STEPHANOSCYPHUS
(SCYPHOZOA)

By P. L. KRAMP
Zoological Museum, Copenhagen

Numerous specimens of the scyphozoan polyps *Stephanoscyphus* were collected by the Galathea Expedition in 33 localities in the Atlantic, Indian and Pacific Oceans. Careful examination and measurements show that they all belong to one species, *Stephanoscyphus simplex* Kirkpatrick, with the exception of some few specimens from shallow water in the Macassar Strait and South China Sea, which I refer to *S. corniformis* Komai.

Provisionally we must retain *Stephanoscyphus* as a generic name for all the various species of scyphopolyps with a horny and annulated or rugose perisarc tube. We know that *S. mirabilis* Allman and *S. racemosus* Komai, which is probably the same species, give origin to coronate medusae of the genus *Nausithoë;* the medusae of the other species are unknown and may belong to different genera; but as long as we do not know the medusae, we must classify the polyps as belonging to one genus, *Stephanoscyphus.*

Young specimens of the medusa of *S. simplex,* ready for liberation, will be described below. These medusae evidently belong to the Coronatae; they are very similar to the young stages of *Nausithoë punctata,* but the generic and specific affinity cannot be stated.

The present large collection has enabled me to carry out a revision of the species with a solitary, unbranched tube. A very valuable account of all the species known up to now is given by E. LELOUP (1937). I have found, however, that some of the distinctive features of the species are due to individual variation. First of all, the presence or absence of internal chitinous processes in the tubes are of no specific importance, whereas the shape and structure of such processes may exhibit some characteristic features which justifiy a separation of species.

LELOUP's account comprises the following species:

With branched colonies: *S. mirabilis* Allman 1874 (= *Spongicola fistularis* Schultze 1877), *S. allmani* Kirkpatrick 1890, *S. racemosus* Komai 1936, and *S. komaii* Leloup 1937. I shall not enter into a discussion of the reliability of these species, since they are not represented in the present collection.

With solitary polyps: *S. striatus* (Vanhöffen 1910) and *S. sibogae* Leloup 1937. These, and possibly also *S. bianconis* Thiel 1936, are identical with *S. simplex* Kirkpatrick 1890, and this latter is a distinct species and not a synonym of *S. mirabilis* Allman as supposed by LELOUP. *S. corniformis* Komai 1936 is likewise an independent species as will be demonstrated below, and not a synonym of *S. mirabilis.*

The two species, *S. simplex* and *corniformis,* are characterized by their solitary tubes which are attached to the substratum by a small button-like pedal disk. I have seen several specimens of *S. corniformis* and nearly 1000 specimens of *S. simplex* and I may state with certainty that the solitary habit is an absulutely constant feature; the pedal disk never shows the slightest indication of producing stolonial outgrowths from which other polypoid individuals might be developed. In this regard these species are quite distinct from the stolonial colonies of *S. mirabilis* as described by ALLMAN. There is no reason to believe that the absence of stolons is due to the polyps being attached to objects with a clean surface and not embedded in sponges like *S. mirabilis* and *racemosus.* When occasionally a tube of *S. simplex* seems to carry one or more lateral branches, it is simply because one or more specimens have attached themselves to the tube of another specimen and chosen it as substratum. There is no organic communication between them. *S. simplex* and *corniformis* are purely solitary species.

S. striatus and *bianconis* differ from *simplex* and *corniformis* merely by the absence of internal processes. In a previous paper (KRAMP 1951 p. 124)

I described some specimens of *S. simplex* from deep water in the Atlantic Ocean and expressed the opinion that the internal processes "do not seem to be of specific importance", and this supposition is confirmed by the examination of the numerous specimens in the Galathea collection. In every locality I have found a great variability in the number of internal processes.

Also in other respects the specimens are very variable. The rings of the annulated tube may be more or less prominent, with more or less sharp edges, close together or more or less distant, and the longitudinal striation between the rings may be very distinct or only sligthly indicated.

The relation between *S. simplex,* which is a deep-sea species, and *S. corniformis,* which occurs in rather shallow water, will be discussed below.

Stephanoscyphus simplex Kirkpatrick

Pl. 1, figs. 1-11.

Stephanoscyphus simplex Kirkpatrick 1890 p. 14, Pl. 3 fig. 2.
Spongicola sp. Lo Bianco 1903 p. 269, Pl. 7 fig. 6.
Tubularia striata Vanhöffen 1910 p. 280, fig. 6.
Scyphistoma striatum Vanhöffen 1910, p. VII.
Stephanoscyphus bianconis Thiel 1936 p. 389, fig. 199 f.
In part *Stephanoscyphus mirabilis* Leloup 1937 p. 60.
Stephanoscyphus striatus Leloup 1937 p. 64.
Stephanoscyphus sibogae Leloup 1937 p. 67, fig. 43.
Stephanoscyphus simplex Kramp 1951 p. 123, Plate figs. 4-5.

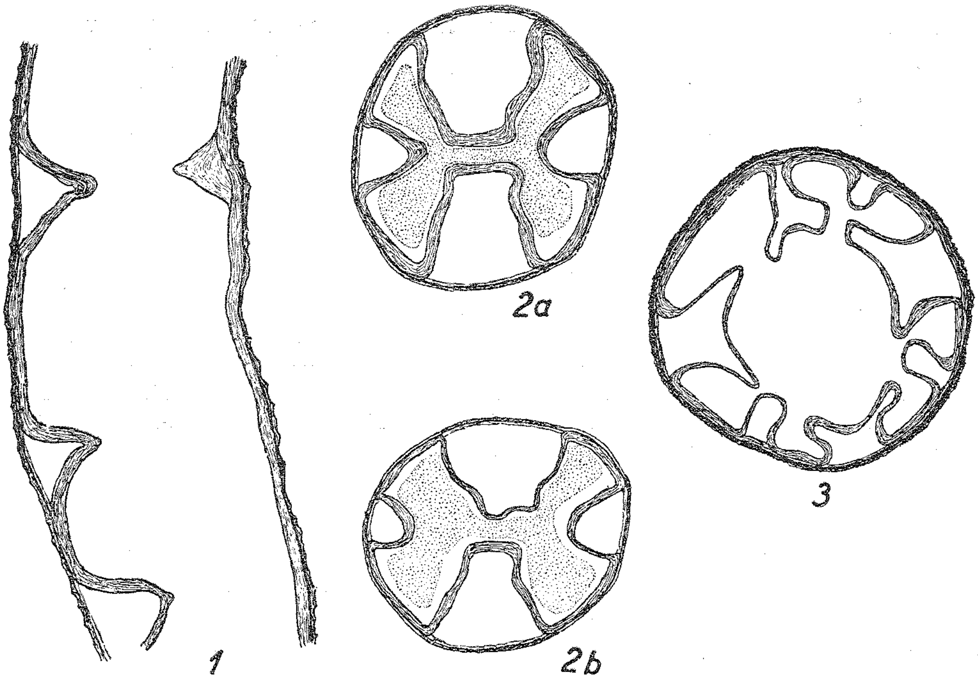
Description of the specimens in the Galathea collection

The chitinous tube. – In the majority of the numerous specimens observed the tube is less than 15 mm in length, but some few are up to 20 mm, one specimen even 28 mm long. It is evenly increasing in width from a very narrow base towards the terminal aperture. The ratio between the diameter of the aperture and the length of the tube is variable, usually between 0.10 and 0.16, exceptionally as much as 0.20-0.25; the average ratio is 0.13. The tube is generally slightly curved, though sometimes almost straight; irregular curvature may also occur. It is attached to the substratum by a small button-like pedal disk, usually circular in outline (Pl. 1, figs. 1-3), rarely slightly lobated. The pedal disk is hollow, traversed by irregular trabeculae (Pl. 1, fig. 4); the cavities contain prolongations from the living tissues of the polyp.

The external wall of the tube is annulated, divided into numerous rings, more or less prominent and with more or less sharp edges; the distance between the rings is likewise very variable as seen in the two tubes in figs. 1 and 2 which are from the same sample (stat. 471). A longitudinal striation is usually seen in the spaces between the rings, but also in this respects the variation is very considerable.

The wall of the tube consists of two layers (see text-figs. 1-3). The external layer is thin, and the annulation only comprises the outer surface of this layer, whereas its inner surface is smooth (see the longitudinal section in fig. 1). The inner layer is quite smooth, very thick in the lowermost portion of the tube, decreasing upwards and very delicate near the aperture. The growth of the tube evidently takes place in a similar way as that described by Komai (1935 p. 309) in *S. racemosus:* The uppermost part of the body of the polyp "which may be termed neck, has a thick epidermis, which contains numerous granular and clear gland cells . . . It is evident that the epidermis of this region plays an important part in the secretion of the periderm. The growth in length of the theca is apparently due to the secretion of new rings from this part, while the growth in thickness is brought about by the addition of new substance to the periderm by the more proximal part of the epidermis of the tube." Apparently the external, annulated layer of the chitinous tube is once and for all secreted by the "neck", whereas this part of the body is of very slight importance for the formation of the inner layer, which continually increases in thickness by secretion from glands in the entire length of the body-wall. This may account for the solidity of the lower portion and the delicacy of the upper portion of the tube.

The formation of the hollow internal processes is difficult to explain. They are figured in longitudinal section in text-fig. 1 and in transverse sections in text-figs. 2-3. The variation in number of these peculiar structures will be discussed below. They are arranged in distinct whorls of usually four large invaginations, placed cross-wise, and sometimes a small one in the middle of each space. The external layer does not take part in the formation of the invaginations, which are fissures in the internal perisarc layer expanding so as to form large, empty



Figs. 1-3. *Stephanoscyphus simplex.*
Fig. 1. Longitudinal section of the theca; stat. 279.
Fig. 2a-b. Transverse sections of the theca at the levels of two whorls of internal processes; stat. 279.
Fig. 3. Transverse section of a theca with small secondary internal processes between the four large ones; stat. 436.

cavities projecting into the central room of the tube (text-figs. 2 and 3). The shape of the processes is somewhat variable (see the figures), and they may project more or less deeply into the cavity of the tube; but in this species they have a broad or fairly broad base (in contradistinction to *S. corniformis,* see below), and they are frequently broader in transversal than in longitudinal direction (see Pl. 1, figs. 5 and 6, which present two successive whorls of one specimen, in which the tube has been cut open and spread out flat). The soft tissues of the body fill out the spaces between the processes and must attain a shape in accordance herewith. The number of whorls may amout to 14 but is usually much smaller, and some specimens have none at all. In one and the same specimen the whorls are not equidistant but separated by unequal distances. The distal portion of the tube is destitute of internal processes, but the distance from the uppermost whorl to the aperture of the tube is very variable.

Variation (Tables I-IV and text-figs. 4-5). Numerous specimens from different geographical areas and different depths have been examined in order to see, whether any correlations between various structural features might be pointed out. In all respects the variation is considerable, and it is evident that in all respects there is an even transition between specimens of both extremities, from which we may safely draw the conclusion that they all belong to one species.

Table I immediately shows that the limits of variation of the length of the tube and the number of whorls of internal processes is very nearly the same at all depths. We may be allowed, therefore, to draw general conclusions from the observations illustrated in the following tables.

Table II gives the ratio of the diameter of the terminal aperture and the length of the tube. It will be seen that in the vast majority of the specimens the ratio is between 0.10 and 0.16, whereas divergences beyond these limits are rare. I have thought of the possibility that the variation of the longitudinal striation might show a correlation with the width of the tube, so that a particularly distinct and dense striation might occur in tubes of particularly slender shape, but no such correlation can be discerned.

Table III and text-fig. 4 show, as might be expected, that the average number of whorls of internal processes is increasing with the length of the tubes, but the table also shows that within each group of length the number of whorls is very variable.

Table IV. With the increasing thickness of the walls of the tube the colour changes from a light yellowish shade to a more or less dark brown. Notes have been made on the shades of colour in numerous specimens. The results cannot be expressed in exact figures, but some notion of the significance of the colour may be obtained by means of the percentage number of specimens which may

Variation in **Stephanoscyphus simplex**

Table I. Length of tubes and number of whorls of internal processes in specimens from different depths.

Depth, m	580-1000	1000-2000	2000-3000	3000-4000	4000-5000	5000-6000	6000-7000
Number of specimens examined........	200	1	95	15	150	11	120
Length of tubes, mm	2-21	5	4-17	2-10	2-13	2-12	3-15
Number of whorls of internal processes .	0-13	5	0-8	0-9	2-14	0-7	0-13

Table II. Ratio of terminal diameter and length of tube, d/l.

d/l	0.08	0.10	0.12	0.14	0.16	0.18	0.20	0.22	0.24	average 0.13
Number of specimens	7	20	39	32	27	0	5	1	1	

Table III. Correlation between length of tubes and number of whorls of internal processes.

Number of specimens examined.....	4	12	9	14	17	17	8	8	5	2	2	2	2
Length of tubes, mm	3	4	5	6	7	8	9	10	11	12	13	14	15
Number of whorls	0	0-5	0-3	0-7	0-4	0-7	0-9	0-9	3-10	1-3	1-13	8	4-9
Average number of whorls	0.0	1.0	1.1	1.9	1.9	3.1	4.7	5.0	6.8	1.5	6.5	8.0	6.5

Table IV. Proportion of dark tubes to length of tubes and number of whorls of internal processes.

Average length of tubes, mm	6.1	6.8	8.9	8.8	11.6	12.0
Number of whorls	0-1	2-3	4-5	6-7	8-9	10-13
Percentage number of dark tubes ..	12	22	44	91	100	100

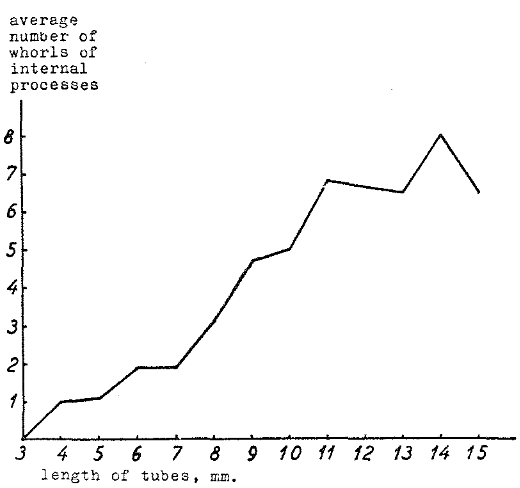


Fig. 4

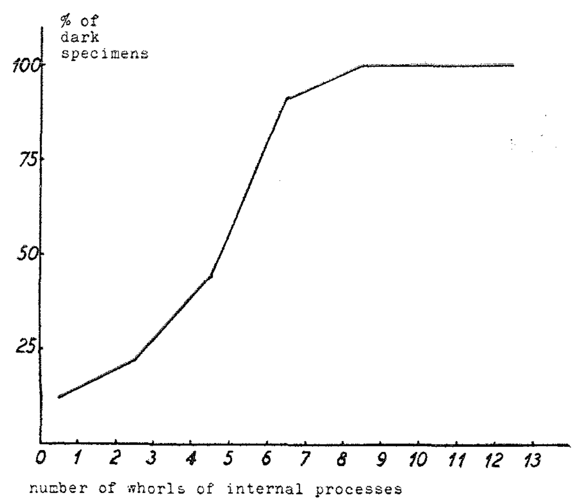


Fig. 5

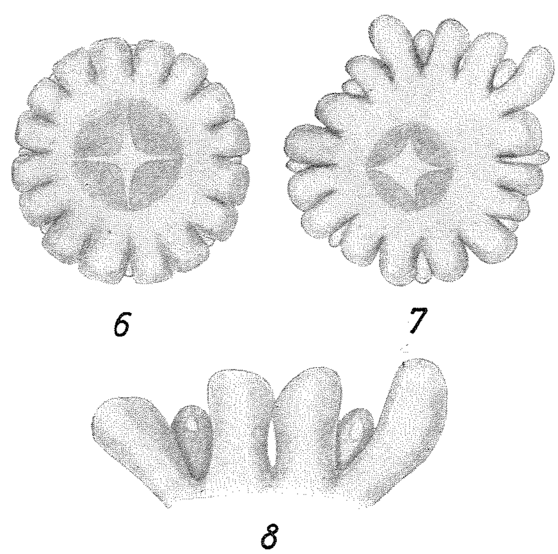
Variation in *Stephanoscyphus simplex*

be designated as "dark". Also in this respect the variation is considerable, but Table IV clearly shows that a dark colour is mainly found in the longest tubes. A particularly distinct correlation is shown between the colour and the number of whorls of internal processes; in the majority of the specimens with 6-7 whorls and in all specimens with more than 8 whorls the chitinous walls of the tube have a dark colour. This is further illustrated in the curve in fig. 5. That means that new whorls are continually added to the previous ones during the life of the polyp. The way of formation of the processes seems rather puzzling; it may have some connection with the strobilation, but since I have seen only one specimen in the act of producing medusae, I cannot state anything with certainty in this respect.

The soft tissues of the polyp. In the majority of the specimens hauled from the cold deep water through the warm surface layers the soft tissues were decomposed, usually quite destroyed, so that only the empty tubes were secured; but in one locality (stat. 279) the tissues were retained in some of the specimens, apparently in good condition, and I immediately preserved these specimens in Bouin's fluid. When later on I cut them into sections I found, however, that the fixation was very unsatisfactory. I ought perhaps to have cut open the tubes before the treatment with the fixative, though it is also possible that the tissues were already in a beginning state of decomposition. Some other specimens simply preserved in 70 % alcohol (stat. 436) were in a much better condition. They were not suitable for examination of minute histological details, but they give an impression of the general structure of the body (Pl. 1, figs. 7-11). Pl. 1, fig. 4 is an oblique section of the pedal disc, showing remnants of the tissues between the chitinous trabeculae. In the other figures the four taenioles are seen in transverse sections. They are quite distinct, each of them surrounded by a layer of muscular strands, and they contain numerous nuclei and some few nematocysts. In the section of the narrow pedicel of the polyp (Pl. 1, fig. 7) two of the taenioles are very thin, whereas the two others are rather wide even in this basal part of the body. In the parts between the whorls of internal processes (Pl. 1, figs. 8 and 9) the taenioles have a circular outline in transverse section, but at the levels of the processes they are more or less compressed and disfigured (Pl. 1, figs. 10 and 11). The endodermal epithelium of the stomach cavity is more or less mutilated. No successful sections have been made through the upper portions of the polyps, and tentacles are not observed.

The medusa. In one of the speimens at stat. 436 (among the Philippine Islands, 710 m) several small medusae had recently been liberated from the polyp and were found in the distal portion of the tube (Pl. 1, fig. 3). They are all in the same stage of development, about 0.3 mm wide in their contracted condition (text-figs. 6-8). They have eight deeply cleft marginal lappets, each with a prominent sensory club as seen in the figures. The stomach may be discerned through the exumbrella. In all essential features they resemble newly liberated specimens of *Nausithoë punctata* and may belong to the same genus, of which three bathypelagic species are known, but it would be premature to put forward any opinion on their affinity, beyond the fact that they evidently belong to the order Coronatae.

The polyp had withdrawn into the lower portion of the tube as far as to the level of the uppermost of the four whorls of internal chitinous processes, which leads me to presume that the formation of these processes has some connection with the strobilation, but the tissues of the terminal part of the polyp were not in a condition suitable for anatomical examination. Unfortunately no other specimens were observed in the act of strobilation.



Figs. 6-8. Medusae of *Stephanoscyphys simplex* removed from the theca of a specimen from stat. 436, aboral views. In fig. 7 two of the marginal lappets are expanded.

Occurrence of Stephanoscyphus simplex
(see the map, fig. 9).

Stat. 99. Off Angola, 8°40'S. 11°10'E. 11. Dec. 1950. Depth about 2690 m. Yellowish clay. Bottom temp. c. 3.9°C.[1] 9 specimens on living lamellibranchs.

Stat. 182. Off South-East Africa, 33°28'S. 38°32'E. 27. Jan. 1951. Depth 5110-5340 m. Bottom temp. c. 0.7°C. 1 specimen, on pumice.

Stat. 196. Off Durban, 29°55'S. 31°20'E. 14. Feb. 1951. Depth 430 m. Bottom temp. c. 8.3°C. 40 specimens, on a calcareous tube.

Stat. 202. Off Durban, 25°20'S. 35°17'E. 21. Feb. 1951. Depth 590 m. Bottom temp. c. 7.4°C. 28 specimens, on living gastropods and one on a piece of slag.

Stat. 234. Off Mombasa, 5°25'S. 47°09'E. 10. March 1951. Depth 4800 m. Bottom temp. c. 1.8°C. About 110 specimens.

Stat. 279. East of the Maldive Islands, 1°00'N. 76°17'E. 8. April 1951. Depth 4330 m. Bottom temp. c. 1.3°C. About 60 specimens, on pumice.

Stat. 280. East of the Maldive Islands, 1°56'N. 77°05'E. 9. April 1951. Depth 4350 m. Bottom temp. c. 1.3°C. 17 specimens.

Stat. 281. South-west of Ceylon, 3°38'N. 78°15'E. 10. April 1951. Depth 3310 m. Bottom temp. ca. 1.8°C. About 20 specimens, partly on living lamellibranchs.

Stat. 299. Bay of Bengal, 17°10'N. 84°30'E. 24. April 1951. Depth 2820 m. Bottom temp. c. 1.7°C. About 90 specimens, on shells and pieces of coal and slag.

Stat. 314. Bay of Bengal, 15°54'N. 90°17'E. 3. May 1951. Depth 2600 m. Bottom temp. c. 1.7°C. 8 specimens.

Stat. 408. South China Sea, 12°47'N. 116°24'E. 4. July 1951. Depth 4330 m. Globigerina ooze. Bottom temp. c. 2.5°C. 5 specimens, on pebbles.

Stat. 423. East of Cebu, Philippines, 10°27'N. 124°18'E. 25. July 1951. Depth 810 m. Bottom temp. c. 10-11°C. About 60 specimens, on sponges *(Farrea)*, wooden pegs, and shells of living gastropods and lamellibranchs.

Stat. 436. East of Cebu, Philippines, 10°12'N. 124°14'E. 9. August 1951. Depth 710 m. Green mud. Bottom temp. c. 10-11°C. About 60 specimens, on stones, slag, pieces of wood and shells of gastropods and lamellibranchs.

Stat. 437. East of Cebu, Philippines, 10°19'N. 124°01'E. 10. August 1951. Depth 784 m. Bottom temp. c. 10-11°C. About 50 specimens.

Stat. 443. Mindanao Sea, 8°48'N. 124°09'E. 16. August 1951. Depth 1500 m. Mud. Bottom temp. c. 10°C. 4 specimens, on a calcareous tube and living lamellibranchs.

Stat. 450. Celebes Sea, 1°50'N. 119°20'E. 21. August 1951. Depth 4940-4970 m. Bottom temp. c. 3.8°C. 8 specimens, on stones.

Stat. 471. Sunda Trench, 10°26'S. 114°15'E. 10. Sept. 1951. Depth 2990-2810 m. Bottom temp. c. 1.7°C. 11 specimens.

Stat. 497. Banda Trench, 5°18'S. 131°18'E. 23. Sept. 1951. Depth 6490-6650 m. Soft clay. Bottom temp. 3.6°C. 32 specimens, on polychaet tubes.

Stat. 574. Tasman Sea, 39°45'S. 159°39'E. 18. Dec. 1951. Depth 4670 m. Bottom temp. c. 1.2°C. 21 specimens.

Stat. 601. Tasman Sea, 45°51'S. 164°32'E. 14. Jan. 1952. Depth 4400 m. Bottom temp. 1.15°C. 16 specimens.

Stat. 626. Tasman Sea, 42°10'S. 170°10'E. 20. Jan. 1952. Depth 610 m. Globigerina ooze. Bottom temp. c. 8°C. 20 specimens.

Stat. 650. Kermadec Trench, 32°20'S. 176°54'W. 15. Jan. 1952. Depth 6620-6730 m. Clay with pumice. Bottom temp. 1.3°C. About 50 specimens, on pebbles.

Stat. 651. Kermadec Trench, 32°10'S. 177°14'W. 16. Feb. 1952. Depth 6960-7000 m. Clay with pumice. Bottom temp. 1.3°C. About 45 specimens.

Stat. 653. Kermadec Trench, 32°09'S. 176°35'W. 17. Feb. 1952. Depth 6180 m. Clay with pumice. Bottom temp. 1.3°C. 35 specimens.

Stat. 654. Kermadec Trench, 32°10'S. 175°54'W. 18. Feb. 1952. Depth 5850-5900 m. Clay with pumice. Bottom temp. 1.2°C. 15 specimens, on pumice.

Stat. 661. Kermadec Trench, 36°07'S. 178°32'W. 23. Feb. 1952. Depth 5340 m. Bottom temp. 1.1°C. 4 specimens.

Stat. 663. Kermadec Trench, 36°31'S. 178°38'W.

1. Some of the temperatures are derived from observations in neighbouring localities.

24. Feb. 1952. Depth 4410 m. Sandy clay. Bottom temp. c. 1.2°C. 1 specimen, on a living lamellibranch.

Stat. 664. Kermadec Trench, 36°34'S. 178°57'W. 24. Feb. 1952. Depth 4540 m. Clay and pumice. Bottom temp. 1.1°C. 7 specimens, on living lamellibranchs, and on pumice.

Stat. 716. Off Nicaragua, 9°23'N. 89°32'W. 6. May 1952. Depth 3590 m. Dark clay. Bottom temp. 2.0°C. 11 specimens, on living lamellibranchs.

Stat. 724. Gulf of Panama, 5°44'N. 79°20'W. 12. May 1952. Depth 3190-2950 m. Dark clay and stones. Bottom temp. 2.0°C. 3 specimens.

Stat. 726. Gulf of Panama, 5°49'N. 78°52'W. 13. May 1952. Depth 3670 m. Clay. Bottom temp. c. 2.0°C. 1 specimen, on pumice.

Previous records

Atlantic Ocean: 56°11'N. 37°41'W., 2650 m (Kirkpatrick 1890). 28°25'N. 61°05'W. to 28°05'N. 60°49'W., 5500-5987 m; 24°12'N. 63°23'W. to 24°28'N. 63°18'W., 5850-5860 m; 2°26'N. 39°26'W. to 2°24'N. 39°12'W., 4474-4430 m (Kramp 1951). Near the Azores, 38°20'N. 28°04'45" W., 1500 m; 38°35'30"N. 28°05'45"W., 1250 m (Leloup 1937).

Mediterranean: Near Capri, Italy, 950-1000 m (Lo Bianco 1903, Thiel 1936).

Indian Ocean: Somali Coast, 6°19'N. 49°32'5 E., 1079 m (Vanhöffen 1910).

Antarctic Ocean: about 65°S. 85°E., 2450 m (Vanhöffen 1910).

Malayan Archipelago: North of Soembawa, 794 m (Leloup 1937).

Horizontal distribution

As will be seen from the lists above, our knowledge of the geographical distribution of *Stephanoscyphus simplex* has been greatly augmented by the collections of the Galathea Expedition. The localities in the Atlantic Ocean are still few and scattered. The occurrence in the Indian sector of the Antarctic Ocean *(S. striatus* Vanhöffen) may seem very isolated but is easily explained by the hydrographical conditions which will be discussed below. In the tropical parts of the Indian Ocean it was taken only once before, but the "Galathea" found it in

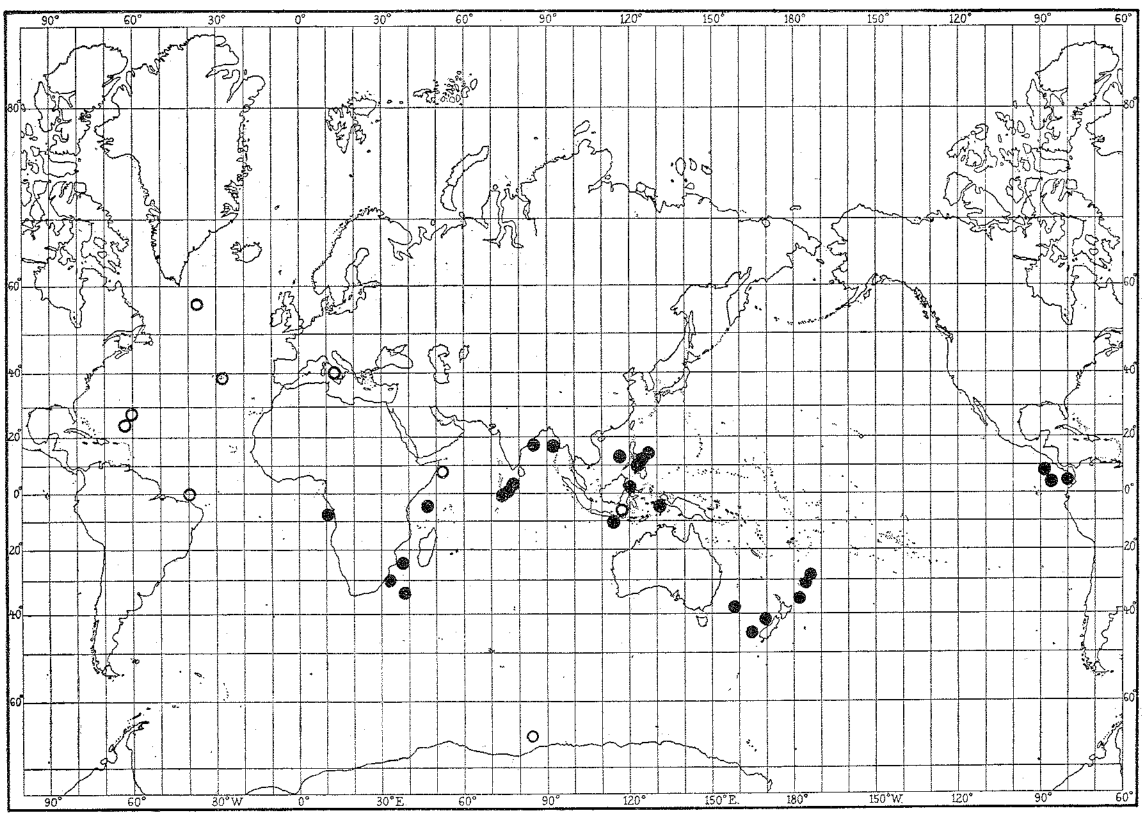


Fig. 9. Geographical distribution of *Stephanoscyphus simplex*. ● Localities where the species was collected by the "Galathea" Expedition. o Previous records.

Table V. *Stephanoscyphus simplex*. General survey of the vertical distribution and relation to temperature.

Depth, m	Temperature, °C.							Total
	< 1°	1-2°	2-3°	3-4°	4-6°	6-10°	> 10°	
430- 500						1/6		1/6
500-1000					1/?	2/48	3/170	6/218 +
1000-2000					2/?	1/?	1/4	4/4 +
2000-3000	1/?	3/109		2/9 +				6/118 +
3000-4000		3/34						3/34
4000-5000		8/233	1/5					9/238
5000-6000	1/1	2/19	2/4	1/8				6/32
6000-7145		3/130		1/32				4/162
Total.	2/1 +	19/525	3/9	4/49 +	3/?	4/54 +	4/174	
Grand total . . .	28/584 +				7/54 +		4/174	

Fat types: number of localities.
Light types: approximate number of specimens.

eleven localities from the east coast of Africa to the Java Deep. It was more or less abundant in six localities in the Malayan Archipelago, from where it was recorded only once before (*S. sibogae* Leloup). Moreover it was taken in three localities in the Tasman Sea and in seven of the hauls made in the Kermadec Trench, usually in considerable number. Of particular interest is the occurrence in the eastern tropical Pacific, where several specimens were found in three localities which were inhabited by an extraordinarily rich fauna of many other kinds of animals. *Stephanoscyphus simplex* thus seems to have an almost cosmopolitan distribution in the deep parts of all the oceans, except in the arctic basins.

Vertical distribution and relation to temperature

The total extent of vertical distribution of *Stephanoscyphus simplex* is very considerable, ranging from 430 to 7000 m at temperatures from slightly above 0° to 10 or 11°C, perhaps even to 13°, if the Mediterranean form *S. bianconis* belongs to the same species. There is no doubt, however, that *S. simplex* has its principal occurrence in the abyssal region at temperatures below 4°, from which it may descend into the hadal and, under certain conditions, ascend into the bathyal region, where it is exposed to higher temperatures.

A general survey of the occurrence is given in Table V comprising all records known up to now, including those derived from previous literature. For each depth and temperature is given the number of localities (fat types) and the entire number (actual or approximate) of specimens found in these localities (light types). The number of specimens taken in a single haul with the trawl or dredge is, of course, rather accidental and may not be considered as a reliable expression of the abundance of the species in the locality in question. Nevertheless, the total number found under equal conditions (depth and temperature) may serve to give a general impression of the multitude as compared with the multitude under other conditions.

It immediately appears from the table that by far the most catches are from depths exceeding 2000 m and temperatures below 4° (28 localities with nearly 600 specimens, of which 19 localities with more than 500 specimens at temperatures between 1 and 2°). The considerable number of specimens found in the four localities with the highest temperature (above 10°) needs special consideration. The predominance in the deep, cold waters is evident.

At any rate, one must bear in mind that shallow and intermediate depths are much more thoroughly investigated than the deep-sea areas. Were the species equally common at intermediate depths, as compared with the abyss, it would invariably have been found there in much greater quantities.

It is also evident that this species prefers low temperatures, but it does not occur in shallow water, even if the temperature is low. It must therefore be designated as a predominantly stenobathic species. Its preference of low temperatures also marks it as a species with a low temperature preference, but in this regard it is more adaptive than many other abyssal animals, since it may occur at temperatures several degrees above the optimal.

Origin[1]	Locality	Depth	Temp.	Number of specimens
"Gauss"	Antarctis	2450 m	0-0.2°	unknown
G. St. 182	S. E. of Africa	5110-5340 m	0.7°	1
"Albatross"	N. E. of Brazil	4474-4430 m	1.3°	3
G. St. 279	E. of Maldive Isls.	4330 m	1.3°	60
G. St. 280	–	4350 m	1.3°	17
G. St. 574	Tasman Sea	4670 m	1.2°	21
G. St. 601	–	4400 m	1.15°	16
G. St. 650	Kermadec Trench	6620-6730 m	1.3°	50
G. St. 651	Kermadec Trench	6960-7000 m	1.3°	45
G. St. 653	–	6180 m	1.3°	35
G. St. 654	–	5850-5900 m	1.2°	15
G. St. 661	–	5340 m	1.1°	4
G. St. 663	–	4410 m	1.2°	1
G. St. 664	–	4540 m	1.1°	5
G. St. 234	off Mombasa, E. Africa	4800 m	1.8°	110
G. St. 281	S. W. of Ceylon	3310 m	1.8°	20
G. St. 299	Bay of Bengal	2820 m	1.7°	90
G. St. 314	–	2600 m	1.7°	8
G. St. 471	Sunda Trench	2990-2810 m	1.7°	11
G. St. 716	off Nicaragua, E. Pacific	3590 m	2.0°	11
G. St. 724	Gulf of Panama –	3190-2950 m	2.0°	3
"Albatross"	W. Atlantic	5500-5987 m	2.1°	3
–	–	5850-5860 m	2.1°	1
G. St. 408	South China Sea	4330 m	2.5°	5
Kirkpatrick	N. Atlantic	2650 m	3°	unknown
G. St. 99	off Angola, W. Africa	2690 m	3.9°	9
G. St. 450	Celebes Sea	4940-4970 m	3.8°	8
G. St. 497	Banda Trench	6490-6650 m	3.6°	32
Prince of Monaco	Azores	1500 m	5°	1
–	–	1250 m	6°	1
"Siboga"	Flores Sea, Indonesia	794 m	5°	several
G. St. 202	off Durban, S. E. Africa	590 m	7.4°	28
G. St. 196	off Durban, S. E. Africa	430 m	8.3°	40
G. St. 626	W. of New Zealand	610 m	8°	20
G. St. 423	E. of Cebu, Philippines	810 m	10-11°	60
G. St. 436	– –	710 m	10-11°	110
G. St. 443	Mindanao Sea, –	1500 m	10°	4

1. G. = "Galathea".

Table V gives only a rough outline of the occurrence of the species. The above complete list of the available records allows a more detailed analysis. In this list the localities are grouped according to the bottom temperatures. Some of these are actual observations, others are estimated from observations in neighbouring localities. In some instances the number of specimens is likewise approximate.

Occurrence below 1°C. – In very cold water, below 1°, the species was found by the German South Polar Expedition near the Indian sector of the Antarctic Continent ("*Tubularia striata*" Vanhöffen). Observations of the bottom temperature in this locality are not available to me, but from a not very distant "Discovery" station we may presume that at the depth of 2450 m, where the polyp was taken, the temperature has been slightly above 0°. The icy cold antarctic bottom water moves downwards along the slope of the continent and is overlayered by the "warm deep water" penetrating southwards from the Indian Ocean, and the locality, where the polyp was found, must be in the lower part of this body of water. "Galathea" stat. 182 is south-east of Africa, depth 5110-5340 m, where the temperature of the bottom, 0.7°, is influenced by the antarctic bottom water moving towards the east and north.

1-2°. – Among the 19 localities with temperatures between 1 and 2° is one from the western Atlantic; the others are scattered across the Indian and Pacific Oceans at depths between 2600 and 7000 m, and in several of these localities the polyps were taken in considerable numbers. The three localities with slightly higher temperatures, 2.1-2.5°, may conveniently be discussed in this same connection; two of them are in the deep western part of the Atlantic Ocean, between 5500 and nearly 6000 m ("Albatross") the third in the South China Sea, 4330 m. These extensive areas constitute the principal habitat of the abyssal species *S. simplex*. In the Kermadec Trench it was found to descend somewhat into the hadal region, as far down as 7000 m, and it was even fairly abundant in these great depths ("Galathea" stat. 650-653). Presumably, however, it is not a regular inhabitant of the hadal region (the depths exceeding 6000 m in the trenches); it was not taken in the two deepest hauls in the Kermadec Trench, 7630 and 8200-8300 m, and it was completely absent in the New Britain Trench where three hauls were made, all of them at depths exceeding 8800 m, and in the Philippine Trench, where no hauls were made in less than 10000 m. On the other hand, it might have been expected to occur in the Sunda Trench south of Java, where several hauls were made between about 3000 and 7300 m, but it was only taken in one of these hauls, the shallowest one, 2990-2810 m (stat. 471). Numerous animals belonging to the abyssal region have a cosmopolitan distribution, and this also applies to *S. simplex*. But since apparently it does not descend very far into the hadal regions, it does not contribute to a comparison between the hadal faunas of the different trenches.

3-4°. – *S. simplex* is still rather plentiful in the uppermost part of the abyssal region, at 3-4°, from which four records are known, two of them in the Atlantic Ocean, depth 2650-2690 m. The two others are from considerable depths, 4940-6650 m, in the Celebes and Banda Seas (stat. 450 and 497), yet at comparatively high temperatures, 3.8 and 3.6° respectively.

4-6°. – Records from areas with temperatures between 4 and 6° are very scanty; a few specimens have been found in two localities in the Atlantic near the Azores, 1250-1500 m, temp. about 6° and 5°. An interesting record is that from the Flores Sea north of the Indonesian island Soembawa, where the "Siboga" Expedition found several specimens ("*S. sibogae*" Leloup); the depth was only 794 m, the temperature about 5°. These records are interesting in so far as they establish a connection between the occurrences of the species in the abyssal region with temperatures below about 4° and the remarkable catches at much higher temperatures.

More than 7° but less than 10°. – Several specimens were found at stat. 202 off the south-eastern coast of Africa, 590 m, 7.4°, some few also at the neighbouring stat. 196, where the depth was only 430 m and the temperature as high as 8.3°. Further north, off Somaliland, the "Valdivia" Expedition found the same species at 1079 m, 8.2°. Under similar conditions it was found off the west coast of New Zealand, "Galathea" stat. 626, 610 m, temperature about 8°.

Above 10°. – Still more peculiar is the considerable abundance in which it occurred at the stations 423, 436, 437 and 443. All these are in the inland waters among the Philippine Islands at depths between 710 and 1500 m, where the temperature at the bottom is about 10-11°.

One might suspect that the specimens found in these comparatively warm bodies of water belonged to another species. Morphologically, however, they cannot be distinguished from abyssal specimens and, as mentioned above, specimens of the same appearance have been observed at intermediate temperatures connecting the high degrees among the Philippines with the low temperatures in the abyssal region.

Now, all these coastal areas, along the shelf of the East-African coast as well as in the sounds and basins between the Philippine Islands, are known to be inhabited by a very rich fauna. The nutritive conditions are certainly very favourable, and that may be the reason why an abyssal species like *S. simplex* is able to live and propagate in spite of the high temperatures prevailing there. High temperatures demand a vivid metabolism which can only be fulfilled, when considerable amounts of food are available.

Thus a closer analysis confirms the supposition that *Stephanoscyphus simplex* is a preferably abyssal species with a low temperature preference, but under certain conditions, especially under favourable food conditions, adaptive to the somewhat higher temperatures of the bathyal regions.

Stephanoscyphus corniformis Komai

Pl. 1, figs. 12-13.

Stephanoscyphus corniformis Komai 1936 pp. 175-183, figs. 1-4

in part *Stephanoscyphus mirabilis* Leloup 1937 p. 60

This species, which occurs in rather shallow water, is very similar to *S. simplex,* but differs from it in some respects. It was thoroughly described by KOMAI (1936), and some of the specimens recorded by LELOUP (1937) as belonging to *S. mirabilis* Allman most probably belong to the same species.

During the "Galathea" Expedition 10 specimens of *S. corniformis* were taken in the Macassar Strait (stat. 451); some others, from shallow water in the South China Sea (stat. 404), presumably also belonged to this species, but unfortunately the specimens have disappeared. Moreover the Danish "Atlantide" Expedition collected 7 specimens in the Gulf of Guinea.

Material:

"Atlantide" stat. 85. Gulf of Guinea, 5°37'N. 0°38'E. 30.I.1946, 50 m.

"Galathea" stat. 404. South China Sea, 5°09'N. 106°47'E. 30.XII.1951. 63 m. On a coral and a gastropod shell.

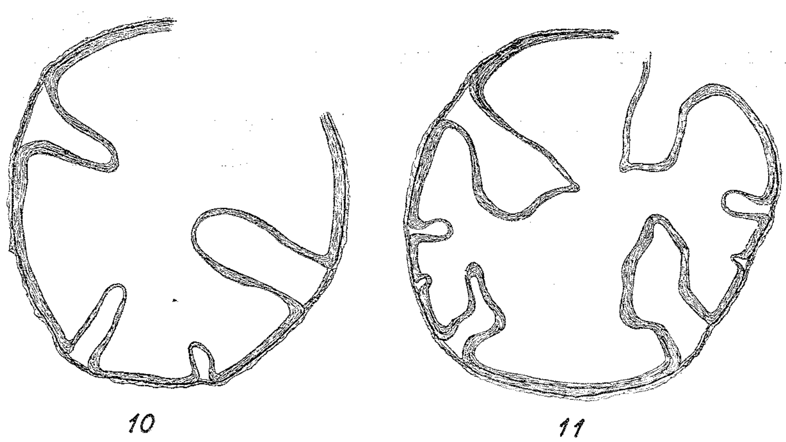
"Galathea" stat. 451. Macassar Strait, 1°25'S. 117°05'E. 23.VIII.1951. 60 m. On lamellibranch shells.

Remarks on the specimens.

S. corniformis is a solitary polyp attached to solid objects by means of a small button-like pedal disk. The tube is more or less curved, evenly increasing in width from a very narrow base to the terminal aperture. The length of the tube is usually less than 16 mm, but two of the specimens from the Macassar Strait are 22 and 24 mm in length. In the specimens 10-16 mm long the aperture is 0.8-1.1 mm wide, the ratio between the diameter af the aperture and the lenght of the tube varying between 0.06 and 0.10, average 0.075. The two largest specimens have a comparatively narrow aperture: length 22 mm, aperture 0.9 mm, ratio 0.04; length 24 mm, aperture 1.3 mm, ratio 0.054. Evidently, therefore, the tubes of this species are generally more slender than in *S. simples.*

The annulation and the longitudinal striation of the tube differ in no essential way from those in *S. simplex;* the edges of the rings are usually rather prominent and sharp.

The most important distinguishing feature between the two species is the shape of the internal chitinous processes. All the specimens of *S. corniformis* examined by me have several sets of these structures. Eash set consists of a whorl of four processes placed approximately at the same level, and frequently a number of additional, much smaller processes more or less irregularly scattered between the four primary ones (text-figs. 10-11, Pl. 1, figs. 12-13). In one very small specimen, 3 mm long, there is only one whorl, in the others the number varies between 3 and 9. In the Japanese specimens described by KOMAI the number of whorls was 7-10. In contradistinction to *S. simplex*, in which the processes have a broad base and frequently are broader in transversal than in longitudinal direction (see above, p. 3), the processes in *S. corniformis* are elongated in the longitudinal direction of the tube and have a narrow, almost slit-shaped base (see the figures, particularly, Pl. 1, fig. 13 which is an internal view of a part of the tube of a specimen from the Gulf of Guinea, cut open and spread out flat). KOMAI very adequately compared these processes in *S. corniformis* with the thorns of a rose.



Figs. 10-11. *Stephanoscyphus corniformis;* "Atlantide" stat. 85. Transverse sections of the theca at the levels of two whorls of internal processes.

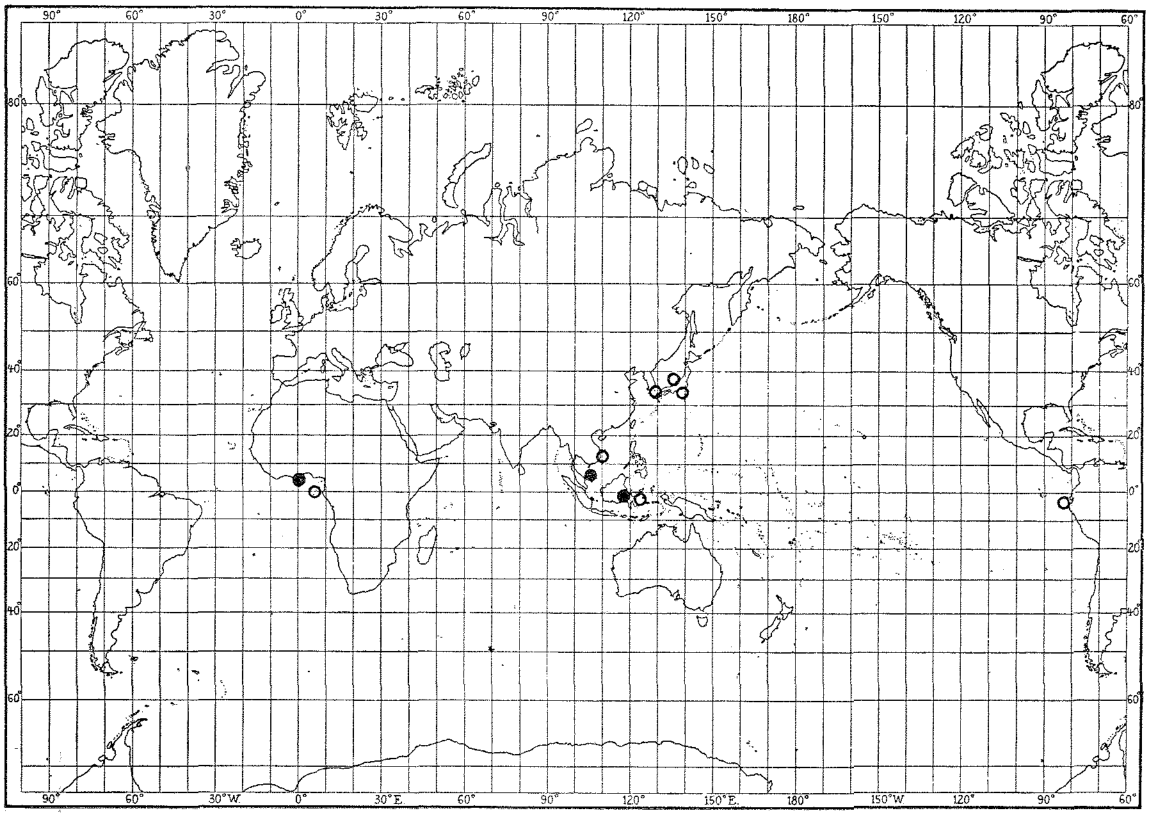


Fig. 12. Geographical distribution of *Stephanoscyphus corniformis*. • Localities where the species was collected by the "Atlantide" and "Galathea" Expeditions. o Previous records.

The number of whorls in the specimens examined are as follows

"Galathea" stat. 451		"Atlantide" stat. 85	
length of tube, mm	no. of whorls	length of tube, mm	no. of whorls
14	3-4	10	6
16	5-8	11	5
22	7	12	8
24	7	14	5
		16	9

The soft tissues of the polyps are not in a suitable condition for anatomical description.

Further distribution of S. *corniformis* (see the map, textfig. 12).

The original specimens described by KOMAI were found near the coasts of Hondo, Japan, at depths of about 58-91 m. Some specimens mentioned in a letter from Sir Sidney HARMER to prof. KOMAI probably belong to this species; they were collected by the "Siboga" in the Malayan Archipelago east of Celebes, depth 75-94 m; LELOUP has examined these specimens (1937 p. 61, fig. 30A) and referred them to *S. mirabilis* Allman. I am rather sure that the specimens recorded as *S. mirabilis* by LELOUP (p. 62) from the following localities should likewise be referred to *S. corniformis:* Ilheos das Rolas in the Gulf of Guinea (fig. 38B), Machalillo off the coast of Ecuador in South America, depth 10 m (fig. 38C), and off Nhatrang in Viet Nam, depth 40 m (figs. 38D, E).

The species thus seems to have a circumglobal distribution in tropical seas in comparatively shallow water, 10-94 m.

REFERENCES

ALLMAN, G. J., 1874: On the structure and systematic position of *Stephanoscyphus mirabilis,* the type of a new order of Hydrozoa. – Trans. Linn. Soc. London, Ser. 2, Zool., vol. 1.

KIRKPATRICK, R., 1890: Report upon the Hydrozoa and Polyzoa collected . . . in the China Sea. – Ann. Mag. Nat. Hist., Ser. 6, vol. 5.

KOMAI, T., 1935: On *Stephanoscyphus* and *Nausithoë.* – Mem. Coll. Sci. Kyoto Imp. Univ., Ser. B, vol. 10, no. 5.

– 1936: On another form of *Stephanoscyphus* found in the waters of Japan. – Ibid. vol. 11, no. 3.

KRAMP, P. L., 1951: Hydrozoa and Scyphozoa. – Rep. Swedish Deep-Sea Exped. Vol. 2, Zool., no. 10.

LELOUP, E., 1937: Hydropolypes et Scyphopolypes recueillis par C. Dawydoff sur les côtes de l'Indochine française. – Mém. Mus. R. d'hist. nat. Belgique. Sér. 2, fasc. 12.

LO BIANCO, S., 1903: Le pesche abissali . . . nelle adiacenze di Capri etc. – Mittheil. Zool. Stat. Neapel, Bd. 16.

THIEL, M. E., 1936: Scyphomedusae, 3. Lief. – Bronn's Klassen und Ordnungen des Tierreichs. Bd. 2, Abt. 2.

VANHÖFFEN, E., 1910: Die Hydroiden der Deutschen Südpolar-Expedition 1901-1903. – Deutsche Südpolar-Exped. Bd. 11, Zool. Bd. 3.

Explanation of Plate 1.

Figs. 1-2. Two specimens of *Stephanoscyphus simplex,* both from "Galathea" stat. 471 in the Sunda Trench, one without internal processes, the other with several whorls of processes.

Fig. 3. A specimen in strobilation, the tube containing several newly hatched medusae; stat. 436.

Fig. 4. Oblique section of the pedal disc; stat. 436.

Figs. 5-6. Two successive whorls of internal processes of one specimen, in which the theca has been cut open and spread out flat; stat. 299.

Figs. 7-11. Transverse sections of a specimen showing the soft tissues; stat. 436.

Fig. 7. Section of the pedicel; obs. the thick chitinous wall of the theca and the taenioles, two of which are broad, the two others very narrow.

Fig. 8. Section between two whorls of internal processes; obs. the circular outline of the four taenioles.

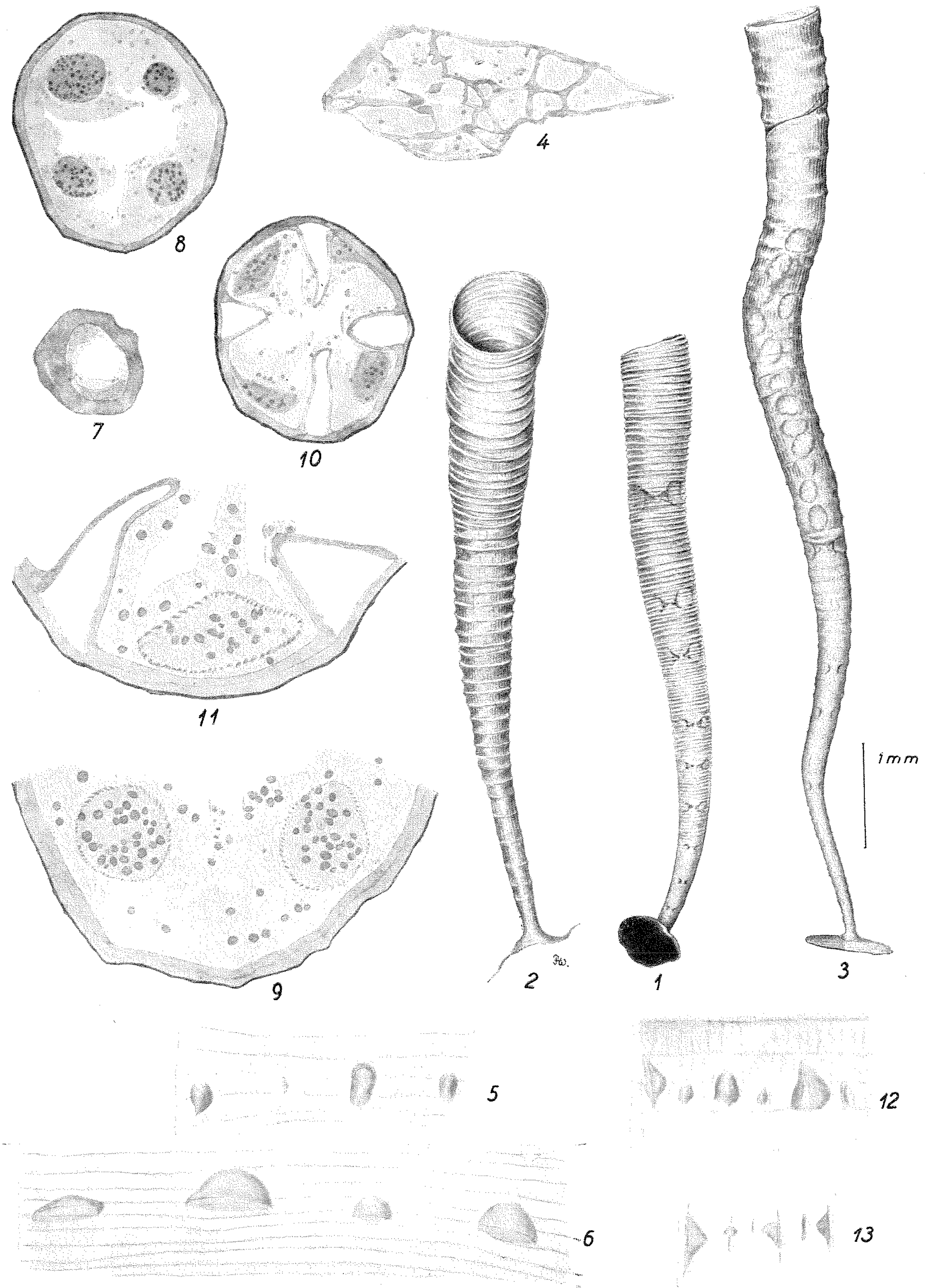
Fig. 9. Part of the same section in higher magnification.

Fig. 10. Section through a whorl of internal processes; obs. the more or less compressed taenioles.

Fig. 11. Part of the same section, showing one of the radial endodermal septa.

Figs. 12-13. *Stephanoscyphus corniformis.* Internal views of parts of thecae cut open and spread out flat to show the shape of the internal processes. Fig. 12 "Galathea" stat. 451, fig. 13 "Atlantide" stat. 85.

Figs. 1-3 are drawn by P. WINTHER, the others by the author.


8
4
7
10
11
9
2
1
3
1mm
5
12
6
13

15. 2. 59. 600. 125