia gracilis	Eutima insignis	Eutima gegenbauri	Eirene viridula	Tima bairdii	Aglantha digitale
2888	10. X	57°46′5	11°21′	90	0	10.2	21.4	180 m	c	+	..	..	..	..	..	..	c	..
					90	9.6	34.2	wire										
2889	—	57°37′5	11°28′5	85	0	10.2	21.4	bottom	r	r	..	..	..	..	..	..	r	+
					85	9.5	34.8											
2890	—	57°12′	11°19′	23	0	11.9	22.9	near	c	r	..	..	..	r	..	..	r	..
					90	21.1	33.9	bottom										
		Skagerrak																
2892	11. X	57°48′5	10°45′5	90	0	10.2	24.6	—	..	..	r	r	..	..	..	..	c	+
					90	8.2	35.2											
—	—	—	—	—	..	..	..	bottom	r	r	..	r	..	..	..	..	+	+
2895	12. X	58°13′	9°34′	650	0	8.9	30.4	1000 m	..	..	..	..	..	..	..	..	..	+
					650	5.1	35.1	wire										
2898	—	57°54′	9°34′	100	0	10.1	32.6	bottom	..	..	..	..	..	..	..	..	r	r
					100	7.6	35.2											
2902	13. X	57°11′	8°57′	15	0	11.2	33.8	—	..	..	..	r	r	r	..	..	..	..
					15	11.4	34.3											
2906	14. X	57°41′	9°04′	70	0	10.8	32.1	—	+	..	..	?	..	r	r	r	r	r
					70	9.0	35.0											
2912	15. X	57°43′	10°22′	25	0	10.8	33.8	—	+	..	..	r	..	..	..	..	..	..
					25	11.2	32.8											
		Eastern Kattegat																
2922	18. X	57°07′	11°43′	30	..	..	..	near bottom	c	+	r	r	..	r	..	..	..	..
2923	—	57°05′5	11°53′	52	0	9.5	19.5	100 m	c	+	..	..	r	..	..	..	..	..
					52	11.5	34.0	wire										
2924	19. X	56°33′5	12°13′5	50	0	9.5	20.6	near	c	..	..	..	r	..	..	..	r	..
					50	11.4	33.2	bottom										
2926	—	56°09′	12°22′5	88	0	9.5	17.5	50 m wire	c	..	..	..	..	..	..	..	..	..
					28	11.5	33.4											
		The Sound																
2927	—	55°58′	12°41′5	30	0	8.8	10.0	near	r	..	..	r	..	..	..	..	..	..
					30	10.8	32.2	bottom										
2928	—	55°49′	12°44′5	23	0	8.7	10.0	—	r	..	..	..	..	..	..	..	..	..
					23	11.5	32.6											

Moreover: *Laodicea undulata:* St. 2837, 2844, 2851, 2859 **r.** *Melicertum octocostatum:* St. 2879 **rr.** *Eucheilota maculata:* St. 2846, 2849, 2858 **rr.**

Table XII. "Dana" 1923.
Ringtrawl and Petersen's Young fish trawl.

Station No.	Date	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul	Sarsia tubulosa	Hybocodon prolifer	Bougainvillia britannica	Rathkea octopunctata	Halitholus cirratus	Staurophora mertensii	Tiaropsis multicirrata	Obelia sp.	Obelia nigra	Eutonina indicans	Tima bairdii	Aglantha digitale
									blue											
2937	1. IV	57°21′	9°17′	20	..	..	..	15 m wire	..	..	..	..	..	..	..	..	..	..	..	r
2939	—	57°05′	11°30′	25	..	..	..	40 —	c	rr	..	rr	..	..	..	..	..	..	..	..
								90 —	+	rr	..	rr	rr	..	..	..	..	..	..	..
2940	—	56°34′	12°12′	40	..	..	..	bottom	rr	..	..	..	rr	..	..	..	..	..	..	..
2941	2. IV	55°52′	12°44′5	20	..	..	..	65 m w.	r	rr	..	..	rr	..	..	..	..	..	..	..
		S.E. Kattegat																		
2944	17. IV	56°20′	12°40′	18	0	6.0	34.4	0 m	..	..	..	..	..	..	..	..	..	..	..	..
					18	6.5	34.9	50 m w.	c	c	..	r	rr	..	..	+	..	..	rr	rr
2945	—	56°23′	12°15′	32	0	4.8	17.4	30 —	rr	..	..	..	rr	..	..	..	..	..	..	..
					10	3.8	19.2	90 —	r	..	..	..	r	..	..	..	..	..	rr	..
					32	6.5	34.9													
2946	—	56°17′5	11°51′	27	0	4.1	17.0	0 m	..	..	..	..	r	..	..	..	..	..	..	..
					27	5.3	33.3	60 m w.	r	..	..	r	r	..	..	..	..	..	rr	..
2947	—	56°09′	11°44′	23	0	4.1	18.1	0 m	..	..	..	..	..	..	..	..	..	..	..	..
					23	5.7	33.8	60 m w.	..	..	..	..	r	..	..	..	..	..	..	..
2948	18. IV	56°11′	12°09′	21	0	4.1	17.0	0 m	..	..	..	..	r	..	..	..	..	..	..	..
					21	5.0	32.3	bottom	..	..	..	..	r	..	rr	..	..	..	..	rr
2949	—	56°07′5	12°13′	8	0	4.5	22.9	—	..	..	..	..	+	..	..	..	..	..	..	..
					8	4.4	24.0													
2950	—	56°06′5	12°26′	9	0	5.4	24.2	—	..	cc	..	..	+	..	..	..	..	..	..	..
					9	5.2	29.4													
		East of Sealand and Falster																		
2953	19. IV	55°33′	12°26′	8	0	4.2	7.8	—	..	..	..	..	rr	..	..	..	..	..	..	..
					8	3.8	8.3													
2954	—	55°26′5	12°28′	14	0	5.9	7.9	—	r	cc	..	rr	..	..	rr	..	..	rr	..	..
					14	4.4	14.3													
2956	—	55°09′	12°16′	9	0	5.6	7.7	near	..	..	..	..	..	..	..	..	..	..	..	..
					9	4.3	7.7	bottom												
2957	—	55°03′	12°33′	21	0	3.2	7.8	—	..	..	..	..	..	..	..	..	..	..	..	..
					21	2.9	17.1													
2958	20. IV	54°52′	12°20′	21	0	4.5	8.1	0 m	..	..	..	..	..	..	..	..	..	..	..	..
					20	2.8	18.8	60 m w.	rr	..	..	..	rr	..	..	..	..	..	..	..
2959	—	54°40′	12°22′	17	0	4.7	9.0	0 m	..	..	..	..	..	..	..	..	..	..	..	..
					17	3.0	15.4	near bottom	r	..	..	..	+	..	..	..	..	..	..	..
		Western Baltic																		
2960	—	54°27′	12°12′	25	0	6.1	10.8	0 m	r	..	..	..	..	..	..	..	..	..	..	..
					25	3.1	20.6	80 m w.	+	r	..	..	c	..	..	..	..	..	..	..
2961	—	54°24′	11°47′	21	0	6.9	11.2	0 m	+	..	..	..	..	..	..	..	..	..	..	..
					21	3.8	21.9	60 m w.	c	..	..	..	c	..	..	..	..	..	..	..

Table XII (continued). "Dana" 1923.

Station No.	Date	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul	Sarsia tubulosa	Hybocodon prolifer	Bougainvillia britannica	Rathkea octopunctata	Halitholus cirratus	Staurophora mertensii	Tiaropsis multicirrata	Obelia sp.	Obelia nigra	Eutonina indicans	Tima bairdii	Aglantha digitale
									blue											
2962	20. IV	54°21′	11°27′	22	0	5.5	10.8	0 m	..	..	..	..	..	..	..	..	..	..	..	..
					22	3.9	22.5	60 m w.	..	..	..	..	..	..	..	..	..	..	..	..
2963	21. IV	54°35′5	11°07′	28	0	4.8	13.4	0 m	r	..	..	..	r	..	..	..	..	..	..	..
					28	3.8	25.4	60 m w.	c	r	..	r	+	..	..	..	..	..	..	..
2964	—	54°42′	10°46′	23	0	5.8	13.5	20 —	+	..	..	..	r	..	..	..	..	..	..	..
					23	4.3	27.7	80 —	c	r	..	..	+	..	..	..	..	..	..	..
2965	—	54°41′	10°31′	30	0	6.1	12.5	20 —	..	..	..	..	rr	..	..	..	..	..	..	..
					30	4.0	25.5	80 —	+	..	..	..	c	..	..	..	..	..	..	..
2966	—	54°47′	10°26′	26	0	6.1	12.9	30 —	rr	..	..	..	c	..	..	..	..	..	..	..
2969	23. IV	54°50′	10°34′5	8	0	5.4	12.9	bottom	c	..	..	r	+	..	..	..	..	..	..	..
					8	3.8	14.0													
2971	—	54°50′	10°14′	33	0	5.3	13.2	40 m w.	+	..	..	..	r	..	..	..	..	..	..	..
					33	3.2	24.6	80 —	c	..	..	..	+	..	..	..	..	..	..	..
2972	—	54°42′	10°08′	13	0	5.7	12.9	surface	r	..	..	..	..	..	..	..	..	..	..	..
					13	4.4	13.4													
2973	—	54°42′	10°17′	21	0	6.0	12.8	20 m w.	..	..	..	..	..	..	..	..	..	..	..	..
					21	4.1	13.4	bottom	+	..	..	..	r	..	..	..	..	..	..	r
		Great Belt																		
2974	24. IV	54°56′	10°52′5	26	0	5.8	15.0	10 m w.	r	..	..	..	..	..	..	..	..	..	..	..
					26	4.5	29.1	bottom	r	+	..	r	rr	..	..	rr	..	..	..	r
2975	—	55°13′	10°55′5	11	0	6.2	15.9	near	+	+	..	r	c	..	..	..	..	rr	..	r
					11	4.9	18.9	bottom												
2976	—	55°26′	10°55′	26	0	5.7	17.3	20 m w.	r	..	..	..	..	..	..	..	..	..	..	..
					26	4.7	30.1	bottom	r	+	..	r	..	..	..	rr	..	rr	..	+
2977	—	55°27′	10°41′	12	0	5.3	17.9	—	+	c	..	+	+	..	..	rr	..	rr	..	..
					12	4.7	20.0													
		Samsö Bay and S.W. Kattegat																		
2978	25. IV	55°51′	10°49′	45	0	5.2	18.4	30 m w.	+	+	..	..	+	..	..	..	..	..	..	..
					10	5.0	18.7	90 —	c	cc	..	r	..	..	..	+	..	rr	..	rr
					20	4.9	25.1													
					45	5.1	31.7													
2979	—	56°06′	10°57′	30	0	5.1	17.4	20 —	..	..	..	..	..	..	..	..	..	..	..	..
					10	4.9	20.7	70 —	r	cc	..	r	..	..	rr	+	..	rr	..	rr
					20	5.0	31.1													
					30	5.1	31.9													
2980	—	56°21′	11°15′	22	0	5.2	17.7	10 —	r	..	..	..	..	..	..	..	..	..	..	..
					10	5.1	17.7	70 —	+	r	..	r	..	..	rr	r	..	rr	..	..
					22	5.8	33.8													
		Eastern Kattegat																		
2981	—	56°43′	11°50′	44	0	5.2	17.9	40 —	r	..	..	..	..	..	..	..	..	..	..	..
					10	4.8	30.2	90 —	r	..	..	..	..	..	..	..	..	..	..	..
					20	6.0	34.5													
					44	6.2	34.6													

Table XII (continued). "Dana" 1923.

Station No.	Date	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul	Sarsia tubulosa	Hybocodon prolifer	Bougainvillia britannica	Rathkea octopunctata	Halitholus cirratus	Staurophora mertensii	Tiaropsis multicirrata	Obelia sp.	Obelia nigra	Eutonina indicans	Tima bairdii	Aglantha digitale
									blue											
2982	26. IV	56°39′5	12°10′5	37	0	5.1	18.5	40 m w.	r	..	..	..	..	..	..	..	..	..	..	..
					10	5.5	32.7	90 —	r	+	..	r	rr	..	..	r	..	r	..	r
					20	6.1	34.6													
					37	6.3	34.8													
2983	—	56°51′5	11°45′5	47	0	5.1	19.4	30 —	+	r	..	..	..	..	..	..	..	..	..	..
					10	4.8	26.0	80 —	r	..	..	..	..	..	..	..	..	rr	..	r
					20	5.9	34.5													
					47	6.3	34.8													
2984	—	57°07′	11°28′	60	0	5.3	20.0	20 —	+	r	..	..	..	..	..	..	..	..	..	..
					10	5.1	33.9	90 —	+	..	..	..	rr	..	rr	..	..	..	..	r
					20	6.0	34.5													
					60	6.5	35.0													
2985	—	57°18′5	11°18′5	85	0	5.2	22.4	30 —	+	rr	..	..	..	..	..	..	..	..	..	r
					10	5.2	30.0	80 —	rr	..	..	..	..	..	rr	..	..	..	..	r
					20	6.1	34.5													
					85	6.4	34.9													
		Northern Kattegat																		
2986	28. IV	57°24′	10°48′	32	0	5.6	22.9	30 —	rr	..	..	..	..	..	..	..	..	..	..	rr
					10	6.1	34.5	80 —	..	..	..	..	..	..	..	..	..	..	..	rr
					32	6.4	34.8													
2987	—	57°35′5	10°28′5	6	0	6.1	34.1	30 —	r	..	..	..	rr	..	..	..	..	..	..	..
					6	6.5	34.1													
2988	29. IV	57°36′5	10°43′5	24	0	4.1	27.8	60 —	..	..	..	..	..	..	..	..	..	..	..	+
					10	4.8	33.6													
					24	5.8	34.5													
2989	—	57°37′	11°01′	30	0	4.8	28.1	40 —	..	..	..	..	..	..	..	..	..	..	..	r
					10	4.6	31.3	bottom	rr	..	..	..	..	..	..	rr	..	..	..	r
					20	5.6	34.0													
					30	5.8	34.3													
2990	—	57°38′	10°54′	26	0	5.4	27.8	20 m w.	rr	..	..	..	..	..	..	..	..	..	..	rr
					10	4.8	32.8	bottom	..	..	..	..	..	..	..	..	..	..	..	r
					26	5.8	34.4													
2991	—	57°45′	11°20′	85	0	6.1	23.0	20 m w.	rr	..	..	..	..	..	..	..	..	..	..	..
					10	4.8	32.3	150 —	..	..	..	..	..	..	..	..	..	..	..	+
					85	6.2	35.0													
		Skagerrak																		
2992	—	58°11′5	11°13′	62	0	6.0	22.9	30 —	r	..	..	..	rr	..	..	..	..	..	..	r
					10	5.0	29.0	80 —	rr	..	..	..	..	..	..	..	..	..	..	+
					20	4.9	33.9													
					62	6.1	34.1													
2993	—	58°02′	10°49′	ca.200	0	5.5	20.8	20 —	..	..	..	..	..	..	..	..	..	..	..	r
					20	5.7	33.2	150 —	..	..	..	..	..	..	..	..	..	..	..	r
					75	6.1	34.4													

Table XII (continued). "Dana" 1923.

Station No.	Date	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul	Sarsia tubulosa		Hybocodon prolifer	Bougainvillia britannica	Rathkea octopunctata	Halitholus cirratus	Staurophora mertensii	Tiaropsis multicirrata	Obelia sp.	Obelia nigra	Eutonina indicans	Tima bairdii	Aglantha digitale
									blue												
2994	30. IV	57°48′	10°15′	82	0	5.7	28.2	20 m w.	..		..	..	..	..	..	..	..	..	..	..	..
					10	5.8	34.1	150 —	..		..	..	..	..	rr	..	..	..	..	rr	..
					82	5.8	34.3														
2995	—	57°40′5	10°21′	10	0	6.6	34.4	bottom	..		..	..	..	..	..	..	..	..	r	..	..
					10	6.7	34.4														
2996	—	57°36′5	10°08′	7	0	6.9	34.4	bottom	rr		..	..	..	..	..	..	..	..	..	..	r
					7	6.9	34.4														
2997	—	57°21′	9°18′	15	0	6.0	33.7	50 m w.	..		..	r	+	..	rr	r	r	r	cc	..	+
					15	5.7	33.8														
									red	brown											
2998	—	57°14′	8°51′	23	0	5.5	33.8	10 —	..	..	..	r	+	..	..	..	r	r	c	..	r
					23	5.4	33.8	60 —	rr	r	..	..	+	..	..	rr	..	rr	+	..	+
2999	1. V	57°10′5	8°53′	15	0	5.6	33.4	25 —	rr	rr	..	r	+	..	..	..	..	r	c	..	+
					15	5.5	33.6														
3000	—	57°07′	8°46′	7	0	6.1	33.6	25 —	..	..	..	r	r	..	..	..	..	..	+	..	r
					7	5.7	33.8														
		North Sea																			
3001	2. V	56°58′	8°12′	24	0	5.4	33.4	10 —	..	..	..	r	..	..	..	..	..	..	r	..	..
					24	5.3	33.6	60 —	..	r	..	rr	r	..	rr	..	rr	..	c	..	rr
3002	—	56°44′	8°11′	9	0	6.1	33.1	30 —	..	..	..	r	r	..	..	..	..	..	r	..	..
					9	5.8	33.1														
3003	—	56°30′	7°54′	24	0	6.5	32.7	20 —	..	rr	..	r	..	..	..	..	..	..	r	..	..
					24	5.5	32.9	70 —	..	+	..	r	r	..	..	rr	..	..	c	..	r
3004	—	56°02′	7°45′	26	0	5.8	32.6	30 —	..	r	..	..	..	..	rr	..	..	..	r	..	..
					10	5.7	32.6	80 —	..	cc	..	..	..	..	..	..	..	..	+	..	..
					26	5.3	32.7														
3006	5. V	55°16′	7°47′	22	0	8.8	31.3	20 —	..	..	..	r	..	..	..	rr	rr	..	..	..	rr
					10	6.2	32.5	70 —	..	..	..	c	r	..	rr	..	..	rr	c	rr	rr
					22	6.2	32.7														
3007	—	55°10′	7°05′	33	0	7.3	32.2	30 —	..	..	..	cc	..	..	rr	..	..	..	cc	rr	+
					10	6.1	32.9	80 —	+	rr	..	+	+	..	rr	rr	r	+	c	..	r
					33	5.1	33.2														
3008	6. V	55°11′	6°20′	45	0	7.5	32.5	40 —	..	..	..	+	rr	..	..	..	..	..	cc	..	..
					10	6.0	32.8	90 —	rr	..	..	r	rr	..	..	..	rr	rr	cc	..	c
					45	5.5	33.6														
3009	—	55°40′	6°35′	40	0	7.1	32.2	30 —	..	..	..	r	..	..	..	..	rr	..	r	..	r
					10	6.0	32.8	80 —	..	..	..	+	r	..	..	..	..	..	cc	..	c
					40	5.1	33.9														
3010	—	56°12′	7°00′	35	0	6.6	32.6	40 —	..	..	..	r	..	..	rr	..	..	..	+	..	..
					10	6.2	33.0	90 —	..	..	..	+	+	..	r	..	..	..	cc	rr	cc
					35	4.6	34.1														

Table XII (continued). "Dana" 1923.

Station No.	Date	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul	Sarsia tubulosa		Hybocodon prolifer	Bougainvillia britannica	Rathkea octopunctata	Halitholus cirratus	Staurophora mertensii	Tiaropsis multicirrata	Obelia sp.	Obelia nigra	Eutonina indicans	Tima bairdii	Aglantha digitale
									red	brown											
3012	7. V	56°34′	7°09′	31	0	6.1	32.8	40 m w.	..	..	..	rr	..	..	..	..	..	..	c	rr	r
					10	6.1	33.3	90 —	rr	rr	..	r	r	..	rr	..	r	+	+	..	c
					31	4.7	34.0														
3013	—	57°00′	7°20′	39	0	5.8	32.6	40 —	..	..	..	..	..	..	..	..	..	..	r	..	+
					10	5.6	33.1	90 —	..	..	..	r	..	..	..	+	r	+	c	+	c
					39	5.5	33.4														
3014	—	57°28′	7°30′	135	0	6.6	28.5	50 —	..	..	..	..	..	..	..	..	..	..	..	..	..
					20	5.7	31.9	100 —	..	..	..	..	..	..	..	..	..	rr	rr	..	rr
					50	5.4	32.3														
					100	5.2	32.7														
		Skagerrak																			
3015	—	57°24′	8°13′	70	0	7.1	29.9	40 —	..	..	..	..	..	..	..	..	..	..	..	..	..
					20	5.7	31.9	90 —	..	..	..	rr	..	..	..	..	r	+	+	rr	+
					50	5.7	32.3														
					70	5.7	32.5														
3022	9. V	57°35′	8°59′	41	0	6.9	25.6	40 —	..	..	..	rr	r	..	..	..	..	r	+	..	c
					10	6.0	31.9	90 —	rr	..	..	rr	rr	..	rr	..	..	rr	r	r	r
					20	5.9	32.4														
					41	5.8	32.6														
3023	—	57°42′	9°45′	60	0	7.8	26.0	40 —	..	..	..	..	rr	..	..	..	..	..	+	..	c
					10	6.1	31.6	90 —	..	..	..	+	r	..	rr	r	..	c	cc	r	c
					20	6.0	32.6														
					60	5.9	32.8														
		Western Kattegat							blue												
3036	13. V	56°58′	10°25′	7	0	8.9	25.0	bottom	+		+	..	r	r	..	..	..	+	c	..	c
					7	8.5	27.4														
3038	14. V	57°15′	10°41′5	20	0	8.3	24.1	surface	+		r	..	..	..	..	..	..	..	+	..	+
					20	6.0	33.3	35 m w.	+		+	..	r	..	..	..	+	+	cc	..	+
3040	15. V	57°37′5	10°58′	32	0	8.3	26.6	10 —	r		..	..	..	..	..	..	..	..	r	..	r
					32	6.2	33.2	75 —	..		..	rr	..	..	..	..	..	..	+	..	+
		Skagerrak																			
3042	—	57°53′	10°33′	130	0	5.3	25.8	50 —	..		..	..	..	..	..	..	..	..	r	..	r
					20	6.1	34.1	150 —	..		..	r	..	..	rr	..	..	r	+	..	r
					130	5.3	34.8	near bottom	..		..	..	..	..	rr	..	..	rr	r	+	r
3043	16. V	58°19′	9°37′	4—600	0	7.9	23.9	50 m w.	..		..	..	..	..	..	..	..	..	rr	..	..
					40	4.9	34.1	500 —	..		..	..	..	..	..	..	..	..	..	..	r
					580	5.3	35.1														
3044	—	58°08′	10°02′	300	0	7.3	24.4	70 —	..		..	..	..	..	..	..	..	..	r	rr	r
					30	5.7	34.3														
					300	5.9	35.1														

Table XII (continued). "Dana" 1923.

Station No.	Date	Position Lat. N. Long. E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul	Sarsia tubulosa	Hybocodon prolifer	Bougainvillia britannica	Rathkea octopunctata	Halitholus cirratus	Staurophora mertensii	Tiaropsis multicirrata	Obelia sp.	Obelia nigra	Eutonina indicans	Tima bairdii	Aglantha digitale
		Eastern Kattegat						blue											
3047	17. V	57°26′5 11°23′	65	0	8.6	24.1	20 m w.	rr	..	..	..	..	..	..	..	..	..	..	..
				10	8.5	24.1	85 —	..	..	+	..	..	rr	..	..	..	cc	..	+
				20	7.4	27.9													
				30	6.2	33.4													
				65	6.0	33.8													
3048	—	57°07′ 11°28′	80	0	8.4	23.9	25 —	+	..	..	..	..	..	..	..	..	rr	..	r
				20	6.2	32.8	90 —	r	..	r	..	..	rr	rr	..	rr	cc	..	r
				30	6.1	33.7													
				50	5.9	34.3													
				80	6.2	34.7													
		Aalborg-Plateau																	
3050	18. V	56°46′5 11°33′	15	0	8.4	21.7	20 —	c	rr	..	rr	r	..	..	rr	rr	r	..	r
				15	6.8	30.1													
3051	—	56°46′ 11°09′	15	0	8.2	22.2	20 —	rr	..	..	..	..	..	..	..	..	rr	..	rr
				15	6.2	32.7													
3052	—	56°39′ 10°34′5	12	0	8.1	25.4	10 —	rr	r	..	..	rr	..	..	..	r	r	..	c
				12	6.8	32.4													
		N. of the Sound																	
3054	19. V	56°06′5 12°35′	30	0	7.2	10.3	30 —	c	c	rr	c	rr	..	rr	+	..	+	..	r
				15	7.0	30.7													
				30	6.6	34.7													
		The Sound																	
3055	28. V	55°51′5 12°45′	46	0	8.6	9.1	60 —	+	..	..	..	..	..	×	..	..	+	rr	+
				20	6.8	32.7													
				46	6.6	34.3													
		Southern Kattegat																	
3056	—	56°20′ 12°40′	20	0	10.3	16.4	50 —	cc	..	..	..	..	..	+	×	..	r	rr	r
				10	8.9	21.2													
				15	7.9	27.1													
				20	6.9	34.1													
3057	29. V	56°34′ 12°12′	40	0	9.8	21.2	20 —	r	..	..	..	..	..	..	..	..	..	..	..
				10	9.3	22.3	85 —	+	..	..	..	..	..	..	r	r	+	..	+
				20	6.6	32.4													
				40	6.4	34.5													
3058	—	56°32′ 11°36′	31	0	10.2	20.3	10 —	rr	..	..	..	..	..	..	..	..	..	..	rr
				15	7.0	22.8	75 —	..	..	rr	..	..	..	..	+	..	+	..	..
				20	6.3	33.2													
				30	6.2	34.2													
3059	—	56°06′ 10°57′	25	0	11.2	20.3	55 —	+	rr	rr	..	..	..	..	rr	rr	+	..	c
				10	9.1	24.9													
				15	6.9	32.9													
				25	6.7	33.6													

Table XII (continued). "Dana" 1923.

Station No.	Date	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth m	Tp. °C	Sal. ‰	Depth of haul	Sarsia tubulosa	Hybocodon prolifer	Bougainvillia britannica	Rathkea octopunctata	Halitholus cirratus	Staurophora mertensii	Tiaropsis multicirrata	Obelia sp.	Obelia nigra	Eutonina indicans	Tima bairdii	Aglantha digitale
		Samsö Bay							blue											
3060	30. V	55°51′	10°49′	30—49	0	10.3	16.1	15 m w.	rr	..	..	..	..	..	..	..	..	..	..	..
					15	7.5	29.1	60 —	r	..	..	..	..	..	..	rr	..	+	..	c
					20	6.8	33.1													
					49	6.6	33.9													
3061	—	55°45′5	10°39′5	23	0	10.8	17.3	45 —	+	..	rr	..	..	..	+	r	r	+	r	c
					23	6.9	32.9													
3062	—	55°47′	10°29′	31	0	13.3	18.3	45 —	+	..	rr	..	..	..	+	..	r	c	..	c
					31	6.7	33.3													
3063	—	55°41′5	10°16′	21	0	11.6	21.9	35 —	+	..	rr	..	..	..	r	..	r	c	..	×
					21	6.6	33.3													
		Great Belt																		
3064	31. V	55°30′5	10°50′5	31	0	10.0	14.9	40 —	c	..	..	..	..	..	..	r	..	c	..	c
					31	6.8	33.2													
3065	—	55°15′	10°56′5	26	0	11.6	12.8	40 —	+	rr	rr	..	..	..	+	..	..	+	..	c
					26	6.9	32.3													
3066	—	55°09′	10°59′5	26	0	11.5	12.4	50 —	+	..	rr	..	..	..	..	..	..	+	..	..
					26	6.8	33.1													
3068	1. VI	54°50′	10°55′5	24	0	11.3	10.2	40 —	r	..	rr	..	..	..	..	..	..	c	..	×
					24	7.0	31.2													
		Western Baltic																		
3069	—	54°34′	10°42′	23	0	11.5	11.8	?	..	..	..	..	..	..	..	..	..	..	..	+
					23	6.9	28.5													
3072	2. VI	55°02′	10°01′	36	0	10.9	16.0	70 m w.	..	..	..	..	..	..	..	..	..	+	..	+
					36	6.4	27.8													
3073	—	55°13′	9°45′	23	0	11.4	16.6	35 —	..	..	..	..	..	..	..	..	..	+	..	+
					23	7.3	23.1													
3074	—	55°05′	9°38′	28	0	13.5	16.7	45 —	c	+	..	..	..	..	..	..	..	+	..	..
					28	6.9	27.5													
3075	4. VI	54°52′	9°48′	25	0	10.8	17.0	40 —	..	..	..	..	..	..	..	..	..	..	..	rr
					25	5.1	21.4													
3078	—	54°38′	10°54′	22	0	11.9	12.8	40 —	rr	..	..	..	..	..	..	..	..	+	..	+
					22	7.1	29.6													
3080	5. VI	54°22′	11°41′	25	0	10.7	9.5	40 —	..	..	..	..	..	..	..	..	..	..	..	+
					25	6.3	27.4													
3081	—	54°25′	12°10′	26	0	11.4	11.0	40 —	..	?	..	..	..	..	..	..	..	+	..	..
					26	6.2	20.6													
		Baltic proper																		
3082	—	54°37′	12°17′	18	0	9.9	8.3	40 —	+	+	..	..	..	..	..	r	..	+	..	r
					18	6.1	21.4													
3088	7. VI	54°47′	12°31′	19	0	10.5	—	bottom	..	..	..	..	..	..	..	..	..	r	..	..
					19	7.4	—	(dredge)												

Table XII (concluded). "Dana" 1923.

Station No.	Date	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Depth of haul	Sarsia tubulosa	Hybocodon prolifer	Bougainvillia britannica	Rathkea octopunctata	Halitholus cirratus	Staurophora mertensii	Tiaropsis multicirrata	Obelia sp.	Obelia nigra	Eutonina indicans	Tima bairdii	Aglantha digitale
									blue											
3089	7. VI	54°55′	12°28′	22	0	11.0	8.7	40 m w.	..	..	..	..	..	..	..	..	..	rr	..	..
					15	11.0	8.7													
					22	6.5	20.3													
3097	9. VI	54°56′	13°06′	40	0	8.7	7.9	80 —	..	..	..	..	rr	..	..	..	..	..	..	..
					40	6.5	14.8													
3098	—	54°53′	13°25′	45	0	9.2	7.8	85 —	+	..	..	..	rr	..	..	..	..	..	..	..
					44	7.7	15.8													
3103	13. VI	55°28′	14°49′	73—78	0	7.7	7.9	130 —	r	..	..	..	c	..	..	..	..	..	..	..
					73	4.25	16.0													
		The Sound																		
3145	24. VI	55°51′5	12°45′	45	0	12.5	—	60 —	..	..	..	..	..	..	..	..	..	r	+	+
					31	7.3	33.5													

Moreover: *Euphysa tentaculata:* St. 3054 **rr**, 3055 +, 3056, 3061 +, 3062 **r,** 3064 **r**, 3082. *Bougainvillia superciliaris:* 2997 **rr**, 3074. *Podocoryne areolata:* 3012, 90 m w., **rr**. *Leuckartiara octona:* 3007, 30 m w., **rr**, 3009, 80 m w., **rr**, 3054 **rr**. *Leuckartiara nobilis:* 3065. *Neoturris pileata:* 3044, 70 m w., **rr**. *Laodicea undulata:* 2981, 90 m w., **rr**. *Mitrocoma polydiademata:* 3042, near bottom, +, 3044, 70 m w., **rr**, 3047, 85 m w., **rr**. *Phialidium hemisphæricum:* 3001, 60 m w., **rr**, 3007, 80 m w., **r**, 3023, 90 m w., **rr**.

Note: After St. no. 3068 only hauls in which Hydromedusæ were found are included in the table. — Stations between no.'s 3104 and 3144, where no other medusæ but *Halitholus cirratus* were found, are excluded from the table. — At stat. no.'s 2992—3038 the salinity was determined by means of areometer only.

Table XIII. Medusæ, "Thor" 1903—1908 and "Thor"s motorboat 1910.
Including extractions from the journals of the "Thor" (species-names in brackets).

Abbreviations: *br.* bouy-rope. *bt.* bottom. *H.* Hensen-net. *im.* intermediate. *n.* near. *Pl.* plankton-net. *surf.* surface. *Tr.* trawl. *w.* wire. *Y.* young fish trawl.

Agl. Aglantha digitale. *Boug.* Bougainvillia superciliaris. *Euch.* Eucheilota maculata. *Euph.* Euphysa aurata. *Eut.* Eutonina indicans. *Hal.* Halitholus cirratus. *Hyb.* Hybocodon prolifer. *Laod.* Laodicea undulata. *Leukc.* Leuckartiara octona. *Liz.* Lizzia blondina. *Mitr.* Mitrocoma polydiademata. *Ob.* Obelia sp. *Phial.* Phialidium hemisphæricum. *Pod.* Podocoryne carnea. *Sarsia.* Sarsia tubulosa. *Tima.* Tima bairdii.

Station No.	Date	Locality	Position Lat. N.	Position Long. E.	Depth m	Hydrography Dpth m	Hydrography Tp. °C	Hydrography Sal. ‰	Appliance	Species
"Thor"	**1903**									
27	12. III	S.E. of Læsö Trindel..	57°23′	11°30′	..	0	2.6	23.4	Y. 70-0 m	Tima, Agl.
						bt.	3.9	33.7		
31	20. III	N.W. of Anholt Knob	56°47′	11°49′	c. 40	0	3.0	18.2	Y. n. bt.	Tima, Agl.
						40	3.3	32.8		
32	—	East of Læsö	57°15′	11°22′	66	0	3.0	19.4	—	Tima, Agl.
						60	3.8	33.6		
44	15. IV	S. of Blaavandshuk ...	55°29′	8°08′	11	..	..	..		Sarsia
45	16. IV	— — ...	55°28′	8°02′	..	..	..	..	Pl. surf.	(Sarsia)
46	—	N.W. of S. Lyngvig...	56°10′	7°59′	..	..	..	..	Y. 20-0 m	(Sarsia)
50	17. IV	W. of Hirtshals	..	..	30	..	..	..	Y. 15-0 m	Eut.
56	21. IV	N. of the Skaw.....	57°50′	10°42′	115	..	..	..	Pl. surf.	(Agl.)
	29. IV	E.S.E. of Læsö Trindel	..	..	60	..	..	..		Hal. Eut.
	—	Skagerrak.....	57°52′	8°24′	547	..	..	..		Tima
65	23. IX	W. of Hanstholm.....	57°01′	8°18′	..	..	..	..	Pl. surf.	(Agl.)
83	29. IX	Off Blaavandshuk	55°30′	8°03′	..	..	..	..		Leuck. Mitr.
162	19. XI	S. of the Skaw.....	57°40′	10°36′	..	..	..	..	Y. surf.	Phial. Euch. (Agl.)
163	—	N.E. of the Skaw.....	58°02′	10°49′	188	..	..	..	Y. n. bt.	Tima (Agl.)
	1904									
181	16. II	N. of Gilbjerg.....	56°09′	12°18′	14	0	1.6	22.3	Y. surf.	(Agl.)
186	17. II	Skagerrak.....	57°39′	9°26′	26	0	3.3	34.3	Y. surf.	Leuck. Phial. (Agl.)
187	—	—	57°40′	9°12′	42	0	3.7	34.5	Y. im.	(Agl.)
188	—	—	57°46′	8°49′	210	0	3.3	33.0	Y. n. bt.	(Agl. cc)
190	—	—	57°49′5	8°37′	425	..	..	..	Y.	(Agl. cc)
213	10. III	—	58°18′	10°08′	470	..	..	..	Y. n. bt.	(Agl. c)
220	16. III	N.E. of the Skaw.....	57°49′5	10°50′	88	0	0.3	..	Y. im.	(Agl. +)
221	—	— —	57°52′5	10°48′	135	0	1.1	25.9		Leuck. (Agl. +)
222	—	— —	57°55′	10°47′5	170	0	0.1	24.6	Y. n. bt.	(Agl.)
						170	5.6	34.9		
224	17. III	N. of Hirtshals.....	58°04′	9°55′	244	0	3.4	32.5	Y. n. bt.	(Agl. c)
227	21. III	Aalbæk Bay	57°35′	10°35′5	15	0	3.0	29.4		Sarsia
228	22. III	W. of Læsö Trindel...	57°25′5	11°09′5	11	0	1.45	22.3	Y. surf.	(Sarsia +)
230	—	S.E. of Læsö.....	57°08′	11°25′	40—85	0	1.15	20.8	Y. surf. & im.	(Sarsia r)

Table XIII (continued). Medusæ, "Thor" 1903—1908 and "Thor"s motorboat 1910.

Station No.	Date	Locality	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Appliance	Species
233	23. III	N.E. of Hals	57°03′	10°37′	11	0	1.85	20.7	Y. surf. & im.	(Sarsia +)
234	—	Læsö Channel	57°13′	10°43′	20	0	1.95	19.6	Y.	(Sarsia +) Hal.
						20	6.3	28.1		
236	24. III	N. of Fladen	57°12′	11°44′	28	0	1.8	20.5	Y. surf. & im.	(Agl. r)
239	25. III	W. of Anholt	56°43′	11°26′	7—8	0	1.6	19.4	Y.	(Sarsia +) Hal.
273	9. X	Skagerrak	58°04′	9°01′	640	0	11.7	30.3	Y. im.	Laod. Agl. cc
286	14. X	—	58°12′	9°42′	525	0	10.8	26.0	Y.	Sarsia
						525	5.5	34.4	Y. n. bt.	(Agl.)
	1905									
348	18. III	N. part of Læsö Channel	..	..	26	..	..	..	Y.	Hal.
352	23. III	W.N.W. of Hanstholm .	57°14′	7°43′	50	0	4.9	35.0	Y.	Tima
						50	5.0	35.1		
359	30. III	Aalbæk Bay	57°34′	10°35′	16	0	3.4	31.6	Y.	(Sarsia) (Agl.)
						16	3.5	33.2		
361	31. III	Aalborg Bay	56°48′	10°35′	9	0	3.3	23.4	Y.	(Sarsia)
						9	4.0	26.2		
369	8. IV	Skagerrak	58°05′	9°36′	414	0	3.9	32.3	Y. surf.	(Agl.)
						213	2.4	35.0	Y. 100 m br	(Agl.)
377	13. IV	Off Thyborön	56°41′	8°08′	17	0	3.8	32.3	Y.	(Sarsia)
						17	3.9	32.3		
380	14. IV	Doggerbank	55°33′	4°39′	32	0	5.5	34.8	Y. surf.	(Agl.)
						32	5.5	34.8		
621	12. X	N. of the Skaw.....	58°11′	10°05′	440	0	10.4	28.0	Y. n. bt.	(Agl. +)
						440	6.0	35.0		
666	1. XI	N.W. of the Skaw....	57°48′	10°13′	70	0	8.4	32.8	Y. n. bt.	Tima + (Agl. c)
						70	9.1	34.1		
	1906									
721	3. III	The Sound	55°57′	12°37′	18	0	1.6	19.8		Tima
						18	4.7	30.5		
730	8. III	N.W. of Schultz' Grund	56°11′	10°59′	21	0	2.3	20.8	Y.	Hal. Tima
						10	2.3	21.1		
738	14. III	S. of Anholt	56°41′	11°36′	17—23	0	2.1	25.7	Y.	Hal. Tima (Agl.)
						bt.	2.9	29.7		
741	19. III	E. of the Skaw.....	57°48′	11°13′	65	0	2.9	32.4	Y. 20 m br.	(Agl.)
						20	3.1	33.1		
						65	3.8	34.4		
745	20. III	Aalbæk Bay	57°32′	10°42′	28	0	2.8	32.6	Y. 10 m br.	(Tima) (Agl.)
						10	2.8	32.7		
751	23. III	N.E. of the Skaw.....	57°58′	10°50′	140—188	0	2.6	32.9	Y. ca.140 m	(Tima)
						140	5.0	35.0		
						188	5.1	35.0		

Table XIII (continued). Medusæ, "Thor" 1903—1908 and "Thor"s motorboat 1910.

Station No.	Date	Locality	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Appliance	Species
759	24. III	N. of the Skaw.....	57°47′	10°38′	85	0	2.5	31.5	Y. surf.	(Tima)
764	28. III	Aalborg Bay	56°54′	10°35′	8	0	1.4	24.9		Sarsia Hal.
						8	1.5	25.0		
769	30. III	Aalbæk Bay	57°33′	10°43′	28	0	2.05	23.9	Y. surf.	(Sarsia) (Hyb. cc)
						28	3.3	31.5		
770	—	Tannis Bay	57°37′	10°09′	13	0	2.55	30.2	Y. surf.	(Sarsia) (Tima) (Agl.)
						13	4.1	33.1	Y. ca. 8 m	(Sarsia) (Agl.)
782	3. IV	N.W. of Hirtshals.....	57°49′	9°22′	105	0	4.3	..	Y.	(Tima) (Agl.)
						105	5.6	..		
783	—	— —	57°57′	8°50′	510	0	3.45	..	Y. 75 m br.	(Tima)
						510	5.7	..		
784	4. IV	Skagerrak, E. of Oxö .	58°05′	8°21′	108	0	3.2	33.4	Y. surf.	(Agl.)
						108	5.25	34.9		
792	5. IV	N. of Horns Rev	56°06′	6°58′	36	0	4.2	34.3	Y. 15 m br.	Phial. (Agl.)
						36	3.8	34.4		
793	5. IV	N.W. of Horns Rev...	55°52′	6°56′	37	0	4.0	34.5	Y. surf.	(Tima)
						37	3.7	34.8		
794	6. IV	W.N.W. of Horns Rev	55°42′	6°19′	47	0	4.5	34.9	Y. surf.	(Sarsia) (Agl.)
						47	3.9	34.9	Y. 43 m br.	(Agl.)
795	—	— —	55°37′	6°46′	38	0	4.1	34.1	Y. 43 m br.	(Agl.)
						38	3.8	34.8		
802	9. IV	N. of Blaavandshuk ..	55°42′	8°04′	15	0	4.1	33.6	Y. 10 m br.	Boug. Eut.
						15	5.8	33.7		
803	—	N. of Horns Rev	55°53′	7°51′	24	0	4.7	33.7	Y. 10 m br.	(Agl.)
						24	3.9	33.9		
804	—	— —	56°03′	7°38′	30	0	4.4	34.2	Y. 10 m br.	(Agl. cc)
						30	3.9	34.4		
844	17. X	N. of the Skaw.....	58°14′	10°25′	315	0	11.3	..	Y. 375 m w.	(Agl. +)
845	—	— —	58°10′	10°27′	245	..	..	..	Y. 200 m w.	(Agl. +)
852	22. X	E. of the Skaw.....	57°46′	10°50′	41	0	11.0	32.8	Y. 80 m w.	(Agl.)
	1907									
910	25. III	N.W. of Rügen.....	54°41′	13°03′	17—38	0	2.4	9.1		Hal.
			54°47′	13°10′		38	3.2	11.5		
913	25. III	S. of Krieger Flak	54°52′	13°14′	43—19	0	1.6	8.7		Hal.
			54°52′	12°56′		19	2.0	..		
919	26. III	N. of —	55°08′	13°06′	36—28	0	1.8	8.1		Hal.
			55°13′	12°54′		36	3.6	9.5		
938	9. IV	Skagerrak	57°52′	8°44′	550—	0	4.1	32.5	Y. 620 m w.	(Agl.)
					570	bt.	5.7	35.1		
939	11. IV	—	58°08′	9°34′	500—	0	4.4	32.9	Y. 620 m w.	(Agl.)
					600	195	5.8	35.0	Y. 720 m w.	(Agl.)

Table XIII (continued). Medusæ, "Thor" 1903—1908 and "Thor"s motorboat 1910.

Station No.	Date	Locality	Position Lat. N.	Position Long. E.	Depth m	Hydrography Dpth. m	Hydrography Tp. °C	Hydrography Sal. ‰	Appliance	Species
949	15. IV	Tannis Bay	57°39′	10°05′	16	0	5.0	34.9		Tima
						16	5.8	35.0		
955	16. IV	N.E. of Hanstholm ...	57°22′	8°46′	28	0	5.3	34.2	Y. surf.	Tima (Agl.)
						28	5.4	34.8		
956	17. IV	Off Thyborön	56°46′	8°09′	19	0	5.5	32.6	Y. surf.	(Agl.)
			56°42′	8°07′		19	5.6	33.6		
982	29. IV	Horns Rev	55°39′	7°30′	14—15	0	5.4	32.8	Y. surf.	Eut. (Agl.)
						15	5.9	32.8		
989	1. V	W. of Horns Rev	55°15′	6°08′	45	0	6.4	34.7		Tima
						45	5.9	34.7		
991	2. V	S.W. of —	55°15′	6°53′	30—34	0	5.7	33.7	Y. 28 m br.	Eut. (Agl.)
						34	5.6	33.7		
1013	10. V	N.W. of —	56°05′	6°48′	40	0	6.4	34.3	Y. 28 m br.	(Tima) (Agl.)
						40	5.9	34.3		
1017	—	S. of Jutland Bank ..	56°37′	7°00′	37	0	6.4	34.6	Y. 28 m br.	(Sarsia) Tima (Agl.)
						37	5.8	34.6		
1018	11. V	Jammer Bay	57°32′	9°34′	24	0	7.4	33.5	Y. 18 m br.	(Agl.)
						24	6.6	33.7		
1027	14. V	Aalborg Bay	56°35′	10°31′	8	0	8.7	25.0	Y. surf.	(Sarsia)
						8	6.8	29.1		
1028	—	N. of Djursland	56°33′	10°40′	8	0	8.7	..	Y. surf.	(Sarsia)
						8	6.3	29.8		
1031	—	Aalborg Bay	56°50′	10°44′	11	0	9.8	23.9	Y. surf.	(Sarsia) (Agl.)
						11	5.6	29.1		
1039	16. V	Skagerrak	58°18′	10°07′	450	0	8.7	31.0	Y.	(Agl.)
						450	5.1	34.9		
1041	—	W.S.W. of Måseskär ..	57°57′	11°02′	120	0	8.6	26.0	Y. surf.	(Agl.)
						120	5.6	34.4		
1047	22. V	Aalbæk Bay	57°36′	10°27′	7	0	8.6	22.3	Y. bt.	(Sarsia cc)
						7	6.2	31.9		
1049	—	— —	57°37′	10°34′	13	0	8.8	22.3	Y. bt.	(Sarsia) (Tima)
						13	6.1	32.2		
1050	—	— —	57°37′	10°37′	17	0	8.6	22.6	Y. bt.	(Sarsia) (Tima)
						17	6.0	32.1		
1066	24. V	N.W. of Anholt	56°52′	11°20′	13	0	9.9	17.6	Y. surf.	(Agl.)
						13	9.6	17.7		
1073	28. V	Skagerrak	57°47′	9°17′	96	0	9.4	31.6	Y. surf.	(Tima)
						96	5.9	34.9		
1074	—	—	57°47′	8°10′	510	0	8.7	28.3	Y.	Laod.
						510	5.1	34.1		
1075	29. V	S.S.W. of Lindesnes ..	57°47′	7°00′	375	..	..	..	Y. 500 m w.	(Agl.)

Table XIII (continued). Medusæ, "Thor" 1903—1908 and "Thor"s motorboat 1910.

Station No.	Date	Locality	Position Lat. N.	Long. E.	Depth m	Hydrography Dpth. m	Tp. °C	Sal. ‰	Appliance	Species
1076	30. V	S. of Kristianssand ...	57°47′	7°39′	490	0	8.5	28.1	Y. n. surf.	(Tima) (Agl.)
						490	5.5	34.7	Y. 600 m w.	(Agl.)
1079	31. V	W.N.W. of Hanstholm	57°19′	7°34′	60	0	8.1	30.6	Y. 30 m br.	(Tima) (Agl.)
						30	5.9	35.1		
1080	1. VI	N.W. of Hanstholm...	57°29′	8°12′	120	0	7.6	31.1	Y. 30 m br.	(Tima) (Agl.)
						120	6.1	35.1		
1088	—	Jammer Bay.....	57°24′	9°35′	11	0	9.6	33.6	Y. bt.	(Tima) (Agl.)
						11	9.6	33.8		
1112	7. VI	N. of Djursland	56°32′	10°43′	3—4	0	11.5	22.3	Tr. bt.	(Tima)
	1908									
1197	28. IV	S. of Gr. Middelgrund .	56°32′	12°07′	27	0	5.4	17.8	Y. 1 m br.	(Sarsia r) (Hyb. r)
						27	4.9	34.7	Y. 26 m br.	(Sarsia c) (Hyb. cc)
1198	—	S.E. of Læsö.....	57°09′	11°24′	37	0	5.8	20.9	Y. surf.	(Sarsia)
1199	29. IV	Aalbæk Bay	57°42′	10°46′	26	0	5.5	20.4	Y. surf.	(Sarsia c)
						5	4.7	24.0		
1200	—	Læsö Channel	57°26′	10°44′	30—17	0	5.5	20.0	Y. 10 m br.	(Sarsia cc)
			57°22′	10°42′		7.5	5.6	20.6		
						10	4.5	33.2		
						17	4.3	34.9		
1202	—	S.E. of Fornæs.....	56°21′	11°06′	19—21	0	6.0	18.7	Y. 18 m br.	(Sarsia cc) (Hyb.
						21	4.4	33.8		cc) (Agl.)
1205	30. IV	S.E. of Langeland	55°40′	10°48′	22	0	6.7	13.1	Y. surf.	(Sarsia rr)
						22	3.9	21.6	Y. 21 m br.	(Sarsia cc) (Hyb. cc)
1206	—	S.W. of Ærö.....	54°49′	10°13′	28	0	6.0	13.1	Y. surf.	(Sarsia cc)
						28	2.9	23.5	Y. 25 m br.	(Sarsia cc) (Hyb.)
1207	1. V	S.E. of Femern.....	54°17′	11°28′	22	0	6.7	10.7	Y. surf.	(Sarsia r)
						18	4.7	15.9	Y. 19 m br.	(Sarsia cc) (Hyb.
						22	3.8	20.6		cc) (Agl.)
1208	—	E. of Gjedser	54°32′	12°16′	26—28	0	7.2	9.3	Y. surf.	(Sarsia r)
						24	3.7	18.8	Y. 24 m br.	(Sarsia cc) (Hyb.
						28	3.6	19.2		cc)
1209	—	E. of Falster.....	54°46′	12°18′6	21	0	6.1	8.2	Y. surf.	(Sarsia rr)
						21	4.0	18.9	Y. 21 m br.	(Sarsia c)
1212	2. V	N.E. of Arkona, Rügen	54°50′	13°36′	45	0	4.6	7.4	Y. 30 m br.	(Sarsia rr)
						30	5.1	9.2	Y. 45 m br.	(Sarsia c) (Hyb. c)
						45	3.1	19.6		
1213	—	— — —	54°55′	13°59′	44	0	5.8	7.8	Y. 44 m br.	(Sarsia c) (Hyb. c)
						44	3.4	18.1		
1215	4. V	S. of Bornholm.....	54°36′	55°10′	57.5	0	4.7	7.4	Y. 57 m br.	(Sarsia rr)
						57.5	2.7	11.5		

Table XIII (concluded). Medusæ, "Thor" 1903—1908 and "Thor"s motorboat 1910.

Station No.	Date	Locality	Position Lat. N.	Position Long. E.	Depth m	Hydrography Dpth. m	Hydrography Tp. °C	Hydrography Sal. ‰	Appliance	Species
1216	4. V	S.E. of Bornholm	54°43′	15°37′	70	0	4.2	7.3	Y. 67 m br.	(Sarsia rr)
						65	2.5	13.1		
						70	2.6	16.4		
1221	6. V	W. of —	55°12′	14°32′	47	0	4.5	7.4	Y. 47 m br.	(Sarsia) (Hyb. c)
						47	3.9	12.5		
1222	7. V	S.E. of Smygehuk	55°08′	13°42′	45—47	0	4.7	7.1	Y. 47 m br.	(Sarsia cc) (Hyb. cc)
						46	3.5	18.7		
1225	8. V	The Sound	55°52′	12°46′	48	0	7.0	10.2	Y. 20 m br.	(Sarsia) (Hyb. c)
						20	5.2	34.3		
						48	5.1	34.4		
"Thor"s motor-boat	**1910**									
1492	26. X	North Coast of Sealand	56°07′	12°15′5	15	..	..	..	H 15-0 m	Euph. + Pod. rr Liz. rr Phial. rr Euch rr Ob + Agl. +
1495	27. X	— — —	55°57′5	11°30′	13	..	..	..	H 13-0 m	Phial. rr Ob. cc
1500	28. X	— — —	55°59′	11°52′	12	..	..	..	H 12-0 m	Euph. + Phial. rr Ob. r Agl. rr
1501	29. X	— — —	56°07′	12°22′5	12	..	..	..	H 12-0 m	Euph. rr Ob. rr Agl. rr
1504	—	— — —	56°04′2	12°35′	18	..	..	..	H 18-0 m	Euph. rr Agl. rr
1505	—	The Sound	55°59′	12°34′	14	..	..	..	H 14-0 m	Euph. rr Ob. rr Agl. rr
1508	30. X	—	55°46′	12°36′5	12	..	..	..	H 12-0 m	no medusæ

Table XIV. General view of the geographical distribution of the Hydromedusæ in the Danish waters.

Name of Species	North Sea		Skagerrak		East. and South. Kattegat		West. Kattegat		Sound		Samsö Bay		Little Belt		Great Belt		West. Baltic		Baltic proper	
	I	V	I	V	I	V	I	V	I	V	I	V	I	V	I	V	I	V	I	V
Sarsia tubulosa blue	..	..	E	..	×	NS	×	N	×	..	×	×	×	×	×	×	×	N	W	W
— — brown	(×)	N	..	W	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— — red	×	..	W	W	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Purena gemmifera	..	..	(×)	..	×	(N)	..	..	×		..	N	..	(N)	..	N	..	..	..	..
Euphysa aurata	N	..	(×)	..	×	(×)	×	..	×		[×]	N	..	N	(×)	N	..	(N)	..	..
— tentaculata	..	..	..	..	S	..	..	..	×		×	..	..	..	×	..	W	..	..	(W)
Steenstrupia nutans	×	..	(×)	..	×	..	×	..	N	..	×	×	×	..	×	..	..	(N)	..	..
Hybocodon prolifer	..	..	×	..	S	×	×	N	×		×	N	S	×	×	N	W	N	..	W
Eucodonium brownei	..	..	..	..	(×)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cladonema radiatum	..	..	E	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Bougainvillia principis	..	(N)	..	(×)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— superciliaris	(×)	..	(×)	..	(×)	..	?	(N)	..	..	..	..	(S)	..	(×)	..	(W)	..	..	..
— britannica	N[S]	N	W	W	..	(N)	..	(N)	..	..	..	(N)	..	..	..	(N)	..	..	..	..
— ramosa	×	..	×	..	×	..	×	..	..	..	×	..	×	..	..	..	..	..	..	..
Lizzia blondina	N	..	×	..	×	N	..	×	..	N	[×]	N	..	N	..	N	..	..	..	..
Podocoryne carnea	(×)	..	(×)	..	×	..	×	..	×	..	×	..	×	..	×	..	×	..	..	..
— areolata	..	(N)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Rathkea octopunctata	×	..	×	..	S	N	×	N	×		×	N	S	×	×	N	W	N	..	W
Halitholus cirratus	..	..	..	E	×	..	..	E	×	..	(×)	..	S	..	(×)	..	×	..	×	..
Tiaranna rotunda	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Leuckartiara octona	×	..	×	..	×	..	×	..	×	N	×	N	..	..	N	..	..	..	..	..
— nobilis	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	(N)	..	..	..	..
Neoturris pileata	..	..	E	..	(N)	N	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cyclocanna welshi	..	..	×	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Laodicea undulata	N	S	×	..	..	(N)	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Staurophora mertensii	[×]	N	[W]	W	..	(N)	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Melicertum octocostatum	..	(N)	×	W	..	(N)	..	(N)	..	..	..	..	..	..	..	..	..	..	..	..
Mitrocoma polydiademata	..	S	E	..	..	(N)	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Cosmetira pilosella	N	..	W	W	..	N	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Tiaropsis multicirrata	N[S]	..	×	..	[×]	N	..	N	?	N	[×]	N	..	(N)	..	(N)	..	..	..	(N)
Phialidium hemisphæricum	×	S	×	..	×	N	×	..	..	N	×	×	×	..	..	..	..	(N)	..	..
Eucheilota maculata	N	S	W	..	[×]	(N)	..	(N)	..	..	..	..	..	..	..	..	..	..	..	..
Obelia geniculata	×	..	×	..	×	..	×	..	..	N	×	×	×	×	×	N	W	N	..	(N)
— dichotoma	×	..	×	..	×	..	×	..	..	N	×	×	..	N	×	N	..	?	..	..
— longissima	×	..	×	..	×	..	×	..	..	N	×	×	(×)	N	×	N	..	?	..	..
Eutonina indicans	×	..	×	..	S	N	×	N	×	N	×	N	..	N	(×)	N	..	N	..	(W)
Saphenia gracilis	N	..	W	..	[×]	N	..	(N)	..	..	..	..	..	..	..	..	..	..	..	..
Eutima insignis	N	S	W	..	?	N	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— gegenbauri	N	S	W	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Eirene viridula	N	(S)	W	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Tima bairdii	[N]	N	×	..	(×)	N	..	N	..	N	..	N	..	(N)	..	..	..	..	..	..
Aglantha digitale f. typica	..	..	×	..	..	(N)	..	..	..	..	..	..	..	..	..	..	..	..	..	..
— — var. rosea	×	..	×	..	×	N	..	N	..	N	..	N	..	(N)	..	N	..	(N)	..	(W)
Normally indigenous	24		33		22		13		?		14		11		13		8		2	
Visitors only or occasionally indigenous	7		5		11		10		?		7		8		7		5		7	
Total number of species	31		38		33		23		19		21		19		20		13		9	

Explanation: *I* indigenous. *V* visitor. × occurrence without further particulars. ( ) rare. [ ] occasionally indigenous.

N, S, E, W in the columns of *indigenous* species indicates that a species is indigenous only in the northern, southern, eastern, or western part of the area respectively.

N, S, E, W in the columns of *visitors* indicates that a species is imported from the north, south, east, or west respectively.

Table XV. Seasonal occurrence of the most important species of Hydromedusæ in the Danish waters.

Month	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Geographical distribution
Aglantha digitale, rosea juv.	•	•	•	•	•	•	●	●	●	●	●	•	southern boreal
Aglantha digitale, rosea ad.	•	•	•	●	●	●	•	•	•	•	•	•	
Tima bairdii juv.	..	..	..	..	•	•	•	•	•	•	..	..	northerly
Tima bairdii ad.	•	•	•	•	•	•	•	..	..	•	•	•	
Obelia spp. juv.	..	..	•	●	●	●	●	●	●	●	●	•	cosmopolitan
Obelia spp. ad.	•	•	•	●	●	●	●	●	●	●	●	●	
Phialidium hemisphæricum juv.	..	..	..	..	(•)	•	•	●	•	•	(•)	..	boreal
Phialidium hemisphæricum ad.	•	•	•	•	(•)	..	•	●	•	•	•	•	
Hybocodon prolifer	•	•	•	●	●	•	(•)	..	..	..	..	(•)	northerly
Rathkea octopunctata	•	•	•	●	●	•	..	..	..	..	..	•	northerly
Sarsia tubulosa, blue	(•)	•	●	●	●	•	(•)	..	..	..	..	..	(northerly)
Halitholus cirratus[1]	..	•	●	●	(•)	..	..	..	..	..	..	..	northerly
Bougainvillia superciliaris	..	•	•	•	•	•	•	..	..	..	..	..	northerly
Eutonina indicans	..	..	•	•	●	●	•	..	..	..	..	..	northerly
Tiaropsis multicirrata	..	..	..	•	•	..	..	..	..	..	..	..	northerly
Bougainvillia britannica	..	..	..	•	•	•	•	..	..	..	..	..	southern boreal
Mitrocoma polydiademata	..	..	..	..	•	•	•	..	•	•	•	..	northerly
Leuckartiara octona	..	..	..	..	•	•	●	●	●	●	•	(•)	cosmopolitan
Steenstrupia nutans	..	..	..	..	(•)	•	•	•	(•)	..	..	..	northern boreal
Podocoryne carnea	..	..	..	..	..	•	●	●	•	•	(•)	..	cosmopolitan
Euphysa aurata	..	..	..	..	..	•	•	●	•	•	•	(•)	northerly
Bougainvillia ramosa	..	..	..	..	..	..	•	●	●	•	(•)	..	southerly
Purena gemmifera	..	..	..	..	..	..	•	•	●	●	•	..	southern boreal
Lizzia blondina	..	..	..	..	..	..	●	●	●	•	•	(•)	southern boreal
Eucheilota maculata	..	..	..	..	..	..	•	•	•	•	•	..	southerly
Saphenia gracilis	..	..	..	..	..	..	•	•	•	•	?	..	southerly
Cosmetira pilosella	..	..	..	..	..	..	..	?	•	•	?	..	southerly
Eirene viridula	..	..	..	..	..	..	..	?	•	•	?	..	southerly
Eutima insignis	..	..	..	..	..	..	..	?	●	●	•	..	southerly
Eutima gegenbauri	..	..	..	..	..	..	..	?	•	•	•	..	southerly
Number of species per month (apart from exceptional cases)	7	9	10	12	15	15	19	18		17		9	

Explanation: *juv.* young individuals. *ad.* adult individuals. • scarce. ● common. ( ) rare.

[1]) In the Kattegat and the Belt Sea.

INDEX OF SPECIES

(Principal references are in darker type).

LIST OF CHARTS

ERRATA

p. 21, line 16 from the bottom: for 174—275 read 274—275.
p. 36, line 8 from the top: for 1 Sept, read 14 Sept.
p. 44, line 2 from the bottom: for 27 July read 27 June.
p. 108, line 8 from the bottom: for St. 1597 read 1587.
p. 152, line 16 from the top: for St. 17 read St. 27.