THE NORWEGIAN NORTH POLAR EXPEDITION WITH THE "MAUD"
1918—1925, SCIENTIFIC RESULTS, VOL. V, No. 7

ALCYONARIANS

WITH

A SYSTEMATIC-BIOGEOGRAPHICAL DISCUSSION OF THE NORTHERN *EUNEPHTHYA*-SPECIES

(WITH 9 FIGURES IN TEXT)

BY

HJALMAR BROCH

PRINTED AT THE EXPENSE OF
STATENS FORSKNINGSFOND AV 1919 AND
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In Arctic regions the Octocorallia are throughout represented by the genus *Eunephthya* (VERILL) sensu KÜKENTHAL, and it is only in the abysmal parts or in localities near the border of the Arctic region that representatives of other genera of octocorals now and again are met with in smaller numbers. The "Maud"-expedition has brought home of Alcyonarians specimens of only two species of *Eunephthya.*

This genus (embracing according to older authors more than fifty variable and hardly distinguishable "species" distributed on several obscure genera), has during several years given trouble to students. W. KÜKENTHAL (1907) commenced the revision of the group, reduced the number of species to a certain extent, and showed that most of the genera must be placed among the synonyma of *Eunephthya.* It was, however, the careful study of more than a thousand specimens from all parts of the northern waters performed by the late Danish Professor Dr. H. F. E. JUNGERSEN which fixed the definite number of northern Nephthyidae at only four circumscribed and well defined species comprised in one genus, viz. *Eunephthya* (VERRILL). It is to be regretted that JUNGERSEN was torn away from his work before he had time to write his final report which he had meant to give out in the publications of the Danish Ingolf Expedition; his elaborate posthumous paper on *Anthomastus* (1927) tells us how he had planned to give a careful and exhaustive review of each species; but neither notes nor drawings were left behind which could furnish a basis for later publications.

Almost at the same time A. R. MOLANDER (1915) proposed a quite new arrangement of the group. He divides it into two genera, viz. *Gersemia* (MARENZELLER 1878) emend. MOLANDER, and *Eunephthya* (VERRILL 1879) emend. MOLANDER. According to his own statements, the new generic groups agree almost entirely with KÜKENTHAL'S main groups (1907) *Gersemia* + *Eunephthya alcyoniformis,* and *Eunephthya nephthyiformis.* However, his treatment of the different "species" clearly shows that he has mixed up many of both groups, and again subdivided others in some curious way of his own, with the result hat his "species" do not in general correspond with any variant groups discriminated hitherto; in fact his "species" don't seem recognizable at all.—MOLANDER is himself aware of the difficulty of a comparison with JUNGERSEN'S data and in his paper on Spitzbergen Alcyonacea (1918) he therefore states in a foot-note: "Da ich ganz andere Ansichten von der Begrenzung der *Gersemia-* und *Eunephthya*-Arten habe, ist es mir nicht möglich gewesen, die von JUNGERSEN angegebenen Fundorte aufzunehmen."

JUNGERSEN had on the other hand previously stated (1916) that "some forms which I have referred to *E. fruticosa* evidently are regarded by M. as belonging to *rubiformis,* and *vice versa",* and "MOLANDER establishes a new variety, var. *truncata* of his *"Gersemia clavata".* The specimens from Finmark certainly belong to *"clavata"* (ɔ: *fruticosa* mihi), but as to the specimens from Spitzbergen I have my doubts. At any rate a specimen in the Bergen Museum, labelled: *Eunephthya truncata* MOLANDER, Spitzbergen 20 M., MOLANDER det. Riksmuseum, Stockholm" is an *E. rubiformis".*

During several years I had occupied myself with studies concerning this intricate genus, and had little by little come to the same conclusion as had JUNGERSEN, namely that only four well definable species of *Eunephthya* can be recognized in northern waters, but that they have been split up by previous authors into a great series of invalid "species". This is due partly to their enormous faculty of variation, partly also to their greatly varying states of contraction when arriving into the hands of investigators as more or less badly preserved museum-specimens. To this we must moreover add the uncritical and unlucky tendency of many zoologists to raise every difference to the rank of "specific character" whether it is due to natural conditions, to casual contractions or to the effect of preservation.—In 1916 I had opportunity during several discourses with JUNGERSEN to state that our points of view completely agreed. Awaiting his final report in the Danish Ingolf-Expedition I left off my studies concerning *Eunephthya* for a while, and have not had an opportunity of continuing them till now, when the examination of the collections brought home by the "Maud"-Expedition offered a suitable opportunity of giving a short review of the main points of the system of classification held by the late H. F. E. JUNGERSEN and myself. Although the collections of the "Maud" contain only two of the species, I nevertheless think it the best way also to deal with the two others, and briefly give the systematical and geographical data of all species of *Eunephthya* inhabiting our Arctic and Boreal waters.

*

In his later Papers KÜKENTHAL (1907, 1909) placed such specimens as in his opinion must be said to possess a calyx ("Kelch"), in a genus of their own for which he adopted the old name of *Gersemia.*

It is therefore necessary to make clear what we shall understand by a calyx, as the ideas concerning this are somewhat vague.—MOLANDER (1918 b) defines it in the following way: "Unter Kelch bei den Alcyonaceen versteht man den wohl begrenzten basalen Teil der freien Polypenenden (Anthocodien). Im Kelche können sich gewöhnlich die oberen Teile der freien Polypen retrahieren, oder auch schliesst sich der Kelch bei der Retraktion von diesen Teilen im Coenenchym über den retrahierten Teilen zusammen. Die Bewehrung des Kelches zeigt hauptsächlich mit derjenigen der Stolonen, der Basalmembranen oder der Kolonierinde Übereinstimmung. Die Spicula sind mit einer hauptsächlich longitudinalen Längsrichtung in 8 Längsstreifen geordnet". Although this definition might seem good from a theoretical point of view, practical studies soon reveal several drawbacks, especially if we consider living specimens of different species and genera.

We may better say that a calyx is present, where the basal, non-retractile parts of the polyp (above the level of the colony) are morphologically different from the distal parts of the polyp, and serve to protect the latter when retracted.

There are in this definition two points to be especially emphasized. First of all that the calyx is a morphological feature. Its presence is demonstrated by morphological differences in the basal (thicker and stiffer) and the distal (thinner, more flexible and

contractile) parts of the polyp wall. Generally also the limit between the calyx and the retractile distal part of the polyp is fairly distinct. Even in cases when spicules are wanting we can demonstrate the said morphological differences between the two regions of the polyp, if a calyx is present, mainly as a thickening of the wall. On the other hand, in species armed with spicula the morphological difference is sometimes to be found almost only in the different studding of the spicula in both regions.

The other point of special importance is that a calyx is not retractile into the coenenchyma of the colony. MOLANDER maintains that the calyx often is reduced to a starlike lid-formation closing above the "anthocodia" when the latter are entirely withdrawn into the coenenchyma of the colony, and he mentions *Alcyonium* as an illustrative example of this kind of "calyx". Closer examinations of living colonies of *Alcyonium* with completely retracted polyps nevertheless reveal no traces whatever of a "lid"-formation which might represent a calyx according to MOLANDER, and also in colonies with fully extended polyps nothing can be traced which might enable us to speak of a calyx, at all events not in our northern, common species *Alcyonium digitatum* LINNÉ.

Now considering the *Eunephthya*-species with retractile polyps, we do not find in extended polyps any traces of calyces. All formations which have been spoken of as "calyces" ("Kelche"), and which have thus served as a basis of the genus *Gersemia* sensu KÜKENTHAL, are indeed referable to phenomena of contraction, and may generally be reduced to different artificialities caused by capture and fixation. We shall have here to recall the features of the musculature in Alcyonarians.—If a live colony is plunged into a fluid for fixation its muscle fibres will contract more or less strongly. The polyp now f. inst. being almost, although not completely retracted, a stronger contraction of the septal musculature will result in a starlike figure on the surface of the colony where the polyp has been almost entirely withdrawn. This will of course be a very common feature in colonies brought home by expeditions. When disturbed and caught by the fishing apparatus the colonies naturally generally contract, although in several cases not so completely that a formation of the starlike figures is prevented. On the other hand this formation is not so commonly observed in undisturbed, living specimens.

However, it is not always this "rudimentary calyx" that has furnished the basis of the old genus *Gersemia*. If we study the retraction and expansion of polyps in living colonies, we find that normally the tentacles and the distal parts of the polyps are successively inverted into the basal parts until the entire polyp is twisted into the coenenchymateous part of the *Eunephthya*-colony, which closes over it. In the same way the expanding is based upon evertion, the whole polyp is so to say turned inside out like a stall.—If then a half everted (or inverted) polyp is plunged into the fixation fluid, a strong contraction will generally take place in the musculature of the stomodæal part of the polyp, and especially at its lower end. This easily results in the formation of a transverse furrow around the polyp at the lower limit of the stomodæal part of the anthocodia, and moreover, owing to contemporaneous contraction of the longitudinal septal muscles, the distal part of the polyp (the anthocodia) will often become somewhat retracted into the basal part, thus making the transverse furrow more evident and emphasizing the false impression of a calyx.

Morphologically, however, there is no trace of a calyx in our northern species, and the genus *Gersemia* as defined by KÜKENTHAL (1907, 1909) has to be abandoned.

Surveying now briefly the several species mentioned as belonging to KÜKENTHAL'S genera *Gersemia* and *Eunephthya* we at once find that they naturally form two large groups according to the faculty of retraction of the polyps: in some species the polyps can be completely withdrawn into the coenenchyma of the colony, in other species the

polyps cannot at all be withdrawn. In specimens with retractile polyps the spicula of the anthocodia are arranged quite symmetrically all around the polyp (forming the "Polypenköpfchen"). In non-retractile polyps one side (the abaxial) is far more copiously furnished with spicula than the other (axial) side. Also in the latter species a contraction of the polyp is normally instigated by an inward bending curvature of the tentacles over the mouth opening; but it stops soon, the polyp on the whole attaining the shape of a short and broad, somewhat curved club. The bend evidently depends upon a stronger contraction of the poorly armed side of the polyp facing the longitudinal axis of the branch of the colony.

MOLANDER (1915) maintains that there are important differences at hand in the canal systems of the colonies of the two groups mentioned. It is, however, impossible to follow him here; the said differences are gradual, and do not seem of any great importance from a systematical point of view.

On the basis of the polyp differences mentioned KÜKENTHAL (1907) divided the genus *Eunephthya* into two groups, viz. Alcyoniformes with retractile polyps, and Nephthyiformes with non-retractile polyps. MOLANDER (1915) raises the groups to the rank of genera and makes use of the names *Gersemia* emend. (= Alcyoniformes), and *Eunephthya* emend. (= Nephthyiformes). I cannot on the basis of the present data consider the differences as sufficient for a generic separation, and I prefer to follow the lead of JUNGERSEN (1915) in referring both groups to one genus which must be named *Eunephthya* (VERRILL) JUNGERSEN.

In spite of their enormous faculty of variation our northern species are easily identified and kept distinct owing to their spicula types and arrangements. This may seem a curious statement considering that all the many "species" from northern waters described and distributed among the old "genera" *Eunephthya, Gersemia, Ammothea, Paraspongodes, Voeringia, Barathrobius, Krystallofanes, Fulla, Nannodendron, Nidalia, Organides, Sarakka, Drifa,* and *Duva* were mainly based upon their spicula. However, even though the spicula and their arrangement and numbers vary on a very large scale, we are able to distinguish between some few very constant types characterising four great groups of variants which constitute our four valid northern species. Only we have to abandon the habit of old investigators who were looking incessantly for differences, however small they might be, and who based a "nova species" on every small deviation, even on a single aberrant spiculum. We have to eliminate

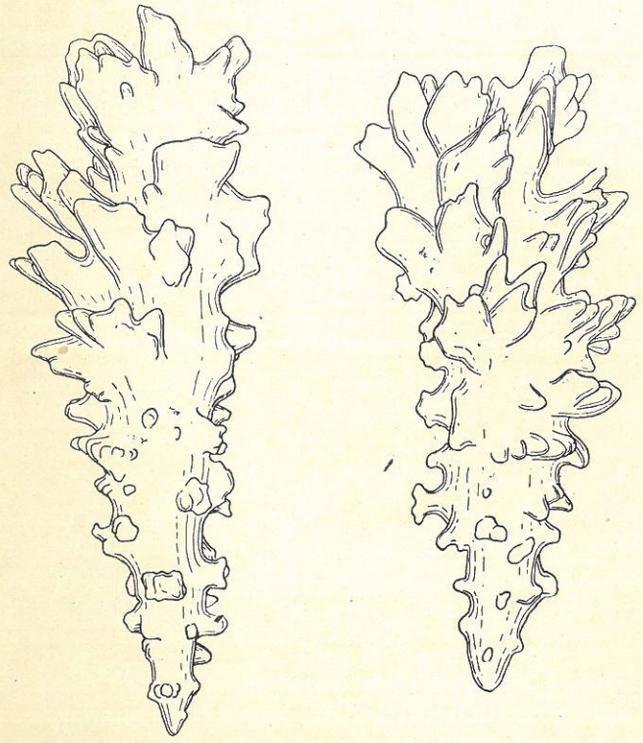

Fig. 1. *Eunephthya glomerata*. Spicula from the polyps of a specimen from the Kolafjord. The spines are more strongly developed on the outer (abaxial) side of the spiculum, and here form comb-like rows. (× 300).

aberrations and to seek out the main type characterising a group of individuals as against every other group.

Considering first the armature of the polyps, we find at once as above mentioned, that specimens with non-retractile polyps attract attention by the oblique arrangement of their spicula. Again we find here a group of specimens showing heavily armoured polyps with rather large and strongly spined clubs ("Stachelkeulen"). The spines are only feebly developed at the narrow (basal) end of the spiculum, but attain at the broad distal end of the club a size and coarseness never attained in any other group of *Eunephthya*; moreover the coarser distal spines very commonly are arranged in comb-like transverse rows and are almost without exception single, not branched (Fig. 1). These polyp spicula characterize the type species *Eunephthya glomerata* (LÜTKEN Ms.) VERRILL. The mentioned main characteristic is seconded by the spicula of the bark of the colony. The latter, it is true, belong

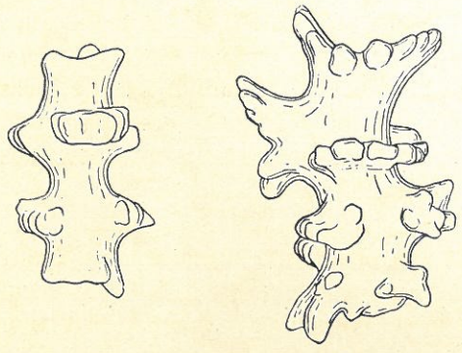

Fig. 2. *Eunephthya glomerata.* Spicula from the bark of a colony from the Kolafjord. (× 300).

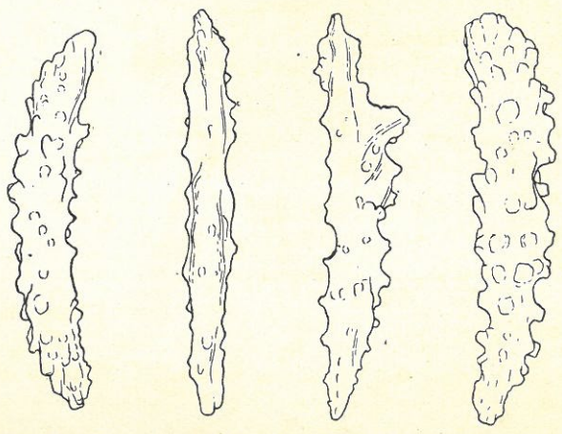

Fig. 3. *Eunephthya florida.* Spicula from the polyps of a colony from the Trondhjem fjord. (× 300).

to the same ground-type as those met with in basal parts of the colonies of *Eunephthya florida*, which again turn up in the coenenchyma all over *Eunephthya fruticosa*, viz. the so-called "double stars". In *Eunephthya glomerata*, however, they exhibit a special feature (Fig. 2), their compound wharts tending to dissolve into distinct transverse comb-rows.

All other specimens with non-retractile polyps have rodlike polyp-spicula (Fig. 3) with small or almost disappearing thorns. In small numbers we find that the polyp-spiculum may have the shape of a very slender club with almost smooth handle, but in no case do we meet with heavily spined clubs like those previously mentioned. Again another characteristic coexists with that of the polyps, viz. the sparsity or, commonly, lack of spicula in the bark of the upper part of the colonies; in greater numbers rather simply built double stars with somewhat compound wharts are met with only in the basal parts of the trunk. Specimens showing these features belong to the species *Eunephthya florida* (RATHKE) KÜKENTHAL.

Turning now to the specimens with retractile polyps we find that on first sight the polyp spicula do not give much assistance, and we have to direct our attention to the spicula of the colony bark, especially of the distal parts of the branches. Here again the investigation soon reveals two very characteristic groups, although the differences in the basal parts may sometimes be somewhat less prominent.

The bark of the branch tips in one group of specimens shows rather large fusiform or rod-like spicula with coarse compound wharts scattered irregularly all over the spiculum and not arranged in whorls (Fig. 4). These spicula show no likeness

with "double stars" and are moreover generally about twice as large as the double stars or other bark spicula found in corresponding parts of other species. In the basal parts of the colony, however, the spicula may often be a little smaller and tend to the appearance of double stars. Again an examination of the spicula of the polyps of this group of specimens reveals that although they are principally of the same type as in the next group, viz. rodlike or somewhat fusiform, they are nevertheless of a heavier build and have especially stronger wharts. The specimens here grouped together belong to the species known of old under the name of *Eunephthya rubiformis* (EHRENBERG) KÜKENTHAL.

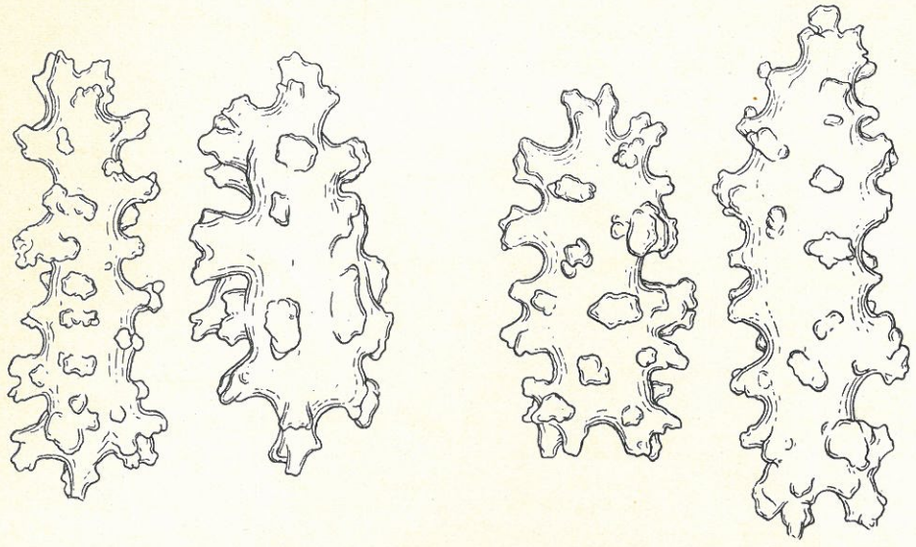

Fig. 4. *Eunephthya rubiformis.* Spicula from the bark of the branch ends. To the left two spicula from a colony from the "Maud"-Expedition Lat. 76° 30′ N, Long. 139° 04′ E, 23 m. depth. – To the right two spicula of a colony from the Porsanger fjord. (×300).

The last group with retractile polyps, and probably the most complexly varying one (especially by reason of its manifold states of contraction) constitutes the species *Eunephthya fruticosa* (M. SARS) KÜKENTHAL. Here we also find a norm or theme of variation in the spicula of the bark of the colony, and this type is without exception most clearly demonstrated in the branch ends: it is the "double star" (Fig. 5). Generally, although not quite without exception, this spiculum has a naked middle part, so that it attains a rather bisymmetrical shape. The compound wharts are mostly arranged in whorls, and this arrangement is moreover emphasized by a tendency in the wharts to develop the greater width vertically to the axis of the spiculum. Sometimes the wharts are almost simple. On the other hand we find in some cases a tendency in the spiculum to develop in the form of clubs, especially at the base of the polyps, the wharts of one end being much larger than those of the other. As is mentioned above, the spicula of the bark of *Eunephthya fruticosa* attain only about half the length of those of *Eunephthya rubiformis*. The length of the spicula of the polyps is on the other hand all but the same in both species, but the spicula of *Eunephthya fruticosa* are generally slenderer with fewer and smaller wharts.

A short recapitulation of the data given is best summarized in a key which will be of use to those who shall later on identify our northern species of the genus *Eunephthya*.

1 (4). Polyps not retractile into the coenenchyma of the colony. The arrangement of the spicula on the polyp assymmetrical, the abaxial side of the polyp strongly armed, the axial feebly or devoid of spicula. 2

2 (3). The polyp spicula coarsely built clubs with strong spines at the distal, swollen end and without or only with smaller spines on the shaft (the proximal part). The bark of the distal part of the colony studded with spicules of the double-star type, their wharts tending to a splitting up into comb-like transverse rows.

1. *Eunephthya glomerata* (LTK. Ms.) VERRILL.

3 (2). The polyp spicula fusiform or occasionally tending to a club shape, with only very feebly developed thorns. The bark of the distal parts of the colony almost or entirely destitute of spicula; in the basal parts containing double stars.

2. *Eunephthya florida* (RATHKE) KÜKENTHAL.

4 (1). Polyps retractile into the coenenchyma of the colony; the arrangement of the spicula in the polyps is symmetrical. 5

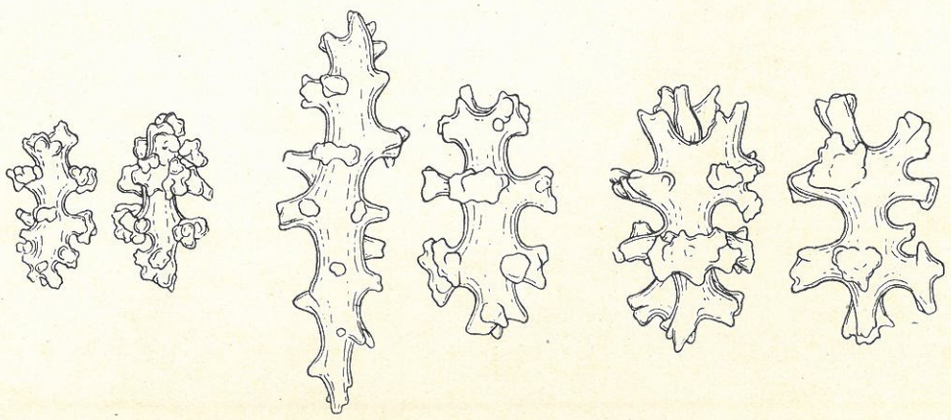

Fig. 5. *Eunephthya fruticosa.* Spicula from the bark of the branch ends in three colonies from the "Maud"-Expedition. To the left two typical spicula from a colourles specimen. In the middle two colourless spicula; the slender type is often seen at the base of the polyps, and may sometimes be a. little more club-shaped, the wharts of one end attaining a larger size with a more compound structure. To the right two densely built, dark red-coloured spicula. (× 300).

5 (6). The bark of the distal parts (the branch tips) of the colony studded with broad, fusiform or rodlike spicula, up to 0.35 mm. in length, richly armed all over with irregularly arranged compound wharts. 3. *Eunephthya rubiformis* (EHRENBERG) KÜKENTHAL.

6 (5). The bark of the distal parts (the branch tips) of the colony more or less densely studded with double stars up to 0.2 mm. in length having transversely arranged compound wharts generally in whorls; occasionally the spicula tend in their development towards clubs.

4. *Eunephthya fruticosa* (M. SARS) KÜKENTHAL.

JUNGERSEN (1915, 1916 a, 1916 b) has given a complete list of synonyms of the four species after a revision of all material at hand, from northern waters, in the museums of Kopenhagen, Bergen, and Oslo, comprising most type specimens of the many species previously described. As to the publication of MOLANDER (1915) JUNGERSEN has given only the synonymy of *Eunephthya glomerata* and *Eunephthya florida*, owing to the discrepancies stated between his descriptions and some of his specimens in the Bergen Museum (comp. also p. 3—4, and 15). Evidently a complete revision of MOLANDER's material is needed to disentangle in detail the synonymy. In the following pages, however, I give the synonymy in accordance with the descriptions given in the paper

of MOLANDER (1915); on the other hand I have left his geographical data out of question in most cases owing to the uncertainty already pointed out by JUNGERSEN.

As to the synonymy before 1915 i refer to the works of JUNGERSEN (1915, 1916 a and 1916 b).

1. ***Eunephthya glomerata*** (LÜTKEN M. S.) VERRILL.

(Comp. JUNGERSEN 1916, Bergens Museums Aarbok, p. 14).

1915. *Eunephthya glomerata* + *E. flavescens* + *E. groenlandica*, MOLANDER, Northern and Arctic Invertebrates pp. 70, 72—78; textfigs. 13 a, b, c; pl. II fig. 15, 17—19.

1918. *Eunephthya glomerata*, MOLANDER, Die Alcyonaceen des Fisfjordes p. 11.

1922. *Drifa glomerata* + *D. racemosa* + *? Duva arborescens* + *? Eunephthya thyrsoidea*, VERRILL Report of the Canadian Arctic Expedition pp. 29, 31, 34; pl. IV fig. 7; pl. V figs. 1 and 2; pl. XIV figs. 2 and 4; pl. XV figs. 1—5; pl. XVII a figs. 2—3.

1926. *Eunephthya glomerata*, RYLOW, Alcyonacea, gesammelt von der Expedition des Schwimmenden Wissenschaftlichen Meeresinstitutes im Jahre 1921, p. 74.

There are some doubtful points in the synonymy as given above. The drawings and descriptions in VERRILL's paper are rather schematic, and in the case of *Eunephthya thyrsoidea* the description is so cursory that the species can hardly be identified at all. This must be regretted the more because VERRILL (1922) makes this species the type of his genus *Eunephthya,* and moreover considers the genus *Capnella* of KÜKENTHAL a synonym of *Eunephthya.* The type specimen of *Eunephthya thyrsoidea* being lost, we shall have to rank this species with the spec. dub., and the right course to follow is, with KÜKENTHAL, to consider the well-known *Eunephthya glomerata* as the type of the genus.

We must also at present question VERRILL's *Duva arborescens.* VERRILL got from Bergen some specimens labelled as this species, and considers them as "type" specimens. His drawings (1922, pl. IV, figs. 7 a—d) nevertheless very strongly recall polyp spicula of *Eunephthya glomerata.*

Turning now to the biogeography we find that the habitat of *Eunephthya glomerata* is a rather limited one (fig. 6[1]). Evidently the species must be characterized as an Atlanto-Arctic species, its distribution neither to the East nor to the West reaching a longitude of 100°. On the other hand the species does not penetrate far to the South in the Atlantic ocean, and although one or some few finding places south of Iceland are lacking, where the species according to JUNGERSEN (1916) has been taken by the Danish Ingolf-Expedition, this will not be able to alter to any important extent the geographical features illustrated by fig. 6.

According to JUNGERSEN (1916) *Eunephthya glomerata* is "arctic and boreal; it occurs in bottom-temperatures above and below freezingpoint and ranges from littoral regions and shallow waters to depths of the open sea surpassing 800 Fathoms (at N. America reaching 1186—1497 Fathoms after VERRILL)." In 1915 he gave 7 fathoms as the upper limit of the species.—These data, however, are a little too schematic and general. Even though specifications as to depth and temperature are lacking in many localities, we can get a few hints as to the biogeographical character of the species through the data present in the literature of this subject.

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[1]) I am much indebted to Professor Dr. N. VON HOFSTEN (Uppsala) who has liberally placed the map frames at my disposal.

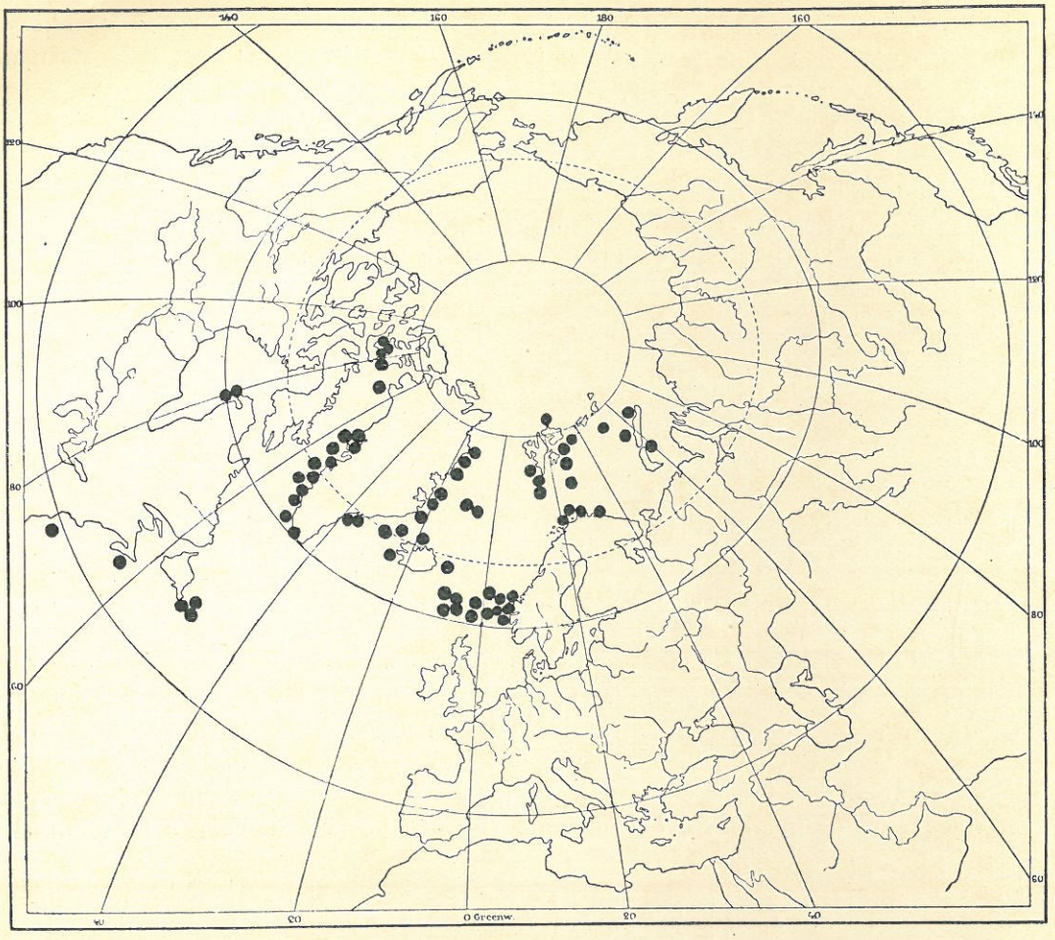

Fig. 6. *Eunephthya glomerata.* Hitherto recorded finding places. (JUNGERSEN states that the species has been taken in more places by the Danish Ingolf-Expedition without giving the positions).

In fact most of the finding places show depths greater than 100 m. (50 fathoms). Published papers mention the following finding places with depths less than 100 metres: North side of Jones Sound; some few localities on the east coast and on the west coast of Greenland; north of Iceland; at Jan Mayen, Spitsbergen, and Bear Island; in the Barents Sea, the Kolafjord, and the Kara Sea. All these localities are situated in purely arctic or at least in boreoarctic regions, and the only shallow-water finds in strictly boreal waters mentioned are on the Norwegian west-coast, viz. at Moldøy (40—200 fathoms) and on the Skreigrund near Ålesund in 75—80 m.

By far the greater number of the finding places hitherto known show depths exceeding 100 m. On the other hand the depths in comparatively only a very few cases considerably exceed 600 metres or thereabouts. This might of course be due to the scarcity of bottom investigations in the deeper parts of the oceans, so that this question must be left open for future studies. However, it is in this connection of interest to note where the deeper finding places are situated, and we shall here especially consider those finding places below 600 m. which display positive temperatures. During the Norwegian North-Atlantic Expedition (1876—1878), one such locality was noted west of Spitsbergen at 761 m. depth with + 0°.8 C. According to JUNGERSEN (1915, 1916) the species has been taken south of Iceland down to 795 fathoms (exact data not given), in the Denmark Strait at 795 fathoms, on the western coast of Green-

land at 700 meters (temperature not stated), and in the Davis Strait at 582 fathoms. In all these cases it seems most natural to assume that the occurrence depends upon larval transport from neighbouring localities with rather strictly arctic features.

Considering the temperatures we find that the majority of the finding places are situated within the "cold area" and accordingly show temperatures at or below the freezing point.—Also in entirely arctic localities the temperature occasionally in shallow waters rises above 0° C. as f. inst. in Spitsbergen waters, or around Nova Zemlja. The arctic character of the localities in question is not altered by such temporary changes. In such arctic localities *Eunephthya glomerata* in some places flourishes abundantly in lesser depths than elsewhere. In other places again positive temperatures of the finding places are combined with very great depth, and the position of these localities with all probability point at a larval transport from arctic or boreo-arctic waters.

In spite of its occasional occurrence in some few places within strictly boreal waters as f. inst. on the western coast of Norway, *Eunephthya glomerata* must be characterized as an arctic and boreoarctic (panarctic) species.

JUNGERSEN (1916) believes that "very likely it will turn out to be circumpolar." In spite of the panarctic character of the species this assumption does not seem to hold good. On comparison with the maps illustrating the finding places of *Eunephthya rubiformis* (fig. 8, p. 15) and *Eunephthya fruticosa* (fig. 9, p. 18) we must maintain that the numerous localities investigated, and the great number of finds of the two last-named species, especially in Siberian waters, rather strongly indicate that *Eunephthya glomerata* is lacking in these parts of the arctic ocean. This view seems the better founded when we keep in mind that the latter species very commonly within its known habitat (and especially in the Murman Sea) occurs together with the two above named species.

2. ***Eunephthya florida*** (RATHKE) KÜKENTHAL.

(Comp. JUNGERSEN 1916, Bergens Museums Aarbok, p. 16).

1915. *Eunephthya rosea* + *E. florida* + *E. spitzbergensis,* MOLANDER, Northern and Arctic Invertebrates pp. 71, 79, 82, 83; textfigs. 13 d—e and 14; pl. II, figs. 14, 16, 20, 21 and 23.
1922. *Duva multiflora,* VERRILL, Report of the Canadian Arctic Expedition p. 35; pl. XV, figs. 6 and 7.
1927. *Eunephthya rosea,* THOMSON, Alcyonaires provenant des campagnes scientifiques du Prince Albert Ier de Monaco, p. 15.

An examination of VERRILL's last paper (1922) corroborates the assumption of JUNGERSEN (1916) that *Duva multiflora* must be ranged with the synonyms of *Eunephthya florida.*

The habitat of *Eunephthya florida* in northern waters (fig. 7) is far more restricted than that of the preceding species, and an analysis of the geographical data tells us that the species by no means can be characterized as arctic (comp. JUNGERSEN 1916) although some few of the finding places are situated within boreoarctic districts or even show temperatures below the freezing point.

JUNGERSEN (1916) rather briefly states "Its bathymetrical range is very wide: from 3 to 600—700 Fathoms." This statement, however, must to a certain degree be characterized as misleading. The species has in fact only in very exceptional cases been met with at less than 200 metres depth (ab. 100 fathoms), viz.: Turner Sound ("3 fathoms"!) and Scoresby Sound (57 fathoms), along East-Greenland and to the north of Iceland (44 fathoms, "Ingolf" St. 127); in some of the western fjords of the Norwegian coast specimens have been taken in lesser depths than 200 metres, the upper limit of the occurrence stated in the literature being 80 metres. In the Davis Strait

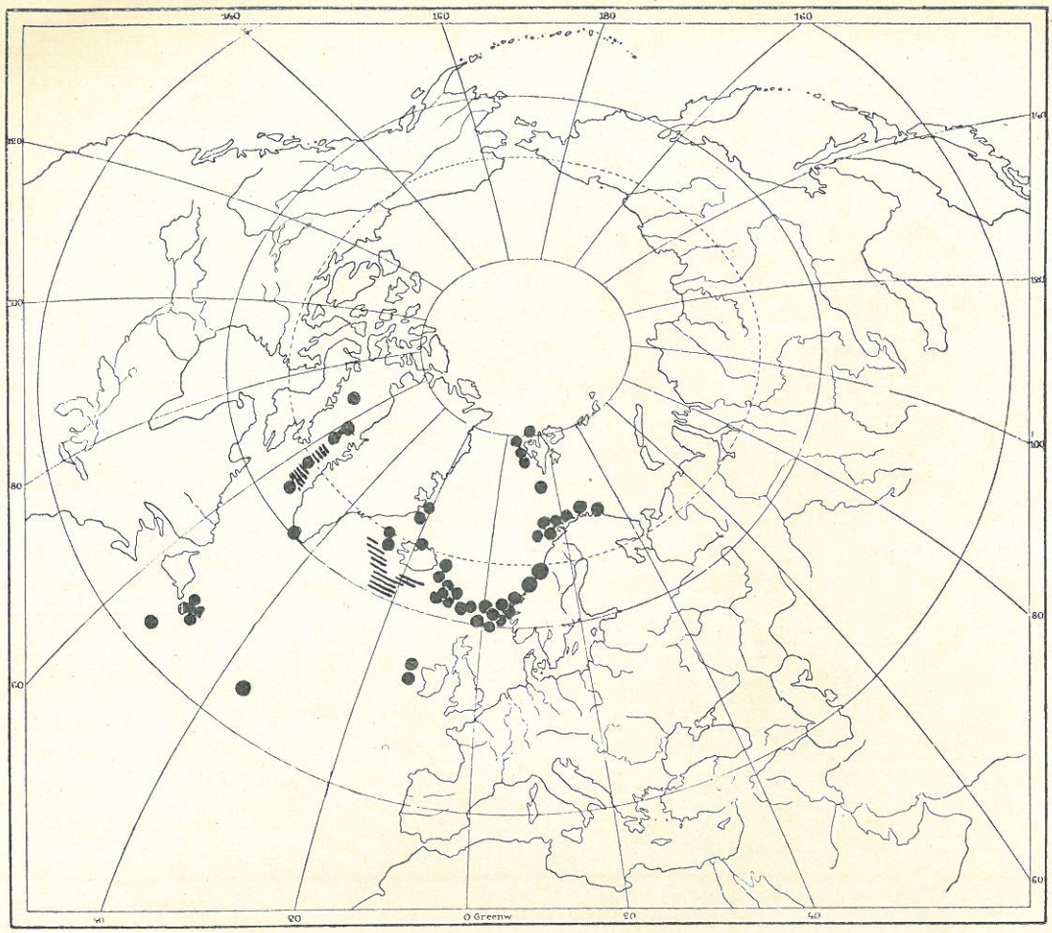

Fig. 7. *Eunephthya florida.* Finding places hitherto recorded. (In the streaked parts JUNGERSEN mentions that the species has been found in several places without giving exact details).

JUNGERSEN mentions 88 fathoms as the upper limit of the finding places, but he gives no exact positions. These few instances, however, evidently are only occasional exceptions. The upper limit of the normal bathymetrical range lies at about the 200-meter (100-fathom) line. In the same way the lower limit of the normal habitat evidently must be drawn at 700 metres depth, although scattered specimens have been met with even much deeper, the maximum depth hitherto noted in a finding place seems to be 649 fathoms.

Concerning the temperature we may at once state that *Eunephthya florida* only quite exceptionally has been met with in localities with temperatures below the freezing point. Leaving the unpublished data from the "Ingolf"-Expedition alluded to by JUNGERSEN out of consideration, we find that the species has been taken in temperatures below the freezing point in the following places: twice in the "cold area" off the southeastern part of Iceland, twice on the slope west of Lofoten, and once on the slope towards the abysmal parts north of the North Sea. A comparison with a map of the currents of the northern Atlantic[1]) at once tells us that the species may easily have been transported to these localities in a larval state from neighbouring localities with temperatures above 0° C., where it has been found more commonly.

[1]) Comp. f. inst. NANSEN and HELLAND-HANSEN'S map.

Nevertheless *Eunephthya florida* evidently prefers comparatively low temperatures. Although it has been met with even in a temperature of 6°.54 C., the species prefers somewhat cooler strata; in the open ocean it has been observed in greatest abundance between + 1° and + 4° C.

The features mentioned afford the explanation why *Eunephthya florida* has a rather restricted habitat in the northern Atlantic.—It must be spoken of as a characteristic species of the deeper parts of strictly boreal waters. It cannot be said to be arctic. On the other hand its distribution southwards exceeds strictly boreal regions in deeper parts of the North Atlantic south of the Faeroe-Iceland-ridges.

3. ***Eunephthya rubiformis*** (EHRENBERG) KÜKENTHAL.

(Comp. JUNGERSEN 1916, Bergens Museums Aarbok, p. 9).

1915. *Gersemia uvæformis* + *G. clavata* + *G. fruticosa* var. *pallida* (pars), MOLANDER, Northern and Arctic Invertebrates pp. 48, 54, 56 and 67; textfigs. 12 b, c, d, e and g; pl. I, figs. 1—5 and 8.

Nec 1915. *Gersemia rubiformis*, MOLANDER, Northern and Arctic Invertebrates pp. 48 and 51.

Non 1918. *Gersemia rubiformis*, MOLANDER, Die Alcyonaceen des Eisfjords, p. 4.

1918 ? *Gersemia uvæformis* +? *G. clavata*, MOLANDER, Die Alcyonaceen des Eisfjords pp. 6 and 7.

1922. *Gersemia rubiformis* +? *G. canadensis*, VERRILL, Report of the Canadian Arctic Expedition, pp. 4, 20 and 48; pl. I, figs. 1 and 2; pl. II, figs. 1—6; pl. III, fig. 8; pl. V, figs. 3—4; pl. XVII a, fig. 1.

1926. *Gersemia uvæformis* + *G. clavata*, RYLOW, Alcyonaceen, gesammelt von der Expedition des Schwimmenden Wissenschaftlichen Meeresinstituts, pp. 66—67, figs. 3—6.

Non 1926. *Gersemia rubiformis*, RYLOW, Alcyonaceen, gesammelt von der Expedition des Schwimmenden Wissenschaftlichen Meeresinstituts, p. 65.

During the **"Maud"**-Expedition this species was found in the following localities:

Lat. 75° 23′ N, Long. 167° 27′ E, 73 m. depth. 1 small colony.
„ 76° 30′ N, — 139° 04′ E, 23 m. — 2 medium sized colonies.

MOLANDER (1915) thinks that KÜKENTHAL (1607) has not fixed sufficiently precise distinctions between *Eunephthya rubiformis* and *Eunephthya clavata,* and that, as a result of this, I have changed the names of these two species in my papers on Alcyonarians from the Kolafjord (1912) and from the Kara Sea (1912). A careful study of KÜKENTHALS's descriptions, and of material from northern collections determined by him and other investigators would have convinced MOLANDER that this is not the case. Quite on the contrary all earlier identifications exactly agree with the synonymy list worked out by JUNGERSEN (1915, 1916), and it is in MOLANDER's paper that the name-change for the first time appears. MOLANDER's nomenclature has been adopted only by RYLOW (1926).

As to VERRILL (1922) the question seems a little difficult. In his synonymy-list of *Eunephthya rubiformis* there figure both JUNGERSEN's and MOLANDER's *"Eunephthya rubiformis"*—which according to the above statement belong to different species—, and his drawing of the spicula are somewhat sketch-like, and do not seem to have been drawn by aid of a camera, so that they give no safe basis for discrimination. Moreover his details concerning the spicula of the bark are too scanty. The figures given nevertheless point in the direction of the species as emphasized by JUNGERSEN and myself. Also his *Gersemia canadensis* seems to belong to the same species, but the identity can only be settled with certainty on an examination of VERRILL's type specimens. From the geographical data it is evident that it is on the whole desirable to have all American collections—especially from Atlantic waters—thoroughly revised.

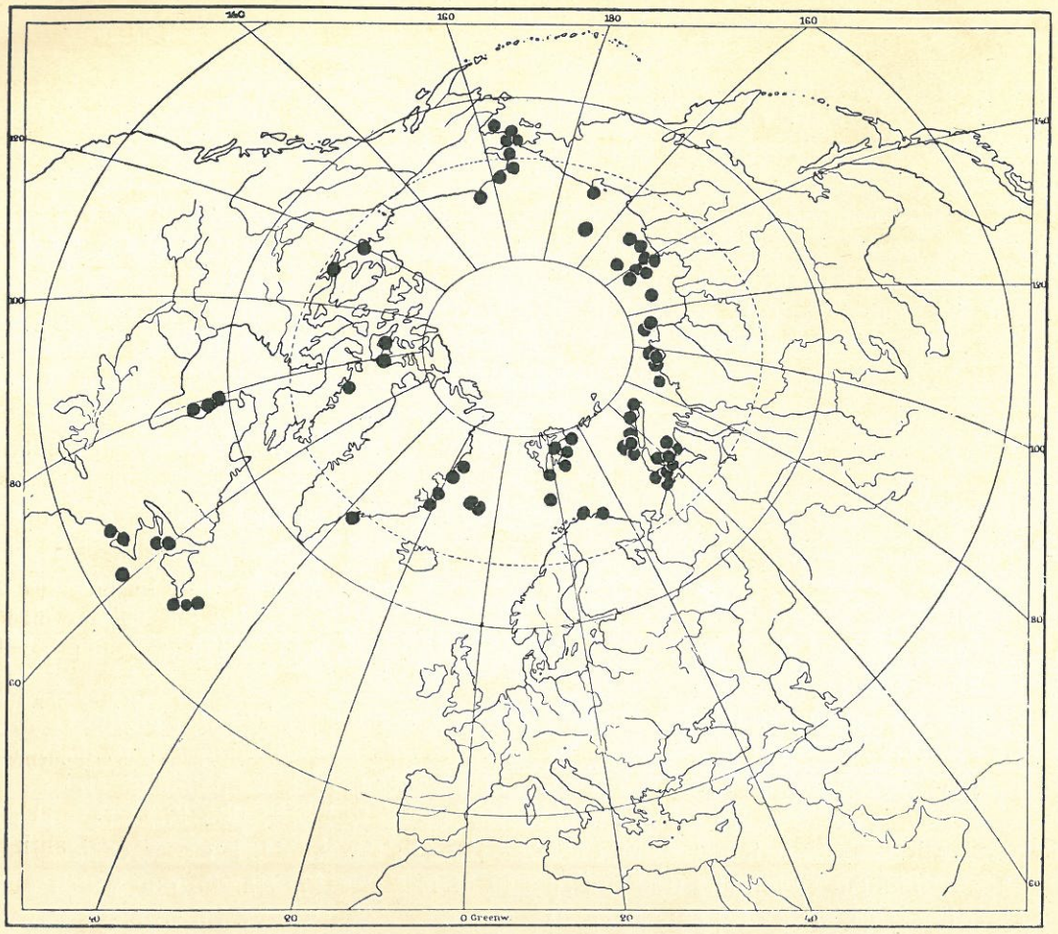

Fig. 8. *Eunephthya rubiformis.* Finding places hitherto recorded.

JUNGERSEN (1916) has, probably by a slip of the pen, ranged MOLANDER's *"Eunephthya rubiformis"* among the synonyms of *Eunephthya rubiformis* (EHRENBERG). MOLANDER's figures and descriptions, however, leave no doubt that these have been based upon typical specimens of *Eunephthya fruticosa* (M. SARS). This thus eliminates the following discrepancy between JUNGERSEN's and MOLANDER's geographical data, that whereas the former maintains that *Eunephthya rubiformis* has been met with neither off West-Greenland, nor in Davis Strait and Baffins Bay, the latter mentions its occurrence both in Davis Strait and Baffins Bay.

On the other hand MOLANDER (1915) tells us that he has had specimens of both *Gersemia clavata* and *Gersemia uvæformis* from Davis Strait and from Baffins Bay, and these species are according to his descriptions and illustrations certainly synonymous with *Eunephthya rubiformis.* To settle this question an examination of MOLANDER's specimens was necessary, and I am greatly indebted to Professor Dr. T. ODHNER of the Riksmuseum at Stockholm who has kindly placed the specimens in question at my disposal for a renewed investigation. As a result of this investigation we may state that only one of the colonies belongs to *Eunephthya rubiformis,* whereas all the others are typical *Eunephthya fruticosa.* The one colony belonging to *Eunephthya rubiformis* is that mentioned by MOLANDER (1915) as a *"Gersemia clavata"* from Baffin Bay Lat. 72° 8′ N, Long. 74° 20′ W, depth 30—80 metres, collected by E. NILSSON $^{11}/_{9}$ 1874. It has thus been captured on the western side of Baffin Bay rather near the mouth

of Jones Sound, where the species was found by the second Norwegian arctic expedition with the "Fram". We must accordingly confirm the statement of JUNGERSEN that *Eunephthya rubiformis* according to present data does not live along the western coasts of Greenland, in Davis Strait, nor in the eastern and central parts of Baffin Bay.

JUNGERSEN (1916) points out the fact that this makes a break in the circumpolar distribution of the species. There is, however, also another gap which is of interest in this connection, viz. that between Spitsbergen and Greenland. Evidently these gaps give us some hints in disentangling the biogeographical features of the species.

Eunephthya rubiformis prefers rather shallow water. Only in exceptional cases has it been met with below 100 m. depth, viz. off Jan Mayen at 100 fathoms, off East-Spitsbergen "down to 240 metres", in Barents Sea at 160 fathoms, in the Porsanger-fjord at 200 metres, the Kola-fjord at 180 fathoms, and in the Kara Sea at 166 metres.—Along the Siberian coast (comp. fig. 8) the bulk has been found at between 12 and 50 metres depth, only one find being noted at less depth (between 5.5 and 7.3 metres; KÜKENTHAL 1909), and a few between 50 and 100 metres. In the Kara Sea most finds have been made a little deeper, namely from 42 to 98 metres, almost exactly corresponding with the depths generally noted from Spitsbergen and the Barents Sea. Off East Greenland again the depths recorded vary from 20 to 50 fathoms. —Already these bathymetrical facts give us the explanation why the species is not met with in the deep-sea between Spitsbergen and Greenland, and in the deeper parts of Davis Strait and Baffin Bay.

Exact data concerning the temperatures of the finding places are all but entirely wanting; nevertheless a comparison with the chart tells us that *Eunephthya rubiformis* only quite exceptionally has been found in localities with temperatures above the freezing point. An extreme exception is that of the only Norwegian find made in the Porsanger-fjord, with a temperature of 3°.16 C. On the whole, a closer examination of the finding places tells us that the species in fact is a high arctic one which only in exceptional cases has been met with even in boreoarctic waters. It seems as though the species in general cannot thrive in places where an intermixture of boreal (or warmer) water is evident, and this is probably the reason why it does not live along the eastern coasts either of Greenland or of Spitsbergen.

In short, *Eunephthya rubiformis* (fig. 8) is a higharctic species of rather shallow waters. Although we must presume with our present knowledge that the two gaps known in the distribution—viz. to the east of Spitsbergen and of Greenland—will persist, we must characterize the species as circumpolar. Already in boreoarctic regions the species is extremely scarce, and in boreal waters it is evidently entirely wanting. This tells us that a renewed investigation of the eastern American localities mentioned in the literature is needed.

4. ***Eunephthya fruticosa*** (M. SARS) KÜKENTHAL.

(Comp. JUNGERSEN 1916, Bergens Museums Aarbok, p. 11).

1915. *Gersemia rubiformis* + *G. fruticosa* + *G. mirabilis*, MOLANDER, Northern and Arctic Invertebrates pp. 48, 49, 51, 60, and 69; textfigs. 12 a, f, h and i; pl. I, figs. 6, 7 and 9—13.

Non 1915. *Gersemia fruticosa* var. *pallida*, MOLANDER, Northern and Arctic Invertebrates p. 67.

1918. *Gersemia rubiformis* + *G. fruticosa* + *G. mirabilis*, MOLANDER, Die Alcyonaceen des Eisfjords pp. 4, 9 and 11.

1922. *Gersemia fruticosa* + *G. carnea* + *G. mirabilis* +? *G. studeri*, VERRILL, Report of the Canadian Arctic Expedition pp. 22, 23, 26 and 48; textfig. 4; pl. III, figs. 5—7; pl. IV, figs. 1—3; pl. V, fig. 5; pl. XI, fig. 1.

1926. *Gersemia rubiformis* + *G. fruticosa,* RYLOW, Alcyonaceen, gesammelt von der Expedition des Schwimmenden Wissenschaftlichen Meeresinstituts pp. 65 and 70; textfigs. 7—10.

1927. *Eunephthya fruticosa* + *Gersemia Danielsseni,* THOMSON, Alcyonaires provenant des campagnes scientifiques du Prince Albert Ier de Monaco pp. 14 and 15.

During the **"Maud"**-Expedition the species was found in the following localities, mostly in numerous, well developed colonies:

Lat.	74° 41′ N,	Long.	166° 10′ E,	57—66	m.	depth.
„	75° 07′ N,	„	164° 44′ E,	58	m.	„
„	75° 24′ N,	„	164° 18′ E,	58	m.	„
„	75° 31′ N,	„	164° 10′ E,	58	m.	„
„	75° 30′ N,	„	164° 28′ E,	58	m.	„
„	75° 23′ N,	„	167° 27′ E,	73	m.	„
„	76° 07′ N,	„	163° 25′ E,	62	m.	„
„	75° 56′ N,	„	162° 57′ E,	54	m.	„
„	76° 05′ N,	„	150° 32′ E,	34	m.	„
„	76° 30′ N,	„	139° 04′ E,	23	m.	„

Although none of the numerous "species" described in older literature and included in the list of synonyma worked out by JUNGERSEN (1916) can be acknowledged as valid species, nor even apparently to represent biogeographically limited groups of variants ("formæ"), a careful study of the enormous collections of *Eunephthya fruticosa* contained in the museums of different countries might possibly reveal geographical (biophysical) forms within this luxuriantly varying species. However, as long as our knowledge stands where it does today, the only correct course to follow is to treat the species as one unit.

According to the last statements of VERRILL (1922) JUNGERSEN erred in placing *Gersemia longiflora* VERRILL 1885 among the synonyma of *Eunephthya fruticosa.* VERRILL is probably right in believing that he has himself under the name of *Gersemia longiflora* thrown together two different species, and that his type which has been dredged off Delaware, and which is again figured in his last paper (1922, textfig. 14 on page 49), has nothing to do either with *"Gersemia"* or with *Eunephthya.* On the other hand his *Gersemia longiflora* var. (?) is more likely an *Eunephthya* (comp. l. c. pl. XIV, fig. 3). In the geographical discussion we had better omit both for the present.

On the other hand we can include his *Gersemia carnea* in the synonymy list as is especially evident from his drawings 1922, pl. IV, figs. 1—3 and pl. XI, fig. 1.

JUNGERSEN (1916) placed the *"Gersemia clavata"* of MOLANDER (1915) with the synonyms of *Eunephthya fruticosa,* although with the remark that specimens from Finnmark determined by MOLANDER as *Gersemia clavata* var. *truncata* belong to *Eunephthya fruticosa,* whereas colonies from Spitsbergen referred by MOLANDER to the same variety are typical *Eunephthya rubiformis.* In Material from Davis Strait and Baffin Bay labelled as *Gersemia clavata* by MOLANDER, I have also found representatives of both species mentioned. Surely this makes the question rather intricate. I have, however, thought it right to place MOLANDER's *Gersemia clavata*—which does not coincide with *Voeringia clavata* DANIELSSEN 1887—with the synonyma of *Eunephthya rubiformis,* as his figures and descriptions no doubt have been based upon specimens of this species.—On the other hand it is doubtless owing to a slip of the pen that JUNGERSEN places the *"Gersemia rubiformis"* of MOLANDER (1915) in the list of synonyma of *Eunephthya rubiformis,* his descriptions and figures leaving no doubt that they have been based upon quite typical specimens of *Eunephthya fruticosa.*

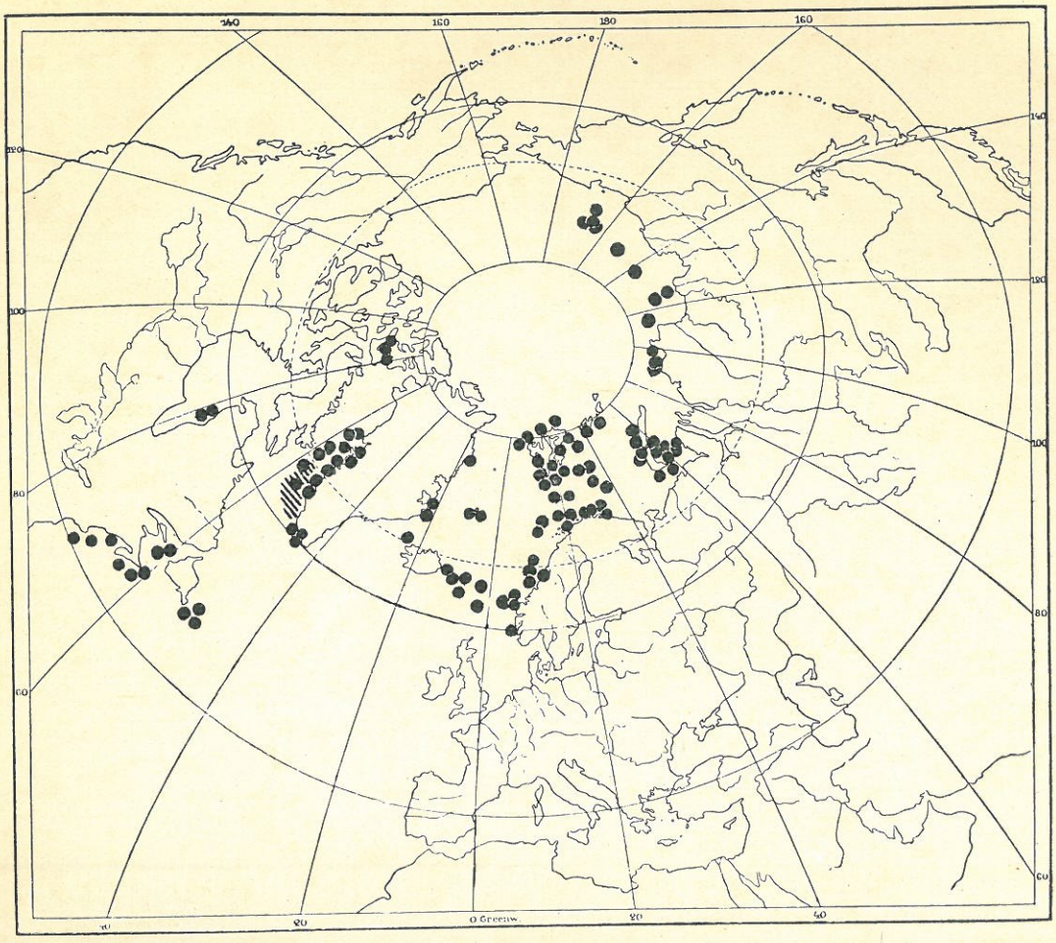

Fig. 9. *Eunephthya fruticosa.* Hitherto recorded finding places. (In the streaked region JUNGERSEN mentions that the species has been taken in many places without giving exact details). Outside the map finds are recorded from the Atlantic-American waters to about Delaware, and from the eastern part of the Atlantic near the Azores.

The habitat of *Eunephthya fruticosa* (fig. 9) is very extensive. The finds of the "Maud"-Expedition have removed the known eastern limit of the species in the arctic Siberian waters from the mouth of the river Lena some 40° towards the east to about Cape Shelagskoi. These finds point in the direction that the species will turn out to have an entirely circumpolar distribution, though at present a great gap is seen in the map from Cape Shelagskoi along the arctic American coasts to Jones Sound. This gap is not throughout owing to lack of dredgings, as is evident from a comparison with fig. 8, and we cannot deny the possibility that some specimens from the mentioned coastal waters recorded as *Eunephthya rubiformis* may on closer examination turn out to belong to *Eunephthya fruticosa.* Nevertheless the circumpolarity of the latter species, however probable it also may be, has yet to be proved by finds bridging the gap mentioned.

A survey of the depths and temperatures appearing in literature is very interesting although evidently to some degree misleading. This is a result of the habit of collecting zoologists in most cases in stating only the depth, and in omitting other hydrographical statements. On compiling the data concerning temperature we therefore face the surprising fact that in the overwhelming majority they give temperatures below the freezing point. On the other hand a great many finds have been made in strictly

boreal waters; but here data concerning temperature generally are omitted. An analysis of the latter localities and their hydrographical data as stated in other places shows, however, that *Eunephthya fruticosa* also thrives in temperatures above the freezing point. In Norwegian fjords it has been found many times in temperatures of 7° C. or even more. We can thus state that the species is rather eurytherm, also it seems to be stenohaline in the warmer, and a little more euryhaline in the extremely cold parts of its habitat. Although *Eunephthya fruticosa,* as mentioned, must be looked upon as an eurytherm species, it evidently prefers somewhat lower temperatures, mostly below 5° C. or thereabouts. This explains the fact that the species only in arctic or exceptionally also in boreoarctic waters is met with at depths of less than 100 metres; in these regions it is in some places common at 50 meters or even lesser depths, and the "M a u d"-Expedition found it in great numbers as shallow as only 23 meters in depth.

Most of the finding places, however, show far greater depths, and the species has been met with in the "cold area" even at 2000 metres. In Davis Strait JUNGERSEN (1915) states its lower limit as 1435 fathoms (2630 metres). The locality, the exact position of which has not been stated, must evidently be situated in Atlantic water layers with temperatures above the frezing point.

A single record *("Paraspongodes clavata")* from the Azores at 927 meters depth together with some localities off the American Atlantic coast point to a yet larger habitat in deeper parts of the oceans than that given in fig. 9. JUNGERSEN (1915) says (in translation): "It is moreover possible that more related forms now figuring in literature under separate genus- and species-names, will turn out to be identical with *Eunephthya fruticosa,* and in this case the habitat of the latter will become much larger than stated here, perhaps including parts of other oceans. At present, however, it is impossible to say more about it than the supposition stated.". These words also today fairly well cover the state of our knowledge, and a revision of related species from other parts of the oceans is needed, if we shall be able entirely to clear up the biogeography of *Eunephthya fruticosa.*

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(A full citation of the older works is found by KÜKENTHAL 1907, and JUNGERSEN 1916 b).

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The following volumes are planned:

Vol. I. **Special reports.**

No. 1. H. U. Sverdrup: *General Report of the Expedition.* (In preparation).
„ 2. Christian Jensen: *The "Maud".* (In preparation).
„ 3. H. U. Sverdrup: *Results of Astronomical Observations.* (1928). Kr. 3.50.
„ 4. Kr. Lous: *Determination of Longitude by the Azimuth of the Moon.* (1928). Kr. 1.00.
„ 5. Finn Malmgren: *On the Properties of Sea-Ice.* (1928). Kr. 4.50.
„ 6. R. Wesøe: *Aurora Photographs.* (1928). Kr. 3.50.

— Ia. H. U. Sverdrup: *Magnetic, Atmospheric-electric and Auroral Results, Maud-Expedition 1918—1925.* Extracted from Publication No. 175, Vol. VI, of the Carnegie Institution of Washington, pages 309 to 524. Published October 1927.

— II and III. **Meteorology.** Under preparation by H. U. Sverdrup.

— IV. **Oceanography.**

No. 1. H. U. Sverdrup: *The Wind-Drift of the Ice on the North Siberian Shelf.* (1928). Kr. 4.00.

Contributions from Finn Malmgren † and H. U. Sverdrup (Results of Oceanographic Observations) and from J. E. Fjeldstad (Tidal Observations and Theory of tidal Currents in a progressive tidal Wave) under preparation.

— V. **Biology, Mineralogy and Etnography.**

A number of papers dealing with the results from the various collections of the Expedition under preparation.

The following papers have been completed:

No. 4. James A. Grieg: *Echinodermata from the Siberian Arctic Ocean.* (1928).
„ 5. T. Soot-Ryen: *Diptera from Arctic Siberia.* (1928).
„ 6. H. Tho. L. Schaanning: *Birds from the North-Eastern Siberian Arctic Ocean.* (1928).
„ 7. Hjalmar Broch: *Alcyonarians with a systematic-biogeographical discussion of the northern Eunephthya-species.* (1928).
„ 20. Ole T. Grønlie: *Fossil and subfossil Shells from "Maud-havn" and environs.* (1928).

The single papers are to be distributed by the Institution which has prepared them for publication and the complete volumes are when finished to be distributed from the Bergen Museum.

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