

Translations of early Tamiji Kawamura papers by Rodney Notomi

1. **On Siphonophores.** Debut, Z. Tokyo, March 2, 1908, Vol. 20, pp. 77-83.
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2. **On Siphonophores.** Debut, Z. Tokyo, April 15, 1908, Vol. 20, pp. 101-109
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3. **On Siphonophores.** Debut, Z. Tokyo May 15, 1908, Vol. 20, pp. 139-148
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4. **“Bozunira” and “Katsuwo no Eboshi” *Rhizophysa* and *Physalia***
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5. **“Batei kurage” *Hippopodius ungulatus*** Dobutz, Z. Tokyo, 22, 468-471, 1910
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NOTE: *Physophora hydrostatica* Forskål. Dobutz, Z. Tokyo, 23, 309-323, 1911
NOT TRANSLATED

7. **“Shidarezakura Kurage” and “Nagayoraku Kurage” *Cupulita picta***
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On Siphonophores
by
Tamiji Kawamura
Debut, Z. Tokyo
March 2, 1908, Vol. 20, pp. 77-83

1. Brief History of Siphonophores

It is needless to speak of the inconvenience encountered in the study of siphonophore due to the difficulties in catching the specimens and in their preservation. It is readily understandable that countless insurmountable obstacles must be faced in such investigations, particularly in the days gone by when many (relative) techniques and methods were yet in their infancy and such uses of formalin as known today were still unknown. In spite of these handicaps, many scientists have contributed much to the advancement of this field overcoming the difficulties through their excellent technical skill and their detailed knowledge of the subject. Some have undertaken the work of clarifying the unknown elements in the study of this subject while others have contributed many valuable reports even going to various parts of the world or have diligently devoted themselves in furtherance of the study. To this we scientists of today cannot help but express our profound gratitude and are exceedingly pleased that we are able to follow a comparatively easier yet most meaningful path in the study of siphonophore while in many other fields of science one may often go astray from one thing to another.

The first research report on siphonophores appeared at the turn of the 18th century, in which G.E. Rumphius (1705) and J. Sloan (1707) discussed the subject of *Physalia*. About 70 years later P. Forskål (1775) recorded 5 new species of siphonophores upon the discovery of these medusae in the Mediterranean. In the 19th century, there were reports of investigations by Bosc (1802), Bory de St. Vincent (1804), Peron and Lesueur (1800-1807), Tilesius (1813), Chamisso and Eysenhardt (1821), Lesson (1826), delle Chiaje (1823-29), Quoy and Gaimard (1827-33), and Eschscholtz (1829), et. Thus, the results of their investigations have become the basis of further studies. Particularly we owe much to their knowledge of the Pacific species of siphonophores since the later reports were mostly devoted to those of the Mediterranean and the Pacific. Of these contributions "System der Acalephe" by Eschscholtz, without doubt, establishes the permanently valuable basis for the taxonomy of Acalephae with exceptional accuracy as it is a minutely detailed account of the species previously known. At the same time it will not be an exaggeration to say that the book equally speaks of by-gone days in which much effort has been exerted. And too, in this publication the name "Siphonophores" was first created.

In the reports by Blainville (1834), Brandt (1835), Milne Edwards (1841), Will (1844), and M. Sars (1846) published between 1830-40, many new general and species were named.

The following period of 10 years is the most noteworthy span in the annals of our science. During this time the alternation of polyp and medusoid and the sexual interchange of siphonophores were discovered. Hence the period is the most brilliant stage in the history of this study in which such scientists as Leuckart (1853-54), Kölliker (1853), Gegenbaur (1854-59), Vogt (1854), Huxley (1851-59) have greatly contributed to the advancement of the science through their invaluable and relentless endeavours. Precisely, it is the period during which such phenomena as the "alternation of generations" was learned and such questions as whether a siphonophore was an individual or a colony became a matter of scientific discussion.

The following period extends from 1860 to the time when the "Challenger" report on siphonophores was published in 1888. Especially great progress was made in the embryological and morphological field, as well as the investigations on the adults and the larval forms; orderly budding of ecto- and endodermal germinal lobe, discovery of nervous system, the studies on the structure of the nematocysts and on the gametes were important contributions. These progressive researches began with the "Naples Siphonophores" by Keferstein and Ehlers (1861), followed by the studies on a detailed morphological structure of the same (Claus, 1860-78), and on the development after artificial fertilisation (Haeckel, 1869). Subsequently, these were succeeded by such outstanding work and reports abundantly rich in information undertaken by such scientists as A. Agassiz (1863, 1865), P.E. Müller (1871), Metschnikoff (1874), Chun (1881-87), Bedot (1884-86). There is still another noteworthy contribution by Weismann, on the gametes in 1883, which was again followed by Haeckel in his "Challenger" report. This report was, however, not limited to the catches (collections) made on the cruise but covers the siphonophores in the Atlantic and Indian Oceans previously investigated by him in the vicinity of the Canary Islands and Ceylon over a period of 20 years, including already known species, making it a most extensive taxonomic study and in which the inclusion of such an unusual group as the Auronectae caught in the deep sea in the classification was truly a memorable occasion for oceanic biology.

In spite of these marked advances made through such great contributions by Haeckel, further research on siphonophores was relentlessly carried on added with increasing numbers of reports on the new species and other discoveries. Chun, about the same time as the Challenger report, completed the taxonomy of all the Atlantic species of siphonophores in his publications on these animals in the vicinity of the Canary Islands (1897). On the other hand, it is an outstanding fact that C. Schneider in 1898 made public an entirely new taxonomic system augmented by the addition of every known species of the world, outranking the Haeckel publication on the taxonomy.

During this period of the investigations, siphonophores were most minutely explored covering every phase of the study: the morphological analysis by Chun (1897) and Schneider (1896), the embryological study of the larva of *Velilla lata* by Woltereck (1906), and in the histology, the study of the nematocyst bands and nematocyst by Schneider (1899, 1900), the study of the nervous system by Schaeppi (1898), and of the gonophores by Dr. Goto (1897) and W. Richter (1907). In the field of taxonomy and the fauna there are such notable records of siphonophores as those reported by Chun (1897) in the "Plankton Expedition", by Romer (1901) in "Fauna Arctica", by Bedot (1903-1905) of species caught during the expeditions by Prince of Monaco and by Vanhoffen (1906) in "Nordisches Plankton", including the taxonomic studies of Chun and Schneider.

Thus, only the names of well known investigators have been mentioned so far in this paper yet there are countless scientists participating in this scientific work. Despite so many enthusiastic and tireless efforts there are still such tremendous amounts of unknown facts to be uncovered by us all that we cannot escape the feeling of being slightly inferior to the fellow scientists of other zoological fields. Particularly this is true with the Pacific species that have been investigated over 50 years ago from which many of the present day classifications are made. Therefore, we cannot help but wonder that, perhaps the research of Pacific siphonophores are based on such indefinite findings that the identifications are doubtful.

2. Various anatomical parts.

Leuckart has classified a metazoan phylum called Coelenterata, lacking a special coelom, in which two different forms are seen - one is the “polyp” having either columnar epithelium or pear-shaped cells and the other free-swimming soft bell-like chrysomitra (medusae). There is a close relation between polyps and chrysomitra (medusae), and between chrysomitra (medusae) and polyps the so called “alternation of generations”. In siphonophores these two forms appear - as a colony on one stem in nectophores and in each case they develop a polyp or a medusoid, are nothing more than simple organs when considered from the functional standpoint because they have lost independent functions through fusion. Thus, the question of whether a siphonophores is an individual polymorphic form arises. Therefore, it would, perhaps, be more appropriate to proceed first with morphological differentiation of polyps and chrysomitra (medusae) setting aside the other phase of the subject previously mentioned. Of various anatomical structures of siphonophores those of the medusae type are “the pneumatophore [**NO! pneumatophore not a medusoid - (outmoded idea)**] and the gonophore” while those of the polyp stage are the siphons, the palpons and the bract [**NO**].

The pneumatophore is a sac that stores a gaseous substance and is situated at the upper end of the body which is variable provided with or without a stigma for the passage of gas to the outside. In any case, the sac functions to maintain the vertical equilibrium of and to regulate the buoyancy of the animal. The secretion of the gas within is accomplished through a special gas gland.

Ordinarily many nectosacs or nectophores are attached to the lower part of the pneumatophore. These are of a thick agar-agar like quality and have the circular canals and somatocyst. However, there are a type of medusae devoid of a gastrovascular cavity [**manubrium**], the oral tentacles and the palpon [? **manubrium**]. The shape indicates a definite symmetry and with this agar-agar like structure, a well developed, muscular subumbrella is found by whose contraction the water within the cavity is ejected and through its pumping motion, the movement of the entire body is carried out.

Gonophores are usually found on the lower part of the body and are either male or female. In no case is dioecious. However, in some cases gonophores of both sexes are found on the same stem while in others they are attached to different stems. The germ cells, that is, eggs and sperm develop and the stalk [**of the oozoid (protosiphon at its tip)**] grows more or less definitely. The medusae usually have four radial canals which are linked together by a circular canal. The gonophores, in most cases, develop [? **on**] the gonodendra at the basal part of the gonopalpon or the siphon. The period of growth of gonophores to medusae form and of the generative period of germ formation vary for each species. In some cases the fast growing germ cells are enclosed by chrysomitra [**not siphonophores**] (medusae) and continue their growth and when the cells are fully developed, most of them become independent, separate medusoid forms having acquired free-swimming characteristics. However, there are instances in which the separation does not occur or in other cases the growth and the ejection of the gametes (germ cells) commence after the separation of the complete chrysomitra (medusae).

Thus, it is assumed that the above 3 developmental types comprise the medusoid stage of the life cycle. However, the appearance of the bud nucleus when budding is indisputable fact. The siphons are a well developed muscular cone, spindle-form or inverted club-like tube (canal), having usually four different anatomical parts: a slender stalk: a basigaster (tentacle) with many nematocyst, on

the ectodermal lobe; a stomach with various glandular processes; a proboscis (manubrium) with a terminal muscular and free opening (mouth) and closing mechanism. These four parts are easily distinguishable and are rarely indistinguishable. The tentacles that extend from the stem [**basigaster**] are often diversely classified as to their developmental origin - sometimes they are considered part of the siphon while on the other hand, they are recognised as an independent anatomical part. In any case, they occur with the siphon, generally as an extremely long contractile thread and in most cases have lateral branches on which numerous nematocyst occur, and known as the tentilla (Nesselknöpfe).

The palpons resemble the siphons in form but lack the oral part, and their tentacles similarly extend from the basigaster: (tentacle) which is simple, short and small, having neither lateral branches or nematocyst. That part which performs the protective function of siphons, palpons and gonophores is the bract a transparent gelatinous mass that is either leaf or wedge-shaped. From some part of the stem a branch enters in and runs toward the lower part, terminating in a blind sac-like end - occasionally clusters of nematocysts are observed on the bracteal surface.

It is readily understandable from the morphological standpoint that the siphons, palpons and bracts [**NO**] just mentioned are of polyp form. However, it is quite debatable whether or not they are, in the true sense, polyps. Some investigators [**Hkl!**] claim that the siphon and the palpon are the result of the separation of the umbrella from the medusa leaving the stalk or regeneration of tentacles at the margin of the umbrella into new sets of tentacles and the bracts result from a partial regeneration of the umbrella. In addition to these anatomical parts Haeckel has identified [**suspected!**] a small terminal canal, often identified as palpons in the past, to be a cyston or anal vesicle. He has further defined, upon investigation, the aurophores occurring in siphonophores to be a nectophore resulting from a special variation [**Rot!**]. But later Chun has stated that its formation is a product of a partial transformation of the pneumatophore.

In any case, the above mentioned parts are not all present in every species and they are not always attached to one stalk. Sometimes a group of several individual parts is separated from the rest. In all the siphons and the gonophores are present but occasionally the tentacles are absent in which such parts may be thought to have been lost in the collection (of the animals). However, the mode of their attachment to the stalk varies with each species and the morphological structures of siphonophores are complex, thus the author has felt the necessity to summarise the question at this time.
(Continued in the next issue.)

On Siphonophores
 by
 Tamiji Kawamura
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In order to have the various anatomical parts which have been previously discussed, assembled, there must be a universal, basal part that is common to all. Such a part is the stem which, in most cases, is a slender tubular organ constructed with both inner and outer layers like a hydrozoan stem but it is sometimes extremely short, becoming almost indistinguishable. Its morphological change is extreme in some cases and diverse formation of parts are often observed. The gastrovascular system within the stem is linked with every part of the body and the only opening to the outside is the mouth of the siphons. However, some investigators claim that the existence of excretion pores at the lower section of the pneumatophore while others insist upon a terminal opening (mouth) of the palpon.

3. General structural aspects.

Without doubt the complexity of anatomical structures of siphonophores explains their numerous taxonomic classifications, and if a discussion of their comparative structures is to be undertaken, one must explore every minute phase of their taxonomy. Therefore, the author has decided to proceed with a discussion of their general structure at this time. To further minimise the unnecessary implication of the study, only a few general groups of siphonophores and their most commonly known scientific names have been used since many of them are differently classified by many investigators.

Ordinarily Calycophorae, which include many small species that can be collected by a surface net, may be said to have a simple form as Chun has stated, since the number of their structural parts are rather small, aside from their being primitive in form.

The family is generally devoid of either pneumatophores or palpons and its most conspicuous characteristic is the presence of one or several nectophores and its highest situated part is the grooved hydroecium on the dorsal section of a so-called subumbrella cavity (that is the nectosac) over which a somatocyst (oil-drop sac) occurs. This cavity is in a polygonal shape, filled with bubble-like cells in which a number of oil (fatty) drops that function as if bubbles are present. Although a long stem is suspended connected to the inner somatocyst of the hydroecium, the part near to the upper terminal of this stem is the budding one from which upward, the nectophore (many nectophores are present) and downward, the cormidia are being formed in orderly fashion. When two nectophores are present, they occur side by side or closely upward and downward. In the latter case the part comparable to the lower hydroecium transforms itself into a longitudinal groove and this sometimes becomes an imperfect (immature) canal as the lip-like ridges of the groove become higher and finally go in together, within which the stem is found. When either two nectosacs are situated side by side or several of them are aligned in two rows the primary nectophores resemble the secondary nectosac and all the rest in form, (but the secondary bell lacks) special structural arrangement to store the oil-drops (i.e. somatocyst). Unevenly distributed cormidia are found on the top of the stem which have one or several siphons, tentacles and gonophores, and which in many cases have bracts to protect these structural parts. The cormidia are those that matured early at

the lower section of the stem and at its upper part the thickly growing immature cormidia can be always observed. These cormidia remain attached to the stem but they sometimes become separated, entering into a planktonic stage, called eudoxids. In cormidia special nectophores are sometimes provided in addition to the bracts, siphons, tentacles and gonophores. Consequently, within the eudoxids, the ersaea with special nectophores can be distinguished from the eudoxid, which lacks this special structural part.

Next in order of discussion is the suborder Physophorae which has a long slender form with a pneumatophore at the upper end and from which a long stem runs through the elongated body. Because this stem, the axis of the body, can be separated into the upper and the lower parts and because the former has nectophores either in two or several longitudinal rows, it is sometimes called the nectosome. On the other hand, the latter possesses evenly distributed cormidia which are either extremely short and inflated or elongated and suspended. In any case, the budding zone is present near the upper terminal of both upper and lower sections of the axis and the degree of growth of the nectophores and cormidia increases downward. Bracts, siphons, tentacles, palpons and the palpon filaments and gonophores comprise the cormidia though sometimes one or two of these anatomical parts are lacking.

With the suborder Auronectae which is thought to be comparable to the Physonectae, the stem changes into a large and short spongy mass, on upper section of which there is a pneumatophore under which a special aurophore is attached. Around the lateral parts of the stem many cormidia are present arranged in spiral fashion.

The pneumatophore of the family Rhizophysidae is exceeding large, having a duct connecting it to the outside on its upper terminal - which is its only locomotory organ. The stem of the Rhizophysidae is thread-like on which, at intervals, siphons tentacles and gonophores occur. In *Physalia*, on the lower side of the pneumatophore is the so-called stem [**side of float really**] from which the parts already mentioned are clustered inn a suspended manner.

Lastly species such as *Velella* and *Porpita* [**not siphonophores**] which are generally classified as Chondrophorae or Disconectae have an extremely large pneumatophore with many compartments (chambers) distributed in a concentric circle. Within the disc directly below the centre, a commonly called liver is present. On the underside of the stem, numerous siphons are suspended, around which the tentacles are suspended. The gonophores form on the outer wall at the root of the siphons and later separate into small medusoid forms, growing germ cells.

4. General development.

In the previous pages, the formation of the various anatomical parts of siphonophores developed by budding has been clearly described. Thus the resultant gonophore (a sexual medusoid) produces male and [**or**] female gametes through whose generative functions the individual siphonophores are propagated. Where only the gonophores are separate from the stem as in the case of the Chondrophorae, the individual medusa (acaleph), a gonophore, may be identified as a sexual generation [**an adult**]. Or when the various parts constituting the cormidia separate themselves from the stem altogether as in the case of the Calycophorae, the eudoxids may be called a sexual generation. However, even if the cormidia remains attached to the stem, we can readily recognise the alternation of both sexual [**medusoid (adult)**] and asexual [**polypoid (larval)**] generations in the life history of siphonophores.

However, our knowledge of the embryonic development of siphonophores is in its early infancy and we may well say that no one, as yet, has traced completely the developmental changes from the larval stages to maturity. With numerous species of siphonophores known we have learned but a small part of the developments during their life history. This, perhaps, is because such biological procedures are carried on in the great depths of the ocean. For the sake of convenience in study, the order of growth is divided into two periods.

The first stage involves the time from the eggs to the larval form period, in which time, a very little difference can be found among the species already known today although with such families as Chondrophorae, Auronectae and Rhizophysidae, it is completely unknown. The siphonophore egg belongs to the plankton and as it is discharged into the water, fertilisation takes place. Its shape is generally ball-like having a diameter of 0.5 to 0.9 m. (Gegenbaur) with the egg membrane either lacking or extremely thin. At the vegetal pole many egg yolk granules are found and while floating in the water the animal pole is situated on its underside. Because of the extreme transparency of the structure, it is common to see the cell membrane and the cell nuclei clearly. The diameter of the cell membrane is generally about one tenth of the diameter of the zygote which after 24 to 36 hours [**authority**] following fertilisation completes the cleavage. Inasmuch as the procedure of this cleavage has not yet been clearly established, a few earlier cleavages are much like the similar morphological changes of other Coelenterata, it is simply a one-sided cleavage of the zygote. On about the 3rd day of development the egg-shaped planula slowly rotates around in the water by the movement of its ciliated ectoderm. About the 5th day of growth, the primitive nectophores and tentacles start to develop either on the upper terminal or one side, showing the larval characteristics of siphonophores. The larval form of all the species at this stage have a common structure but in the second stage each individual begins to show the structural characteristics of the genus.

First of all, in the larval Calycophorae, simultaneously with the growth of the primitive nectophores after the development of the bud-nucleus on a slight upper part of its side, the inferior end of the larva becomes a siphon by elongating itself and forming an opening at the end. The process developed on the underside of the basal part of the siphon and the primitive nectophores grows into a tentacle by again extending itself. The part between the siphon tentacle and the nectophores develops into the initial stem through elongation, around which numerous buds are subsequently formed. The larval form at this stage indicates the primitive nectophores at the superior end of the stem and the siphon tentacle at the inferior terminal. As the elongation of the stem continues, it develops the cormidia one by one. Finally a slender common muscle that is the stem, and the cormidia attached evenly on the top of the stem itself are completed.

The primitive nectophore is a temporary growth of a siphonophore which is subsequently replaced [**in some spp.**] by a structurally different permanent nectophore. This fact was first made known by Chun in 1881 and until then it was generally accepted that the siphonophore provided with a primitive nectophore belonged to some other species although it had been known that the period either as a eudoxid or with the permanent nectophores are the different generations of the same animal. However, although this fact has not been definitely established to be common with all species of Calycophorae, it is generally recognised to be acceptable [**NO!**]

As far as the permanent nectophores are concerned, they are limited to one in some species but there may be two or more. The number of nectophores seem to successively increase to more than two. Even when the growth terminates with two

nectophores the regeneration of this body part can occur through the budding of new nectophores. Therefore, when some multiplication occurs one may well be sure that the old nectophores remain attached in the original place (without isolating themselves) as the new colony develops into a fixed (definite) size.

Next, the variation of Physonectae during this (second) period is still more complicated. That is, the bud which grows along the side and the superior terminal [end] of a larva that has just completed the first stage, does not become the primitive nectophore as in the other family but becomes the pneumatophore [?]. Although the growth of a siphon from the inferior terminal [end] of the larva, and the subsequent growth of the tentacles from its roots is quite similar to that in the Calycocephorae, the difference between these suborders is that Physonectae grows one or several temporary bracts around the pneumatophore, which eventually isolate themselves after enclosing the larva for a short while. However, such a variation is only known in a few genera. Subsequently, the part attached to the underside of the pneumatophore elongates itself into a long stem whose upper half forms a nectosome developing nectophores in succession, while the lower half, simultaneously grows cormidia one by one pushing them downwards. Thus, finally a matured individual is completed.

The most widely known genus of the Rhizophysidae is *Physalia* whose larval stages are fundamentally unlike other siphonophores in some respects. It develops a medusa [NO] that differentiates a pneumatophore, a tentacle, and a siphon. However, the pneumatosac within the pneumatophore of this genus expands at an exceedingly early stage and practically fills the large and stubby stem. Simultaneously, it develops new polyps continuously on the central area.

(Of these parts) the initial siphon and the tentacle, situated at the posterior end of the body, develops numerous immature siphons, palpons and tentacle around it forming some sort of cluster. However, a larger cluster which grows later, collects near the slightly forward section and from this grow well developed tentacles and gonophores.

The embryonic development of Disconectae has not been definitely learned as yet. However, the author wishes, at this time, to discuss the developmental aspects of *Velilla* which differs slightly from several species of siphonophores that have been previously discussed. First all the small medusae that develop on the external wall of the basal section of the siphon hatch a large reddish egg on its stalk after leaving the mother body. This zooid, however, descends to deeper water before maturing. Consequently, its embryonic changes during the first and the early part of the second stages are not all known yet to this author's knowledge. The larval form of the early conaria period that again ascends towards the surface from the sea bottom, has been caught at a depth of 1000 m. This larva has a ball-like bag of 1 mm from whose superior pole toward the middle cavity a reddish cone-shaped process is found. By having stored a oily substance within, it passively continues its upward movement. A new bud grows outwardly from the superior pole, which develops into the pneumatophore and by the time the larva reaches the surface it develops a skirt-like screen on the margin of the pneumatosac. The bag below the pneumatophore grows into a siphon making an opening at its inferior pole. The connecting part between the pneumatophore and the siphon finally becomes a rataria, extending sideways and growing a shelf-like part around it. The diameter of this part is approximately 1.5 mm which continues to grow reaching a diameter greater than the longitudinal dimension. The pneumatophore forms linking compartments in concentric fashion one after another within the stem that has developed into a board-like shape. At the same time a conical process of the conaria develops the liver and other canal systems.

Around the siphons on the underside numerous additional siphons are seen to grow and further, when the tentacles in a ring are formed on the exterior, the body would have reached its maturity.

5. Change in interpretation of various structures of siphonophores.

We have thus far discussed the questions of the structure of siphonophores in their general development as well as what fundamental bearing these facts may have in the interpretation of siphonophores and their taxonomy. Let us, therefore, examine the structural change of various anatomical parts with time. The discussion as a whole was based primarily on previous observed facts; therefore, to present only the abstract conclusion may seem colourless and dry.

The tendency is not necessarily limited to the study of siphonophores but there are two questions which the investigator of the subjects in the past have endeavoured definitely to determine. The first question is whether the siphonophores is an individual organism or a colony and consequently just what relation it may have with the other coelenterates. The second is "how do various species of siphonophore differ from each other?", that is, how they should be classified taxonomically. These questions undoubtedly arise because of their mutual relation.

It is a well known fact that siphonophores have many different morphological and biological characteristics from other members of coelenterates. So much so that countless numbers of theories and reports have been presented in the past as to their adaptations and (anatomical) structures. Some investigators assert that this animal is one individual having exceedingly complex organs while others claim it to be a colonial body consisting of several individuals each having its own specific function resulting from the development of primitive functional division. Such controversial discussions have been carried on by many scientists for a long time. Even today the arguments are very much contested. However, inasmuch as the contentions of scientists differ fundamentally, the question can be generally segregated into two major groups - one "Polyorgan theory"; the other "Polyperson theory". **[BOTH WRONG. An oozoid larva bearing other larvae + adults as polypoid and medusoid buds.]**

Polyorgan theory

In 1821 Eysenhardt stated, by comparing *Rhizophysa* and the Acalephae, that the former is a result of inversion of the latter's umbrella, and the former's stem corresponds to the stalk of the latter. He also asserted, at the same time, that *Physalia* has a common pneumatophore resulting from the fusion of many pneumatophores of the *Rhizophysa* type **[What does this mean?]**.

He is also the pioneer in advocating the existing relation between siphonophores and common medusae. From this he further stated in his theory on the taxonomy of siphonophores that *Rhizostoma* is an individual animal (later classified as a colonial body by Agassiz) *Physalia*, a colony, and *Rhizophysa* an intermediate form. A unique aftermath of this claim is that what had been considered as an individual and as a colony were found to be extremely closely related species. This interpretation by Eysenhardt was similarly presented by Metschnikoff almost 50 years later.

In 1874, however, Metschnikoff classified a comparative specimen as *Sarsia* instead of accepting it as *Rhizostoma*. That is, as *Dip[u]rena* having fully developed tentacles on the stalk, he has considered that such a unique anatomical development is common to siphonophores. Also he believed *Eucope polygastrica* which has numerous auxiliary stalks to be very closely related to *Physalia*. Further he has stated

that the stalk of *Sarsia*, covered with many medusae buds, by greatly elongating, a hat-like bract, which grows in the larval form, is comparable to the umbrella of a medusa. This by once more overlapping itself becomes a pneumatophore when it is turned inside out. In addition among many species as a result of centres of secondary growth on the stalk there are such chrysomitra as gonophores or tentacles and umbrellas without medusae itself, either by changing the position or multiplying by overlapping. Therefore, he has reported that this changing of position and the overlapping is very similar to the budding of stalks on *Eucope* that is commonly observed on any larval form which develops into an intricately constructed animal. Further, he stated that the superior cormidia which isolate themselves as eudoxids in Calycophorae compare to a medusa as a whole and that the bracts are formed from the transformation of the medusa umbrella and its siphon tentacles are comparable to the stalk tentacles. This interpretation of eudoxids coincides with that by P.E. Müller (1871) reported about the same time. A. Agassiz (1865) was, too, an advocate of a similar theory.

Condensing the interpretations by aforementioned investigators it is obvious that siphonophores as a whole are multi-form animals developed from an individual medusa and that from the stems comparable to the stalk, 2 generations bud as deformed medusae, of which one is the gonophore and the others are numerous medusa organs that develop by either changing the positions or overlapping [meaningless ROT].

Prior to this, there was also a similar report made by Huxley in 1859. His interpretation was based on various conditions of a fertilised egg as a whole, instead of implying the word "individual" for the typical form of each species or to different generations. Therefore, it is considered that a siphonophore, too, is an individual medusa that many parts, comprising the animal, are organs that could carry on the independent functions separately as they are attached to the animal body. That is, this theory is a step ahead of those previously cited by investigators, as far as the meaning of the individual organism is concerned. He, too, has concluded that such a part as the nectophore is, without doubt, a result of overlapping of the same organs, and further, since Huxley's theory most clearly advocates siphonophores as individual animals, his name is always identified with the "Polyorgan theory". There is, however, one point that should most carefully be borne in mind. Precisely, he alone interpreted the various parts of siphonophores to be all organs while P.E. Müller and Metschnikoff, etc., and also Haeckel, who were mentioned later, all concluded that of these body parts some represent the individual medusa and others the organs. Consequently, Delage has named Huxley's theory as the theory of "Mixed or combined medusoid".

In short, what "Polyorgan theory" advocates is the growth of various medusa organs by changing their positions or by overlapping. Therefore, Chun has written that this theory looks at siphonophores like multi-form Hindu Buddhas. Actually, "seven-face or thousand-hand Goddess of Mercy" may be said to have a similar structural features as siphonophores according to this theory. (Continued in the next issue.)

On Siphonophores
by
Tamiji Kawamura
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Polyperson theory

For many years there have been some scientists who made comparisons between siphonophores and Hydrozoa in contradiction to the “Polyperson theory”. Among them, Lesueur is considered to be the pioneer who cited the analogous characteristics of various structural parts of siphonophores and the individual organisms of Hydrozoa by citing various structural characteristics. The reason that no scientist had accepted this theory can be readily understood by the reports made by the later taxonomists such as Lamarck (1816), Cuvier (1817), and Eschscholtz (1829) that the siphonophore is a single animal. Following Lesueur, Milne Edwards presented a similar interpretation. He compared, in his study of *Forskalia* (then *Stephanomia*) with the animals belonging to the family Pennatulidae that the former is composed of many individuals which are all in communication with one another. However, this theory, too, appeared to have escaped the attention of many scientists as Siebold (1848) repeated the biological analysis and the taxonomy used by Eschscholtz in his textbook. Vogt and Leuckart later insisted that siphonophores are a planktonic animal colony, and are extremely close to the Hydrozoa.

On the other hand, Vogt (1851) offered the same interpretation of eudoxids as the advocates of the “Polyperson theory” while Leuckart (1851) continued to adhere to the “Polyperson theory” by clearly defining that all the accessory parts of the animal body are individual organisms. Thus, this theory is commonly called Leuckart’s “Polyperson theory”.

Even with sessile *Hydra*, the individual organisms take varied forms because of their functional differences, such as a siphon with the mouth and spiral zooid (?) without it on the other hand. Further, the occurrence of pneumatophore, Skeletopolyp (?) Blastostyle and the sexual medusae that separate after budding out was then unknown. Already Lesueur and Milne Edwards, too, had noticed the similarity between siphonophores and Hydrozoa. Therefore, it was not at all an outlandish assumption that Leuckart had concluded that siphonophores are colonies whose various divisions of labour are highly developed, particularly such structural parts as nectophore, bracts and siphons, which were recognised as organs by those of the opposed school of thought as individual organisms of equal importance.

However, according to this theory, with all polymorphic animal colonies, there exists a morphological rule among the individuals by which they co-operate with each other and have a mutual relation among those of the same generation. This is not so much a morphological and functional coincidence but rather it is an adaptation to their biological function. Consequently the individuals of various generations along the entire colonial body cannot be distinguished but by correlating them all the complete life history can be observed. In other word, each and every individual and generation simply represents a sentence or a paragraph of the life history of this animal - it is merely a chapter linking the story together. But because of these diversified, specific functions, one individual organism loses the organs used by the other individual for their own characteristic functions. The tentacles are lacking on the siphons even in siphonophore catching their prey and protection of the colony is entrusted to the tentacles themselves. In short, this theory is the result of application of the well known Leuckart’s “Polymorphism” to siphonophores. It contradicts the

“Polyorgan theory” and every anatomical part represents an individual organism though some individual loses some of its organs.

However, the alternation of generations too, parallels the polymorphic phenomenon and the relation of the sexually produced individuals to the maternal body is no different from the mutual relation between the individual organisms and it is interpreted that the alternation of generations is no more than the occurrence of “Polymorphic” phenomenon in the development of the animal.

Leuckart staunchly advocated this theory and in order to refute the theory that the eudoxid is a single medusa he cited the separate budding of its anatomical parts such as bracts, siphons and gonophores. Further, to insist also on the independent character of the nectophore, bract, and siphon he challenged a different interpretation contemplated by those of the opposite school. In regard to the structure of pneumatophore he stated, contrary to the definition by Eysenhardt, etc., that the pneumatophore is an inverted umbrella, that the endodermal layer of its air-bladder is similar to the subumbrella layer of a medusa and that its exterior wall is comparable, at the same, to the exumbrella layer of a medusa.

Leuckart’s “Polyperson theory” which had been derived from “Polymorphism” was widely adopted by German scientists of that time. Kölliker (1853), Gegenbaur (1854) and Claus (1863), etc. exerted much effort to amplify this theory from the structural and the embryological standpoint and to find an intermediate form between Hydrozoa and siphonophores. Consequently, the adaptation to this theory is quite obvious in German textbooks. For example Korschelt and Heider in their “Comparative Embryology” (1890) have stated, in attempting to establish the relation of siphonophores to Hydrozoa as its root, that if one hydrozoan is able to remain floating on the surface with a wide basal disc without attaching itself to other objects like Scyphostomae, it should not be difficult for it to transform into such a planktonic form as *Velella* or *Physalia*.

Thus, from the standpoint of the structure, the function and the alternation of generations, siphonophores have been defined on the one hand as an individual having complex organs and on the other hand as a colony showing a polymorphic phenomenon. But in the meantime, a general tendency to analyse the animal from the embryological standpoint was quite apparent. Without doubt, to investigate or to discuss the analogy between siphonophores and medusae or Hydrozoa means to debate, simultaneously, the question of the animal’s lineal development.

Consequently when “Biogentsches Grundgesetz” appeared as the importance of embryological aspect was keenly felt by the investigators as the only rudiment in analysis of the systematic growth many scientists busily turned their eyes toward the developmental phase of the study, realising to investigate the characteristics of its larval form is of the utmost importance to conclude the before mentioned discussion. The theory by Metschnikoff, too, seeks its proof on this aspect. Haeckel in 1869 conducted the artificial breeding of 3 genera of Physonectae in order to study their growth, bearing in mind the fundamental importance of such an investigation from which he has reached the conclusion that their larval forms correspond to a medusa, the former’s hat-like bract, the siphon and the tentacles compared with the umbrella, the stalk and the marginal tentacles of the latter, respectively. Further he stated that the subsequently developed group of appendages are similar to the *Hydra* individuals and the adult form of siphonophore is a colony like *Hydractinia*.

Revival of “Polyorgan theory”

(1) Haeckel when he was about to present his study on siphonophores in the Challenger Report (1888), made known his “Medusome Theory” in which he

attempted to give the true meaning of “Polyorgan” and “Polyperson” theories by changing the already discussed interpretations of adult siphonophores. Medusome collectively signifies each part of a siphonophore system which has recognised to represent a medusa. By further summarising this point it is obvious that siphonophores directly descended from the velum medusae because of the “Palingenetic import” although the initial larval form of siphonophores is generally a simple medusa which changes “coenogenetically” to a degree during its evolution. However, this medusoid appears in two fundamentally different forms - the first is the eight radial “Disconula” traces its roots to Trachymedusae while the second is the [bi]laterally symmetrical “Siphonula” which descended from Anthomedusae.

(2) While the various parts of the larval forms are developing into the adult siphonophore, some become medusoid individuals while others appear with only their organs overlapping. Inasmuch as the overlapping of the nectophores and bracts do not infer an individual organisms but rather organs, and further the cormidia are the result of a continuous inversion of the medusome group (segmentally) yet the latter grows, sometimes, at intervals on the stem. Therefore, Haeckel stated that these two cases should be differentiated as “Ordinal Cormidia” and “Dissolved Cormidia” respectively.

Now the question of systematic growth of the organisms is indispensable in study of morphology and embryology, etc. However, especially according to Haeckel’s theory, it is clearly evident that the discussion on a concrete [objective] developmental aspect accompanies the questions of the structural analysis [theory] - henceforth, these questions were always closely associated. However, to minimise the complexity of the subject it would be better, we feel, to proceed with the anatomical discussion by setting aside the embryological aspect for the time being.

According to Haeckel’s analysis a pneumatophore is a furrowed gas gland on top of the exumbrella of the larval medusa. With this medusa, the stalk transforms to the exumbrella layer, having lost its subumbrella layer, therefore, the ectodermal wall of the pneumatophore is not the subumbrella layer, coinciding with Eysenhardt’s statement.

However, the former’s interpretation that a medusal stalk becomes the stem of a siphonophore is similar to that of Eysenhardt. Of the several parts budding from the stem, the gonophore and the special nectophores (observed in *Elysia*) are single medusiform individuals, and the primitive nectophore present in Calycophorae is an organ of the pneumatophore. The nectophore is an organ resulting from changes in position and overlapping; siphons and palpons are medusae lacking all parts but the stalk and the tentacle is an organ belonging to the siphon. In general summarisation of various parts of a siphonophore some are medusae while others are organs. [NO]

However, because it is the same as the previous statement that such a part of the gonophore already recognised as a medusoid individual even in the “Polyorgan Theory” the difference between the theories of Haeckel and Metschnikoff lies in their interpretation of the pneumatophore and the special nectophore. In general not the slightest difference can be detected between the hitherto known “Polyorgan theory” and Haeckel’s “Medusome theory” as far as their recognition of the anatomical parts of siphonophores consisting of medusae and the organs concerned. Consequently, the latter may be said to be a slightly varied definition of the former. Therefore, conclusively there is hardly a ground for a doubt that such strong opposition to the theory by Chun (1888) and Claus (1889) the advocates of “Polyperson theory” during that time was no more than a repetition of the criticism brought about by Leuckart

(1872, 1875) and Claus (1878, 1883) on the interpretation of the subject by Metschnikoff and Müller.

Present definition of “Polyorgan theory”.

This theory is a composite form of the criticisms advanced by several investigators against the “Medusome theory” of Haeckel and later discovered 32 or 3 facts on the subjects. Yet, despite the change in the interpretation of the “Polyorgan theory” with time there has never been any different definition of the “Polyperson theory” except the discussion of the systematic growth of siphonophores. From the beginning it has been accepted that each anatomical part is functioning independently. Therefore, it is sufficient to say that Chun’s definition represents the recent conception of the theory.

Chun opposing Haeckel’s analysis and the previous interpretations of the “Polyorgan theory” had strongly refuted first of all, the change in the positions of the organs and gave the following biological data. One, there is no conclusive proof of Leuckart’s statement that the bracts, siphons and tentacles all bud out individually like the gonophores, thus they must all be of equal value. Further, he stated that although the followers of the “Polyorgan theory” insist that the so-called tentacles are formed through shifting of position by marginal tentacles of a medusa from its stalk to its basal siphon, the regeneration of siphonophore tentacles, the sense organs (found at the base of the medusan tentacles) and stalks takes place at the original position. Continuing still further he reported that according to Haeckel despite the nectophore being an organ developed through a change in position and overlapping, the special nectophore which undergoes an identical structural growth must be considered as an individual medusa. Finally, Chun interpreted a small umbrella present on the bract of *Athorybia* and *Rhodophysa* as reported by Haeckel, as indicating that the bract itself is an individual medusa unconnected to any other part.

In 1897 Chun again brought up this subject for discussion, pointing out that the stem of the siphonophore compares with the stalk of a medusa which grows at the aboral side of the primitive medusa in the Calycophorae and which occurs connected to the external stem in case of Physophorae. It is analogous to the budding of a medusa in an identical shape on the aboral side of the larval form of the Aeginidae observed by Metschnikoff. But he continues that with Anthomedusae, which are often compared with siphonophores, the stalk does not develop such a subordinate part and grows an isomorphic medusa at all times.

Chun, further, concluded that Hautlaub’s (1896) observation of the regeneration of the stem of *Sarsia* by overlapping cannot be seen under ordinary conditions. By refuting the comparison made by Hautlaub as well as by Metschnikoff that if a medusoid and a polyp simultaneously developed on the stem (*Sarsia*) it is quite difficult to compare the stem of siphonophores with the stalk of medusae. This difficulty, according to Chun, resulted in defining a pneumatophore (air bladder) as a depression of the exumbrella wall following Haeckel’s precedent, but this definition does not apply in the case of the primitive nectophore in the Calycophorae. The budding out of the exumbrella layer cannot be found in any other metamorphosis such as the change in the position of the tentacles to the base of the stalk or the connection of the stalk to the end of the exumbrella layer. Therefore, he concluded that one thus encounters many difficulties in analysing the structures of siphonophores with “Polyorgan theory” while no obstacle would occur should the subject be analysed with Leuckart’s “Polymorphism”.

When these various theories are summarised, it is obvious that the hitherto known definitions of siphonophores have progressed by way of two parallel roads.

The first is the “Polyorgan theory” and its variations have been advocated by Metschnikoff, Eysenhardt and Eschscholtz. These older students of the subject have compared a mature siphonophore to a medusa carrying many buds on its stalk. While Huxley defined it as an individual and Metschnikoff and Haeckel insisted that an immature animal is a medusa and an adult form is also a medusa but with medusoids and organs budding out together on its stalk. Although this theory has not received much support in recent years it is not altogether discarded. Balfour and Sedgewick adopted this interpretation. The second is the “Polyperson theory” which starting with the comparison of Hydrozoa, was roughly formed by Leuckart’s “Polymorphism” - later it was constructed into a finer state. There is one point, however, he should have taken into account - that is these theories do not coincide. However, the difference at present is slightly varied in its interpretation from the argument resulting from a discussion of the individual merits of the theories by Huxley and by Leuckart. From these considerations, this author feels that it is perhaps quite appropriate to call these theories the “Polyorgan theory” and the “Polyperson theory”.

Theory on Lineal Development (p.37)

This author has previously recalled Haeckel’s attempt to find the siphonophore ancestor in two medusae. However, the discussion relative to the lineal growth of the organism did not arise at the same time as it has already been clarified in the previous chapter. the “Polyorgan theory” defines the primitive form of siphonophore as a medusa based on its embryological development, while with the “Polyperson theory” it is interpreted as a planktonic colonial hydromedusa. At any rate, the existence of a close relation between the individual and its lineal development has then been recognised by everyone, but the two theories came to name different ancestral origins. The former theory advocated that the primitive siphonophore is a medusoid stage with an umbrella. From this planktonic organism grow the locomotory organs, such as the nectophores and the pneumatophore by a change in position and large overlappings. Scientists admit that the polyp stage is more rudimentary than the medusoid form and that the latter secondarily assumes a planktonic stage in which a radial jelly-like disc grows and the stalk develops from the gastric tube of the polyp. On the other hand, adherents of “Polyperson theory” insist that the primitive siphonophore is a polyp lacking an umbrella. Therefore, all the locomotory organs are new structures which did not develop from similar organs on the rudimentary form. Thus, the question arises how do we interpret the larval siphonophores which actually have developed from the eggs? According to the first theory, this larval organism is truly a single medusa individual having a morphological value and the result of hereditary repetition of the original primitive form. Therefore, it has a tremendous value from the standpoint of genetics. On the contrary, the “Polyperson theory” acknowledged that the larval form is a polyp which has undergone special metamorphosis having an appropriate value as such.

Then, how did Haeckel cast his ballot in selection of these theories? Of course, without doubt, he has supported the “Polyorgan theory” from which it is apparent that the “Medusome theory” is clearly a transformation of this definition. Precisely, as explained in the first half of the “Medusome theory” he cited the proof that the larval siphonophore, having a medusa form ancestor, possesses a value from the standpoint of genetics, but the existence of two larval forms signifies that siphonophore are derived from two ancestors - that is two medusae.

The followers of the “Polyperson theory” all sought the ancestral siphonophores in the polyp form but they did not agree on transitional stage from the polyp to siphonophore. Leuckart concluded after studying the larval form of

Agalmopsis, that the larvae of the Physophorae are the most primitive siphonophores and that the (mature) siphonophore is a hydrozoan colony entering a planktonic life. However, Claus (1884) presented an analysis differing slightly from the former. He believed that the Calycophorae are the most rudimentary siphonophores and furthermore he rejects the theory of the sessile hydromedusa adopting a planktonic habit. He states that perhaps a primitive larva similar to *Podocoryne* or *Hydractinia* becomes a colonial hydromedusa by entering a sessile stage similar to *Podocoryne* or *Hydractinia*. Those that do not complete the sessile stage become Calycophorae, budding polyp and medusoid forms at the aboral end. Then, finally, other siphonophores were differentiated. These two scientist differ only in the manner of approach in discussing the ancestor. Leuckart maintained that first a colonial hydromedusa appeared and then a siphonophore, while Claus claimed these two stages simply branched out from the same origin.

Schneider (1898) following Leuckart's interpretation cited the lineal differences between Calycophorae even in the most rudimentary form and other siphonophores and opposed Claus's analysis of the latter. He denied the primitive character of the Calycophorae which he claimed to have been derived from an altogether different larval form. Finally he concluded that as far as the lineal growth of siphonophores is concerned, the development of a conglomeration of individuals from planulae can be readily understood from the continuous growth of the individual organisms from colonial hydromedusa, polyps from planulae, followed by further budding of new polyps. Thus, the developmental difference lies at this point as pointed out by Korschelt and Heider.

Consequently, Schneider claimed that a siphonophore is neither a medusa as interpreted by the "Polyorgan theory" nor a polyp with a budding zone at the aboral end as claimed by Claus but rather a group of orderly developed polyps already showing their complexity when first grown out from the planulae. However, during this period, he continued, they are quite in uniformity. Each organism appears to be more like an organ than an individual. Yet, every one is equipped with the parts found in the mature animal and situated at the proper positions. Therefore, these larval parts are just as important morphologically as those of the mature animal.

Chun, too, has sought the ancestral siphonophore in polyp stages. But first he denied the descent of *Velella* larvae from octoradial medusae and the fundamental differences between the larvae of Chondrophorae and of other siphonophores. Then, on the question of the developmental change from a polyp to a siphonophore he definitely rejected the theory of Leuckart and Schneider but adopted Claus's interpretation. Then he called attention to *Nemopsis gibbesi*, observed by McGrady (1859), and its planktonic adaptation with its tentacle although it is not sessile. He also cited *Diplograptus* as having a floating existence so that it was thought to be closely related to siphonophores by many scientists. He stated that even though such a relation may not be true, some *Diplograptus* actually maintain a planktonic life. Therefore, there might be a missing link to clarify the origin of siphonophores among these yet unknown forms. However, the comparison is commonly made with the medusae and this idea has been chiefly adopted by English and American scientists.

“Bozunira” and “Katsuwo no Eboshi”
Rhizophysa and *Physalia*
 by
 Tamiji Kawamura
 Dobutz Z. Tokyo, 22, 445-454, 1910

“Bozunira” is the Japanese name selected by the author for the Japanese species of *Rhizophysa* while “Katsuwo no Eboshi” is the Japanese name for the species of the genus *Physalia*. The purpose of describing these two genera together at the same time is because, despite the conspicuous differences in external appearance, they are closely related. Thus, their structural characteristics are more conveniently studies together. The name of the different parts of individuals will follow the nomenclature used in the chapter “On Siphonophores”, Volume 20, of this journal.

“Bozunira”
 Genus *Rhizophysa*

Although the genus *Rhizophysa* was established by Péron and Lesueur in 1807, a species which was classified as belonging to the genus *Physophora* by Forskål in 1775 is undoubtedly a member of this genus. Among them were some deep sea forms. Haeckel, then, reclassified them into six genera *Aurophysa*, *Cannophysa*, *Linophysa*, *Nectophysa*, *Pneumophysa*, *Rhizophysa* with eleven species. Schneider, without following this classification, divided the group into two genera, *Rhizophysa* and *Pterophysa*, with four species. Chun, on the other hand, rearranged them into three genera *Rhizophysa*, *Bathyphysa* and *Pterophysa*. However the two species of *Rhizophysa*, which will be discussed below, have in every case been classifies in that genus by the investigators mentioned above.

The taxonomic position of this genus is as follows:

Suborder: Cystonectae Haeckel, 1888
 (Reference: “Taxonomy of Siphonophore” No. 259, Zoo. Mag.)
 Family: Rhizophysidae Brandt, 1835

The stem is a long thin tube which elongates vertically. Numerous [? nodal] cormidia occur side by side on the stem between the internodal parts.

Genus: *Rhizophysa* Péron and Lesueur 1807

Each cormidium has a siphon and a tentacle.

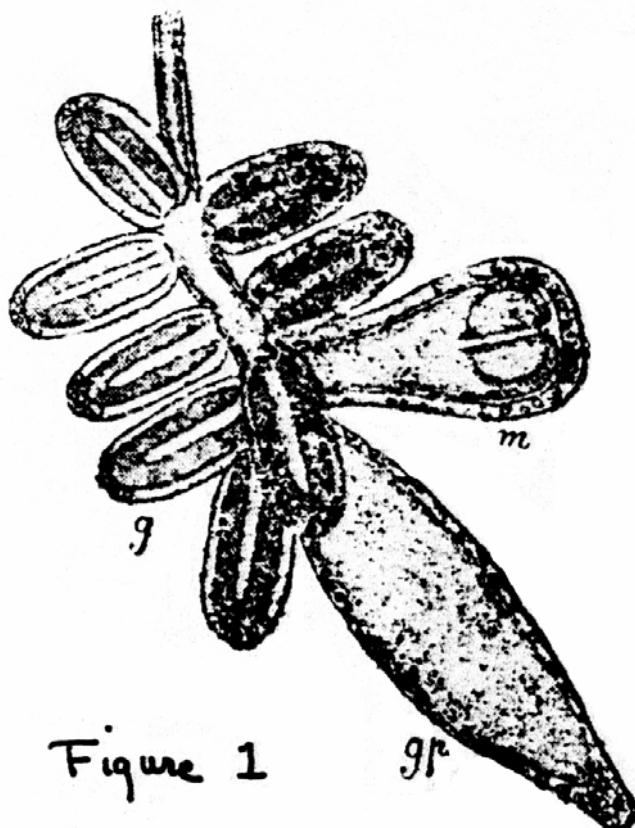
A. Rhizophysa eysenhardti Gegenbaur [Pl. XIV, figs. 1,2]

The body consists of an exceedingly large pneumatophore and a very long tubular stem with cormidia arranged in rows. Although the pneumatophore, stem, and siphon are ordinarily light red in colour, they are sometimes tinged with a light purple or yellow. The stem contracts and expands very easily, reaching a length of several metres when expanded while it barely measures one shaku (Japanese measurement, approximately 1 ft.) when contracted.

Since nectophores are not present [except on gonodendra] in this genus, the pneumatophore is the only locomotory organ [**Haeckel records their snake-like swimming motion**] regulating the ascent and descent of the members of this genus. The large egg-shaped pneumatophore has well developed longitudinal and lateral muscles on its outer wall. The upper one third to on quarter of this wall contains purplish red pigment cells. The pigment becomes denser toward the upper surface reaching a maximum around the central pore on the upper surface. The pneumatosac,

connected to the outside through this pore, is suspended in the inner cavity of the pneumatophore. The septa that in some species longitudinally divide the space between the walls of these layers, that is in the pericystic cavity, are lacking. Hence, the lines of the septa often seen in many siphonophores among the Physophorae, on the pneumatophore are not to be seen on the outside in this genus. The lower part of the pericystic cavity directly below the pneumatosac is filled with a mass of finger-like appendages which can be seen with the naked eye. These are tissues that develop from the pneumatosac are called either the *hypocystic villi* or Würelüsten. The pneumatophore may greatly change in size by expansion and contraction of the well developed muscle on its outer wall.

On the underside of the pneumatophore where it connects with the stem, is a budding zone where numerous young siphons are attached. The siphons gradually become larger as they grow downward. At first they bud out from the stem like nipples but later they develop a tubular opening at their tips. From the upper basal part of the siphons the tentacular buds develop in a similar manner. Each cormidium has a siphon and a tentacle. The siphon is spindle-shaped when contracted and cylindrical when expanded with an opening like a morning glory. The muscle of the wall is well developed and has numerous processes called "hepatic villi". However, such common parts as the stalk, basigaster, stomach and proboscis seen on the siphons of most siphonophores cannot be differentiated.



The tentacle is a long tubular string with develops from the upper surface at the base of the siphon. Along its entire dorsal surface, that is the upper side, a row of lateral branches branch out which are superior to the nematocyst cluster. These lateral

branches are reality merely a cylindrical tubular structure with numerous nematocysts occurring dorsally.

The golden gonophores although usually present at only one place on a node, may occasionally occur in two places. (Haeckel has used this characteristic in his identification of the genus, but later this was found to be an error.) The tree-like gonophore which is attached to the stem by a stalk, rebranches two or three times [??]. On examining a branch of the gonodendron (figure 1), this part is seen to have a gonopalpon (gp), five to ten egg-like gonophores (g), and a medusoid appendage.

Of the five specimens studied by the author, one was caught by R. Uchiyama, three by S. Ishida, two by M. Tahara and the remaining two by the author himself. In all cases, they were caught off the Misaki Marine Laboratory. Of these specimens, the one caught by Uchiyama was the largest and the most ingeniously preserved. However, as has been stated before, since there is a great variability in size depending on the degree of contraction, it is quite difficult to ascertain the size of the specimen accurately. By measuring the specimens preserved in formalin by the author, the pneumatophores were found to be 10 to 17 mm in height and 5 to 9 mm in width with the stem from 0.5 to 1.5 mm in diameter. The other parts had so greatly contracted that they were absolutely no use in measuring them. The measurement of extremely small parts is omitted.

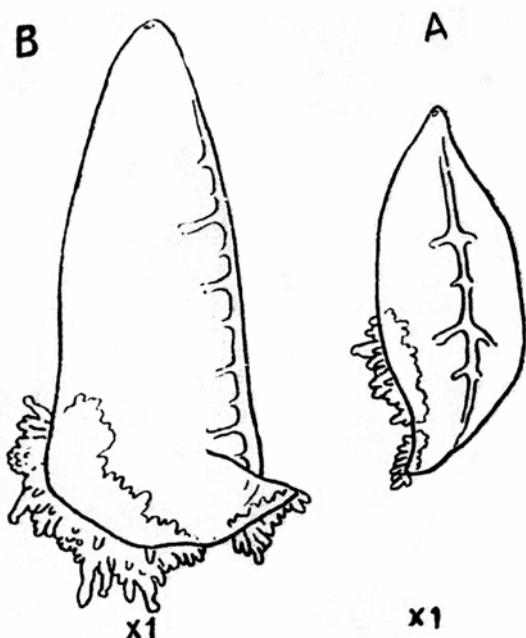


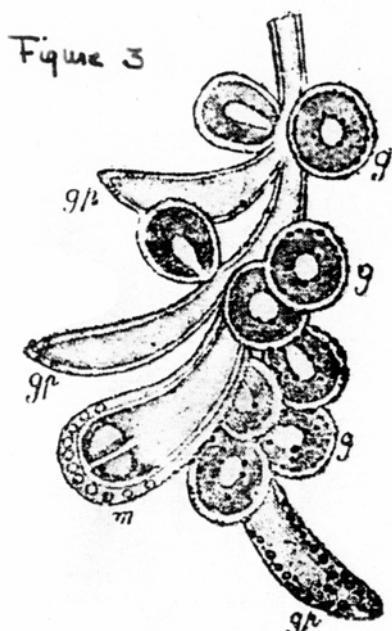
Figure 2

B. *Rhizophysa filiformis* Forskål
(Pl. XIV, fig. 3) [a tentillum]

The only two characteristics differentiating this species from the previous one is that the gonodendron is not present at the node (internodal part) but is attached directly to the underside of the siphon [?], and that the lateral branches of the tentacles separate into three secondary branches. There are absolutely no other differences to distinguish it from the other species. The tentacle will only be discussed here.

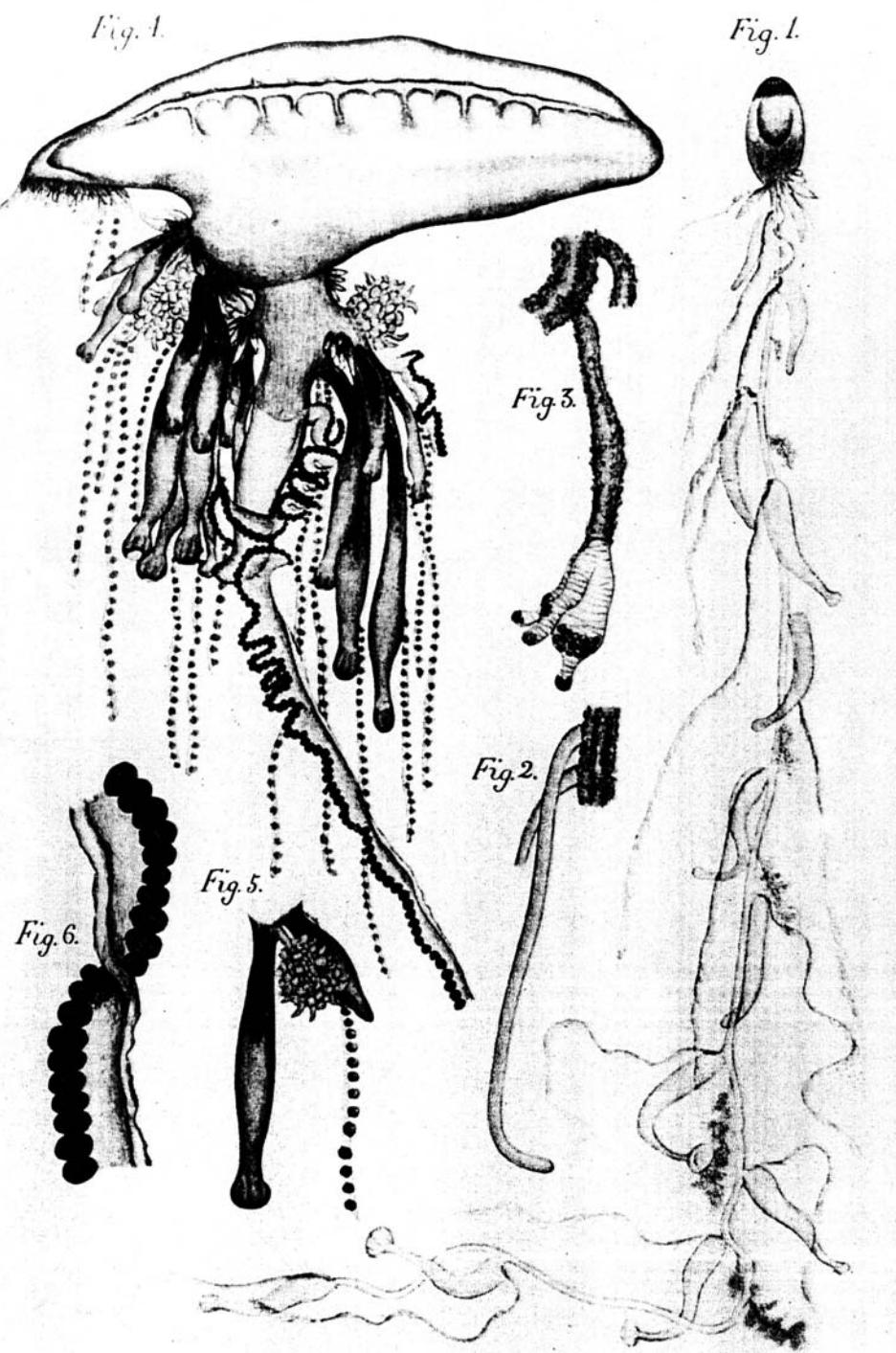
Although numerous lateral branches are present on the tentacle, there is no doubt that the closer these branches are to the base of the tentacle the younger they are. Upon examining a gully grown lateral branch, it was found to be a small cylindrical tube covered by woolly hairs. It ends in three branches. One of these is a large sac-like branch with a small terminal process containing large nematocysts. Its pointed end has smaller nematocysts. The remaining two branches which develop at either side of the first are shorter and have small nematocysts.

Three individuals have been studied by the author so far. One was caught by the author at Misaki. Although this is preserved in a greatly contracted state, its pneumatophore measured approximately 5 mm in height and slightly less than 4 mm in width. The other two were caught off Joga Shima in 1889 and kept in the classroom at the laboratory. They were about the same size as the first specimen.



"Katsuwo no Eboshi"
Genus *Physalia*

Physalia is the generic name selected by Lamarck in 1816 for a taxonomic group that had formerly been recorded under the name of either Medusa or Holothuria. Subsequently, countless numbers of species were placed in the genus and they were further segregated into four genera, *Alophota*, *Arethusa*, *Physalia* and *Caravella* by Haeckel. However, because the first genus appears to be the young form of the third, and the second to be that of the fourth, while the third and the fourth genera seem to be identical, they are at present all reclassified in the one genus *Physalia*. Even the number of species has been considerably reduced in recent years. Schneider, for example, named all species *Physalia physalis* L., calling the Pacific species, *P. utriculus*, a variety. Chun, on the other hand, reclassified this variety into an Atlantic form, *P. arethusa*, and a Pacific form, *P. utriculus*. The present taxonomic position of this genus is shown below.



Explanation of Plate XIV

- NOTE - it is bound in wrong place in Totton's copy, between pages 203 and 203.
- Figure 1. A species of *Rhizophysa* (*Rhizophysa eysenhardti* Gegenbaur) x 1
 - Figure 2. Lateral branch of tentacle. x 15
 - Figure 3. A species of *Rhizophysa* (*Rhizophysa filiformis* Forskål) x 30
 - Figure 4. *Physalia* x 2
 - Figure 5. Cormidium, *Physalia* x 3
 - Figure 6. A part of major (or primary) tentacle x15

Suborder Cystonectae Haeckel, 1888

Family Physalidae Brandt, 1835

There is a short inflated stem [**no stem**] lying horizontally along the ventral surface of the large pneumatophore. Cormidia present in clusters.

Genus *Physalia* Lamarck, 1816*Physalia physalis* var. *utriculus* La Martinière

The body consists of an extremely large pneumatophore with a stem [**no stem**] attached to its ventral surface. The position of the latter, however, is only discernible by the clusters of cormidia.

The pneumatosac of the pneumatophore is quite large horizontally. Its cavity is connected to the outside through a pore in its frontal surface [**at the after or down wind end**]. The position of this pore would ordinarily be at the upper end of the pneumatophore but because the growth of the stem is extremely asymmetrical, the vertically situated pneumatophore becomes horizontal and hence, the lateral position of the pore. The pneumatosac is suspended freely inside the pneumatophore and between it and the outer wall of the pneumatophore there are no partitions. The space between the inner and outer sacs is almost indistinguishable because of the size of the pneumatosac. Consequently, the pneumatophore, at a glance, appears to be a single layered sac rather than a two-layered sac. The lower posterior [**anterior**] surface of the pneumatosac is somewhat opaque. This is actually the gas gland.

The indigo [**sky**] blue outer wall of the pneumatophore contains longitudinal muscle fibres while the inner part contains transverse muscle fibres. The part forming the dorsal side forms a horizontal crest. In young specimens, this is simply a fold of the pneumatophore wall but gradually it becomes separated into a comb-like structure by several septa forming a number of compartments. Between these primary septa secondary septa develop within each compartment which therefore becomes further divided into two smaller compartments. With well developed specimens, a third growth of septa is occasionally seen. The position of the crest, too, in many cases, changes as the growth proceeds. When the animal is in a young stage, the crest is situated directly on the upper median line, but it gradually moves towards the right side as the left side (rarely the right side) of the pneumatophore grows more vigorously than the other. [**Use of r. and L. same as by Woodcock, 1944**] Thus, the median plane of the pneumatophore becomes crooked. Therefore, it finally completely changes its position from the right to the left side. The crest and septa are a somewhat different green from other parts of the pneumatophore.

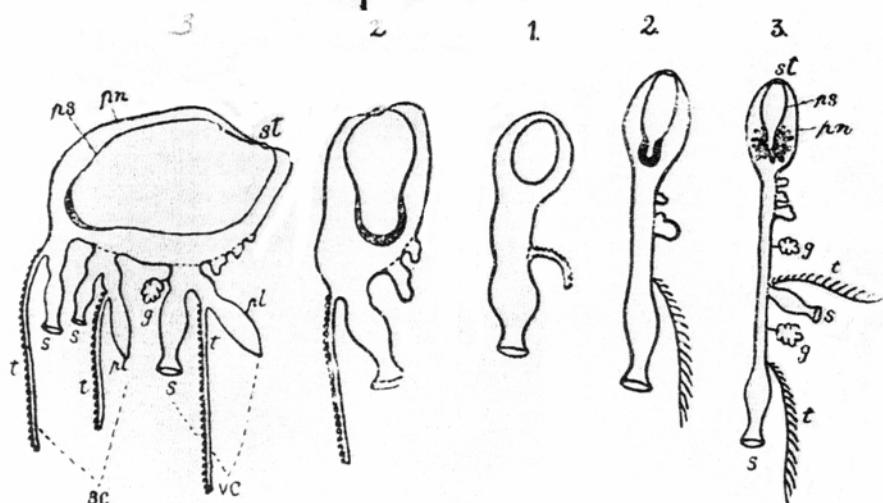
The general shape of the pneumatophore is spindle-like when young, but, because of the crest on the upper surface, it resembles a lamp shade made of net (figure 2A). However, as it develops, its posterior part, that is the side which had originally been the lower part of the pneumatophore, becomes more inflated than the anterior part [**Bad in conception - description**]. Therefore, it becomes egg-like in shape. Furthermore, because the pointed end of the posterior part moves to the right [**port side**] (rarely to the left) side, it finally becomes triangular (figure 2B). The shape of the pneumatophore, however, varies and hence it is not at all uniform. This description, therefore, is quite general.

Numerous individuals are attached in clusters on the underside of the pneumatophore and appear to be irregularly arranged. However, according to earlier investigators on young specimens, the cormidia are rather regularly arranged and each cormidium consists of a siphon, a palpon [**ampulla**] and a tentacle. In the larval stage the individual has a cormidium consisting of one siphon, a palpon [**NO ampulla**], and a tentacle at the posterior end of the pneumatophore. This never develops a

gonodendron even in the adult. Then several cormidia develop in front of this cormidium but all are weak in growth. Haeckel differentiated them by calling them "basal cormidium" [anterior sensu AKT] and "ventral cormidium" respectively.

The ventral cormidia are strongly developed and permanently active, usually growing in clusters, slightly anterior [posterior] to the basal cormidia but never further forward [back] from the centre of the pneumatophore. Either when the crest on the dorsal side of the pneumatophore is divided by the primary septa or when the secondary septa start to develop, they are found on the ventral median line but as the colony develops, the median plane of the pneumatophore grows off centre. When the posterior [anterior] end bends to the right [port], their position is approximately at the left [starboard] posterior corner of the pneumatophore. However, among these cormidia, numerous large siphons, palpons [ampullae] and tentacles clustered without any obvious pattern.

Figure 4



Although a siphon in this case is a simple spindle-like canal when young, the adult form has three separate parts. (This is only true in the ventral cormidia). The part near the basal end that corresponds to the stalk and the basigaster [**the ampulla is the basigaster**] of other siphonophores is extremely short. The large stomach in the centre is very capable of extending and contracting. Its inner wall has a rich growth of clack processes and the lips at its pointed end have a very muscular wall which extends and contracts very freely. It also has nematocyst around the fringe.

The gonodendron which develops near the basal part of the siphon becomes branched. The terminal branch (figure 3) has a large medusoid appendage (m), numerous gonophores, and three to five gonopalpons [**actually 2**]. The gonophores of this species will be discussed in detail with those of the species of *Rhizophysa*.

The parts that develop in a cluster from a common basal part rather than close to the base of the siphon are the individual palpons [**ampullae = basigaster**] with their accompanying tentacle. Studying one of these palpons, it is obvious that its shape is simply cylindrical, ending blindly at the tip, that, like the siphon, many blackish processes are present on its inner wall. The tentacle is an extremely long, thin, tape-like growth with well developed muscles. Its flat sides correspond to the lateral surfaces of the tentacle. Therefore, on its so-called dorsal side, the kidney

shaped nematocysts [**pads**] are attached in a row while the ventral side, with well developed muscle, is inflated like a fringe.

On a cormidium attached to the bottom surface [**of the float**], the tentacle as well as the palpon [**ampulla**] from which it is suspended, attain an exceedingly large size at an early stage. The part of the pneumatophore adjacent to these also elongates to become a suspended canal. Consequently, a cormidium becomes divided into anterior and posterior parts. In order to differentiate this large tentacle from others, it is called the major (principle) or large tentacle. In addition there are sometimes one to several other smaller tentacles present.

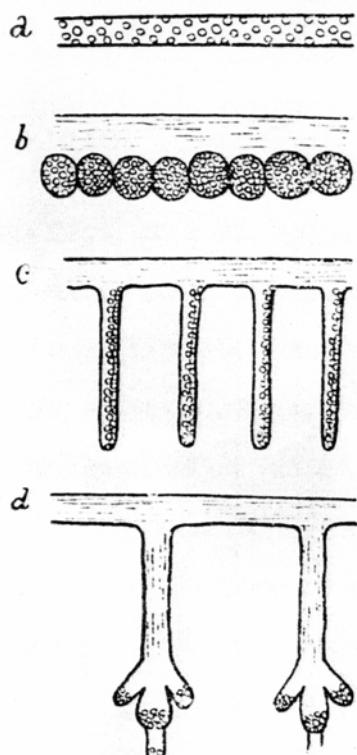


Figure 5

For a long time the number of these so-called principle tentacles has been used as a means of differentiating the Pacific from the Atlantic species - that is, while the Atlantic form was said have many numbers of these tentacles, the Pacific form had only one. However, of the specimens caught by the author near Izu Oshima ($34^{\circ}44'N$, $139^{\circ}24'E$), two of them had two major tentacles while one of them had four such tentacles. Therefore, inasmuch as the shape and size of these tentacles could not have been said to be identical, it was possible to identify the minor or secondary tentacles even on the smaller specimen. And, furthermore, even among the specimens caught off Misaki and preserved in our classroom, there was one individual with two primary tentacles. Since these specimens were comparatively mature forms, the number of their primary tentacles might have perhaps increased with growth. In any case, it is erroneous to assume that the Pacific form has only one of this type of tentacle and that by this alone the distinction can be made. This hasty conclusion ,may have arisen from the fact, as Schneider assumed, that most of the specimens caught in the Pacific had been young. Now by reading the records of the Atlantic form, here and there, it appears that they do have a greater number of primary tentacles, and that not all the

Pacific forms caught were young specimens. Therefore, it might perhaps be best to assume that with this [Pacific] form, the number of tentacles begins to increase at a much later stage of growth than the other form. At any rate, the author believes that the number of tentacles cannot be taken as a characteristic to distinguish these forms definitely. Therefore, they are considered to be the same species. However, there is some definite difference in the number of tentacles. Therefore, the author will tentatively classify the Pacific form as a variety of the other.

The author has been able to study a considerable number of *Physalia*. Of these, seven were collected by the author near Oshima and the others were caught by Prof. Kishikami and the late Mr. Hirota, etc. near Shima Aho (near Mie Prefecture 34°30'N, 139°30'E approximately), Miyake I. (34°05'N 139°32'E) and the Ogasawara (Bonin) Islands. The latter group was subsequently kept in the specimen room of one of our classrooms. The pneumatophores of the author's seven specimens measured 40-65 mm in horizontal length, 12-20 mm in maximum horizontal width. The width of the primary (major) tentacle was, even in the largest specimen, only 2 mm, but its length could not be ascertained since it had been artificially cut off. Among the other group of specimens, the largest one was found in the catch that had been made near Miyake Island, and its pneumatophore measured 80 mm in length and 38 mm in width.

Comparison of *Rhizophysa* and *Physalia*

Before discussing the structural similarity of *Rhizophysa* and *Physalia*, their individual developmental stages should be first studied. For example, figure 4 (1) is a larval form peculiar to the siphonophores of the Order Physophorae [**Rhizophysidae**]. In *Rhizophysa*, this form gradually elongates vertically as shown in figures 4 (2) and 4 (3) to become cormidia consisting of siphons (s), tentacles (t), and gonodendra (g). While the pneumatophore remains in a vertical position as before, the larva develops a gad gland on the under side of the pneumatocyst. However, in *Physalia*, the stages shown in figures 4 (2) and 4 (3) gradually take horizontal positions and the form basal cormidia [**BC**] consisting of siphons (s), tentacles (t), and palpons (p), [**gonos too**] at the posterior end. Next, in addition to these three structural parts, it develops a ventral cormidium [**VC**] which forms gonodendra. The pneumatophore becomes inflated at the same time and the pneumatocyst continues extending horizontally until it fills the inner cavity of the pneumatophore. However, in both cases, the pneumatocyst connects with the outside through a pore.

The tentacles of *Rhizophysa* grow from the base of the siphon. This is characteristic of siphonophores generally. However, since similar structures in *Physalia* develop from the base of the palpon [**basal ampulla = basigaster**], it is somewhat difficult to interpret it morphologically. In fact, many investigators in the past have tried to provide some sort of explanation for this. Eschscholtz, for instance, compared this to the sac at the base of the ambulacral feet of Echinoderms while Leuckart and Huxley called it "tentakelbläschen" (tentacular sac) and "basal sac". Yet it was Haeckel who called it a palpon. With due respect to these investigators, the physiological function of this structure, though variously named, is in reality identical to that of a palpon [**NO - basigaster**]. Haeckel further stated that this could either be considered as a sac which had, secondarily, developed from the base of a tentacle or a pair of siphons which had budded out from a common basal part, one of which had lost its tentacle in the course of development while the other had lost the opening at its pointed end and the hepatic villi on the inner wall.

Comparing the tentacles of *Rhizophysa* and *Physalia*, one finds an obvious difference between them. The branch-like portion of the former has a slender canal while the corresponding portion of the latter has a kidney-shaped globular structure [**nematocyst pad**]. In both cases, however, they are the most primitive form of tentacles found in siphonophores [**except Apolemia**]. Ordinarily, the primary shape that a thread-like protective organ with nematocysts could take, is simply a long thin canal on whose wall numerous nematocysts are spotted (figure 5a). This is a common structure of tentacles in the hydromedusae. Although this type of tentacle is not generally present on [**gastrozoids of**] the siphonophores, the palpacle developed from the base of the palpon of some members of this group has the identical structure of this tentacle. The next type is a simple, slender, muscular canal without spotty presence of nematocysts which, in this case, are massed on the one side of the canal wall as illustrated in figure 5b. Such a type occurs on the tentacle of *Physalia*. Still a different tentacle is the one shown in figure 5c, where the nematocyst groups become collected on lateral branches extending sideways like sticks. In the genus *Rhizophysa*, this is true in the case of *Rhizophysa eysenhardti*. More advanced than this type of structure is that resulting from a second branching or a so-called lateral branch on which are masses of particularly large numbers of nematocysts as illustrated in figure 5d. This is exactly the type of structure seen on the tentacle of *R. filiformis*.

With a still further development complete nematocyst clusters grow on the tips of the lateral branches, and the structure itself becomes extremely complex. Such a growth, for example, may be an elastic filament which does not break easily when the nematocyst cluster attaches itself to an intruder's body, a small thread-like growth on the tip of the lateral branch that causes the nematocyst cluster to discharge when approached by an enemy, a swimming bell [**involuture**] to face the nematocyst cluster upward [**above**], a bell-like covering mantle, or a complex sac, which sometimes becomes doubly or even triply overlapped to store the cell clusters when not in use. Thus, this diversely developed structure is variable in each species but the detailed discussion of these will be postponed to a later date when species with such complex tentacular structures are recorded. The discussion at this time shall be limited simply to a comparison of the tentacles of *Rhizophysa* and *Physalia*.

The obvious analogous part of these animals is the structure of their gonophores. That is, in both cases, these are attached on a much branched stalk, with a gonopalpon and a medusoid appendage. The growth of the male sex cells on the gonophore of either *Rhizophysa* or *Physalia* has been recognised for a long time and [**some of**] the gonophore [**s have been**] is shown to be a male. Therefore, there should not be a female gonophore. Yet Haeckel has assumed that the previously mentioned medusoid appendage is the female gonophore which, upon leaving the parent body, incubates the eggs. On the other hand, Brooks and Conklin have presented the theory that this medusoid appendage is not a female gonophore [**It is an asexual medusoid**]. As a result of this theory all previously known species [**specimens**] of *Rhizophysa* and *Physalia* are males and the female form is not yet known. In all probability they occur in markedly different structures [**NO**]. For this reason, Prof. Goto has also studied *Physalia*. Yet, according to the result of the investigations carried on independently by Stecke and Richter, three or four years ago, gonophores previously considered as male are not always of that sex and a [**so-called male**] gonophore of the gonodendron could be either male or female. [**Confirmed**]

There is still another much debated question from the standpoint of the histology in connection with these siphonophores - namely, the tissue on the underside of the pneumatostac of *Rhizophysa*. [**i.e. giant gas gland cells**] For instance,

the result of studies by Chun and Schneider differ considerably. Consequently, their method of comparing the pneumatophores of this genus with those of other siphonophores also differs from other investigators.

Both *Rhizophysa* and *Physalia* are so well known as stingers that they are greatly dreaded by the fisher folk. *Physalia* particularly, has such an incomparably intense sting that such a sting causes the skin to form blisters like that of a burn.

Rhizophysa too is known to cause much trouble and consternation to the fishermen when they are hauling in fishing lines at night.

These genera both occur at the surface in tropical waters. An Atlantic specimen of *Physalia* recorded by Haeckel [**mentioned largest specimen with tentacle 20-30 metres or more**] had a pneumatophore measuring over 30 cm in length and a palpon of 20 cm in length which is the largest ever reported so far. The composition of the gas in the pneumatophore of *Physalia*, according to the analysis made by Schloessing and Richard is 1.7% carbon gas, 15.1 oxygen and 83.2 nitrogen and argon.

Although the siphonophores generally feed on [**fish and**] crustacea and minute organisms, Bigelow [**not H.B.**] records his experience of seeing a siphonophore feeding on a herring. From this one can readily understand how powerful a weapon the tentacle of *Physalia* is.

“Batei kurage”
Hippopodius ungulatus
 by Tamiji Kawamura
 Dobutz, Z. Tokyo, 22, 468-471, 1910

“Batei kurage” is the Japanese name for members of the genus *Hippopodius* belonging to the family Polyphyidae of the Calycophorae. This family is readily differentiated from other Calycophorae by having more than three nectophores. However, on closer examination, siphonophores with more than three nectophores are not altogether unknown even in the Diphyidae. Therefore, for the benefit of differentiating this family from the other families of the Suborder Calycophorae its outstanding characters are given below.

Family Polyphyidae

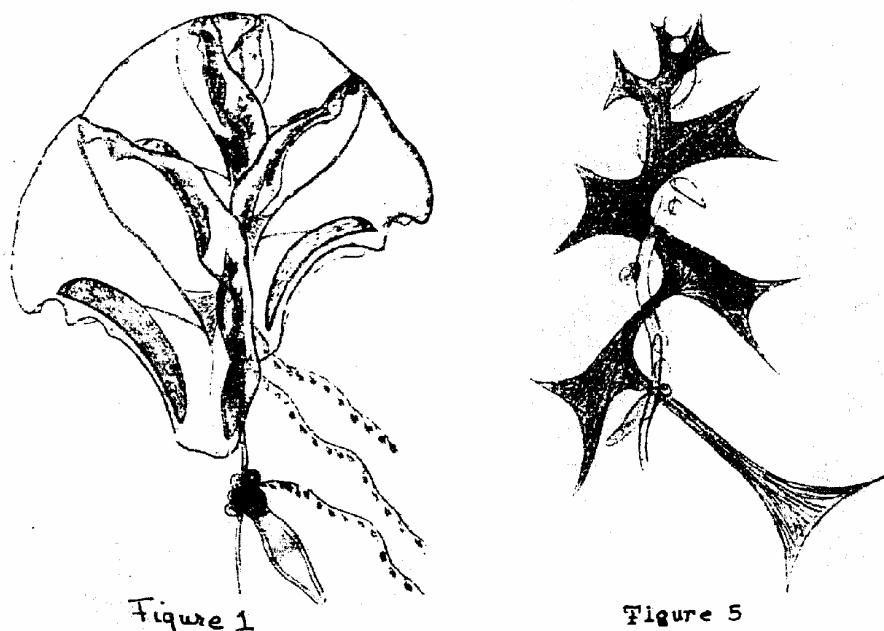
After casting off its primitive nectophore, it grows numerous identically shaped nectophores. The cormidia without bracts and mature attached to the stem [**gonophores swim freely**].

Genus *Hippopodius*

The nectophore is horse-shoe shaped, round and smooth, and without angular edges.

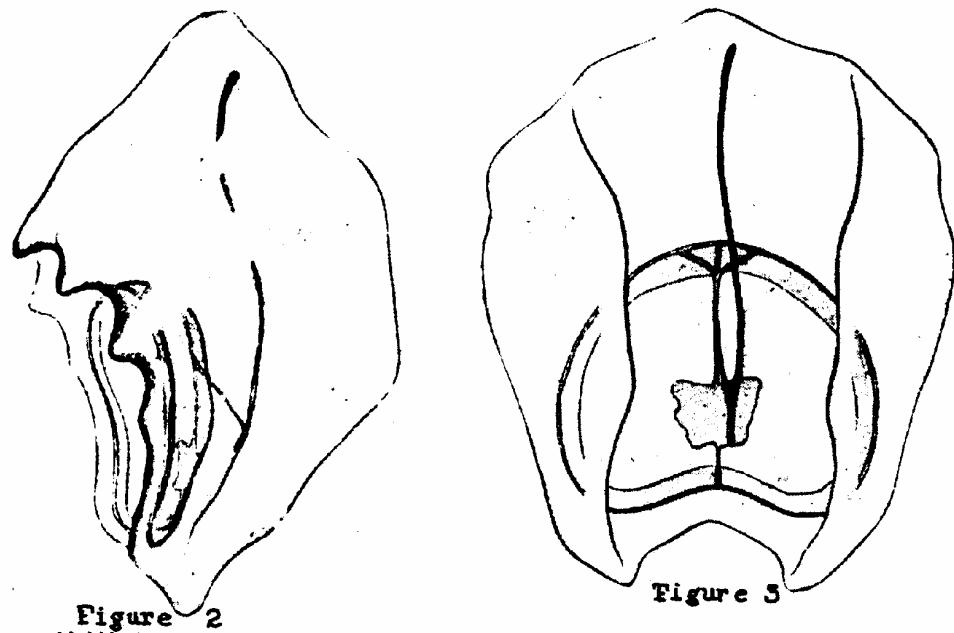
One species *Hippopodius*: *Hippopodius ungulatus* Haeckel

The body consists of numerous nectophores arranged in two rows. It is like a cone pressed slightly from the side. An elongate stem hangs from this. The pressed surfaces of the body correspond to the lateral surface of each nectophore (figure 1).



An individual nectophore is almost horse-shoe shaped when seen directly from the front and if observed from the side is cuneiform with the surface divided into five planes. The lateral surface, that is, the surface which in its natural position faces upwards on the outside, is somewhat convex and is separated into four smaller surfaces by three parallel ridges. At the lower margin, there are four dull pointed

conical processes. The lower surface, that is, the surface facing below toward the outside in its natural position, is horse-shoe shaped and deeply concave. In the centre of the latter is situated the nectosac opening. Surrounding this opening, in addition to the four processes previously described and adjacent to the upper part, there are two very inconspicuous processes on each side and two rather large conspicuous processes on the lower side. Both lateral surfaces of the nectophore are nearly flat, and irregularly quadrilateral in shape. The longest side is on the inner part of the structure while the shortest is the lower part. The upper surface and that which corresponds to the ventral one, that is, the surface that faces inward in its natural position, are saddle-like as they are longitudinally convex and are laterally concave. The sides take a wing-like shape by extending longitudinally, although remaining flat. Several nectophores collected here are actually those on the upper part of the structure, clasped by the opposite side of the wing. At slightly below the middle of this structure, a triangular, muscular, membranous stalk is attached in an arc along the median line of the stem. The nectosac of the nectophore is wide and shallow, almost like a dish. Although its outer rim is rounded, its lower side is concave; therefore, the shape is more like a kidney. Its wide opening faces outwardly below and has a somewhat wide velum.



The cavity canal from the stem enters the gelatinous part of the nectophore slightly below the middle of the ventral median line of the nectophore.

At this point the canal immediately branches to form a second canal running close to the surface of the nectophore along the median line and ending blindly near the upper end. The main canal which runs straight through the gelatinous part, branches into a dorsal and ventral canal at the apex of the nectosac. The dorsal canal is half the length of the ventral canal and branching off from it are a pair of lateral canals. Half way along the ventral canal, there is an inflated part like a truncheon. Since the four canals (dorsal, ventral, and two laterals) correspond to the four radial

canals of the nectosac, which has slightly shifted their positions, they connect with the circular canal at the base of the velum.

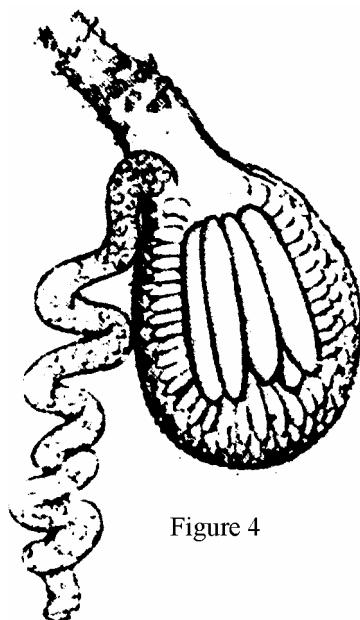


Figure 4

The long, thin canal-like stem has numerous cormidia attached near the top, and each of these cormidia consists of siphons, tentacles, and male and female gonophores.

The siphon consists of a stalk, a basal part, and a large spindle-shaped stomach. The proboscis expands and contracts freely. The upper half of the stomach is a beautiful vermillion colour.

The tentacles are small and long, developing from the stalk. On it are found lateral branches spaced at equal (distances). Each of these consists of three parts - the stalk, the nematocyst cluster, and the terminal filament. The stalk is columnar, and covered with cilia. The nematocyst cluster consists of five extremely large nematocysts and a countless number of smaller nematocysts which are arranged in an orderly manner. Cilia are also present on the outside. The long columnar terminal filament is small and has numerous minute nematocysts.

The gonophores are attached close to the stalk of the siphon and ordinarily one female gonophore is found above it and one or two male gonophores below.

In general, in the siphonophores, the closer the nectophore is situated to the cormidia, the more mature it is but in this genus the situation is reversed. The reason for this is that the attachment of the nectophore bends and elongates as it grows from the apex of the stem. However, the stem is twisted like a rope around the stalk to which the nectophore is attached as shown in figure 5.

Hippopodius unguilatus has been recorded by a number of investigators over a period of many years. Consequently, there are now more than ten accepted synonyms. The two specimens caught by the author were, in both cases, caught off the Misaki Laboratory during August 1907 - one with three nectophores and the other with five nectophores. The author, however, very much regrets that it was not possible to make a detailed study of the cormidia as these specimens were comparatively young and the lower half of their stems had been lost. At any rate, with the larger specimen, the largest nectophores measured 10 mm in length and 8 mm in width.

Supplement

The author wishes at this time to request that, if any investigator ever observes or hears of the occurrence of this species or any other siphonophores, he be good enough to make a detailed report of such finding. Heretofore, as far as our species of siphonophores are concerned, only a small number of specimens have been taken in the vicinity of Misaki, Izu Island, Boshu, Suraga Bay, and Shima. However, the author feels that many siphonophores very possibly occur in our coastal waters, particularly in localities exposed to oceanic conditions. Undoubtedly, the siphonophores are a group which have an extremely large number of individual variations. For this reason the author sincerely hopes for opportunities to study as many specimens as possible.

Genus *Agalma* and *Crystallomia*

by Tamiji Kawamura

Dobutz, Z. Tokyo 22[23], 1-10, 1911 [No. 267]

[pl. 16 of vol. 22 ?1910]

[Who was "my senior Mr. Kawamura"?]

The following siphonophores belong to the family Agalmidae, suborder Physonectae, order Physophorae. The structural features of this family are as follows: the stem is long and cylindrical; the nectosome consists of nectophores in 2 rows; the bracts and palpons are situated on the cormidia; the cnidoband is spiral, either partially or wholly covered by an involucrum.

Although the Agalmidae include a large number of comparatively common siphonophores, there are, however, 2 or 3 genera with quite complex characteristics, not found in previous investigations among other members of the family. However, since the classification of a great many of the old genera is indefinite, and rather confusing the taxonomic characters of this family is no different from other families.

Haeckel, in 1888, recorded 10 genera and 32 species of known siphonophores in the "Challenger" report but there must have been an exceedingly large number of species omitted from this report. Consequently, in 1895 Bedot contemplated the reclassification of this family. Also there are 2 or 3 other classifications by other investigators. We do not, of course, altogether lack some sort of taxonomy for the family at present. Yet, considerable difficulties are encountered because no accurate observation of Pacific species has been made for almost a half century, and the specimens caught on the various expeditions are not all sufficient for identification.

Family Agalmidae can be divided into 2 subfamilies as follows:

1. Subfamily Crystallominae

The hard, short siphosome is surrounded by thick, muscular pyramidal bracts; and is almost the same length as the nectosome. The cnidoband is entirely enclosed by an involucrum.

2. Subfamily Anthemodinae.

The siphosome is equipped with leaf-like or relatively flat bracts, is soft, and considerably longer than the nectosome. The cnidoband is partially enclosed by a bell-like involucrum around its upper part.

Among many siphonophores belonging to this family, observed by the author near Misaki, there were 5 species definitely identified upon close examination of their structure.

Agalma okeni Eschscholtz and *Crystallodes polygonata* Dana belong to the first subfamily.

Agalmopsis elegans Sars, *Stephanomia amphitrides* Huxley, and *Cupulita picta* delle Chiaje [**Metschnikoff**] are of the second sub-family.

In the following only the first two species shall be discussed leaving others for a later date. For *Agalma okeni* the Japanese name "Yoraku Kurage" was used by my senior Dr. Kuwano, but *Crystallomia polygonata* [**okeni**] the author wishes to name, in Japanese, "Koyoraku Kurage" [Translator's note: "Ko..." signifies either a child or a baby in English] because of its general smallness although quite similar to the former.

Genus AGALMA

Bracts in 8 rows; 2 longitudinal ridges.

Agalma okeni Eschscholtz. Plate 16, 1-8 [Vol. 22].

This species very commonly occurs near Misaki especially in winter, and in early spring it occurs in large numbers. The body is cylindrical in shape, with rounded ends. Even the small ones attain the size of 8 cm in length, 2 cm in width, while the large ones sometimes exceed 13 cm in length and 3 cm in width. Seeing them float on the sea surface, it is obvious that they reach the surface when the water is calm but a slight sea makes them descend immediately. Generally, the main axis of the body is maintained diagonally but it may sometimes be perpendicular or horizontal.

The body itself is divided into two parts - the upper part is the so-called nectosome and the lower is the siphosome. Through their centre, the axial stem is situated - which is generally in a straight line but occasionally found to be otherwise.

The nectosome is a dodecagonal shaft slightly tapered toward one end, whose diameter is slightly less than that of the opposite end. It consists of a small pneumatophore at the apical end and 2 rows of nectophores (swimming bells) each row partially overlapping each other.

The pneumatophore is a small egg-shaped bag almost twice as high as it is wide and contains reddish brown pigment at its apex. Within the pneumatophore, there is an air sac with 8 partitions giving the appearance of 8 stripes when seen from the outside. If a live specimen is observed, the pneumatophore is often drawn into the nectosome by the vigorous contraction of the stalk.

The nectophores bud out from the underside of the pneumatophore one over the other in an orderly manner. The extent of this growth downward is an indication of its age. If a nectophore is examined, it is seen to be bilaterally symmetrical, flattened upwards and downwards, while from the centre toward the rear [**inside?**] it becomes thinner like an oar.

When observed from above or below the nectophores resemble the bridge of a stringed instrument ("Koto - Jap. instru."). Both their upper and lower surfaces are large, and they are octagonal in outline. Along the centre of the upper side there is a slight depression forming a gutter running along the median line and on the underside an inconspicuous ridge both extending to the front side, and terminating above and below the opening of the nectosac. Both lateral surfaces of the nectophore are extremely narrow and two perpendicular ridges divide each surface into 3 smaller areas. That is, the forward and the centre parts are square and the terminal end is a triangle. The front (outer) side of the nectophore is small, almost square and the centre is round where the opening of the nectosac is situated around which a wide marginal membrane is found.

The nectosac is comparatively small situated only in the front half of the nectophore and clearly divided into three parts, that is, a median cylindrical part and a pair of coelom-like pouches which branch out from the first part at right angles. The coelenteron growing from the stem, enters the gelatinous part of the nectophore in the median line - that is, at the base of the curve. This canal branches immediately into a pair of simple canals upward and downward while the main canal reaches directly the apex of the nectosac by piercing through its gelatinous part. At this point the canal branches out into 4 radial canals. Of these, the superior and inferior radial canals run unbranched along the nectosac (The other canals) first coil on the upper wall of the nectosac and then turn toward the lower wall, finally reaching the mouth of the nectosac. With this circular canal, it comes connected with both the superior and inferior canals.

There has been a theory as to how the nectophore is attached to the stem. When the nectophore is separated from the stem, the attached part (lamella?) of the entire nectophore aligns on one side of the stem. Consequently, it has also been a

commonly accepted fact that growth of nectophores in 2 rows is nothing more than the result of a twisting of the axis. This interpretation was accepted not only by Claus and Gegenbaur, but also by many other scientists and it is as yet a widely used definition in many books today. However, this theory was later learned to be erroneous. In 1897, Chun corrected this theory of constriction with his "Knospungsgesetz der Schwimmglocken" which states that the nectophore budding at the ventral side buds lateral to both sides [**i.e. moves alternately from one side to the other**], the stalk of the mature nectophore becomes the supporting lamella (Stiellamella), a rectangular membrane, and bends at both ends, hence, its lateral alignments. Following this presentation of Chun's definition, Schneider offered a very strongly refuted interpretation but it was nothing more than a hypothesis without the proof of actual observations of a specimen. The facts that the stem of the nectosome is not at all twisted, and the growth of the supporting lamella (Stiellamella) [**peduncular lamella**] laterally from the ventral side to both left and right were easily verified by this author with 5 species of this family and the genus *Physophora*, and further these facts can be readily recognised when the living specimens are inspected. Thus, it is difficult to understand why such errors were never corrected during all these years. It is, therefore, sufficient to say that many records in the past in the field must have been similarly based on incorrect definitions of the specimens.

As has been described previously, the nectophores bud one by one from directly below the pneumatophore. Therefore, if their young forms attach in a group at this point, are studied, the various stages of growth can be easily observed. Hence, it is possible to learn how they develop.

Although this was known to Leuckart, Kölliker, Vogt and Claus etc. with various genera studied, in 1860 Claus further continued the study of this question with *Stephanomia contorta*.

Our species of *Agalma*, too, has a multiple row of juvenile nectophores directly under the pneumatophore, therefore, this genus is a most ideal object in retracing the developmental stages of nectophores and generally coincides with what has already been described by other investigators. However, our species differ in one respect - that is, during the growth of the radial canal to left and right (this will be discussed later) it temporarily develops a sac-like inflated part [**diverticulum**]. Briefly describing it at this time, the author may say that the nectophore at first buds out from the stem like a nipple with ectoderm and endoderm. This process is shaped like a ball at first but shortly becomes flask-shaped as its basal part becomes constricted its terminal ectoderm layer forms a depression (groove) in which the buds of the bells (Glockenkern) are developed. The neck of the "flask" later becomes a longitudinally flat membrane (sac) then a supporting lamella (Stiellamella) which has been described already. The coelenteron within, gradually, connects the cavity between the stem and the nectophore and then the inflated part of the "flask" that constitutes the main part of the nectophore by taking a laterally symmetrical form as it is slowly pressed both upward and downward. Prior to this, a division of the central part becomes transparent and goes out through an opening while the ectoderm (outside layer) becomes, a so-called superior covering layer of the inside of the nectosac. The muscular wall of the nectosac develops from doubled endoderm by forming a depression because the growth of the nectophores (Glockenkern). As the space between these double layers gradually disappears when they heal together, a part of the nectosac grows into a circular canal and 4 radial canals of the nectophore. From this doubled endoderm toward the outer side - that is, between endoderm and ectoderm the gelatinous substance is produced. This is most conspicuous at the sides

of the base, and gradually spreads toward the other parts, finally lifting the ectoderm. The cells forming the ectoderm can be seen like a superior covering layer of beautiful paving stones in a young nectophore but such a condition cannot be seen when fully developed [sometimes]

Of the 4 radial canals, the lateral ones develop an inflated section at the end of the "horns" of the nectosac [**diverticulum**]. The inflated part, at first, is large and long but gradually decreases in its circumference and length finally disappearing completely. Consequently, in a fully developed nectophore such an inflated section cannot be seen. However, with an ordinary specimen a trace of this growth can be easily seen, even with the naked eye, on several nectophores situated on the nectosome. [No connection or homology between these diverticula and the 'rete' in *H. hippopus*]

This temporary growth of an inflated part, since it also has a bearing on the exterior shape of the nectophore, does not occur in the genus *Crystallomia* which has one less longitudinal ridge on the lateral side of the nectophore as compared with the genus *Agalma*. [!!!?]

The growth of an inflated part on the radial canal has been made known by Eschscholtz as early as 1829. He, however, wrongly identified it as a part of the nectosac (of the nectophore). Aside from this observation this particular developmental stage in the entire siphonophore group has never been reported except in the genus *Hippopodius* [**ventr. sinus**]. In this genus the part forms the shape of a war-truncheon (see above) on the ventral radial canal, and it is a permanent organ while the same part in the genus *Agalma* is a temporary development. Now, if this question of the structural difference of these radial canals is to be stressed, the taxonomic classification is still further divided sometimes as either Monophyidae or Diphyidae. In any case, their structural characteristics, perhaps, may be similar to the inflation of the radial canal in the case of *Agalma okeni*.

Toward the lower half of the body is the siphosome, consisting, according to our observations, of 5 to 15 connected cormidia. Each cormidium consists of a bract, a palpon, a siphon, a tentacle and a gonodendron. Of course, the lower the position of a cormidium the older it is. The siphosome as a whole is almost equal in length to the nectosome but slightly greater in width. But since the entire surface is covered with thick polygonal bracts, it can be safely said that neither the longitudinal nor the lateral dimension changes at all [**passing from nectosome to siphosome**]. It should be noted that since the stem (which is the axis of the body) twists 90° between the nectosome and siphosome without their ventral sides [? so that ventral sides are not aligned?] coming together [**and so**] the nectophores of the nectosome growing toward left and right meet the dorsal and ventral side of the siphosome respectively. [NO twist. The growing points of nectosome and siphosome are on opposite sides of larva in Agalmids (see my large series of larvae of *S. bijuga* from Villefranche.)] Generally, the width of the nectosome and the dimension between the dorsal and the ventral sides of the siphosome are greater. Consequently, this 90° twist in the stem makes their shapes ideally adapted to each other. Further, this structural characteristic seems to be significant in the locomotion of the animal.

The numerous thick, hard bracts which protrude at right angles to the stem closely surround the stem leaving practically no space between each other. They may vary in size but the shape is always the same. They are oar-like or diagonally oblique drill-like. The end near the stem is a blunt wedge while the other ends in the form of a parallelogram as if it was cut off. The external surface of the bract is divided into 4 small surfaces by ridges. With the exception of the centre ridge a still smaller space is

formed at the lower end of each remaining ridge - in each case each area is slightly depressed. The upper side of the bract is raised as a whole, it has indistinct ridges along its arrow-like stem, dropping to right and left. The underside is very much like the upper, only often found to be saddle-like. Within the bract a small canal runs from the inner attachment along the median line on the underside and connects with the coelenteron by a tubular canal.

In each cormidium there are usually 8 bracts, 4 each on the right and left. This manner of piling, too, is quite orderly and 8 rows of bracts are developed about the entire siphosome. For example, on the left side, the left end of the first row of bracts lies slightly over the right end of the second row of bracts - thus 3rd and 4th in order - those of the right contrast those of the left. Thus opposite rows are a mirror image of one another. Furthermore, the size of the bracts increases from the dorsal side toward the ventral side.

The bracts on the ventral side of the siphosome do not grow so closely as on the dorsal or lateral sides. Instead, between the lateral bracts there is a slight space through which palpons, tentacles and siphons are extruded.

Rarely 9 bracts are found on a cormidium in which case the extremely small additional bract is developed on the dorsal side considerably later than the normal set. Chun has, however, recorded his finding of an internodal bract on an *Agalma* in the Atlantic Ocean. This specimen did not have a canal running through the bract and thus differs from this author's specimen. Furthermore, I have not yet seen a so-called "internodal bract" [i.e. no canal & dorsal] in either *Agalma* or *Crystallomia*.

Up to the present, the manner in which siphonophore bracts attach themselves to the stem have been described in many different ways, but none of the descriptions are clear. For example, Haeckel (1888) in describing the Atlantic species of *Crystallodes*, stated that the inner end of the bract is pointed, by which it attaches itself to the stem, and even in other species it was similarly defined and also shown in the illustrations. Huxley (1859) on the other hand, insisted that in *Stephanomia* the bracts are attached by a triangular process, while Claus (1879) also reported the presence of very muscular stalk in *Halistemma*. Fewkes (1881), too, figures the growth of a somewhat similar part in *Agalmopsis elegans*. However, a discussion of this is omitted here.

The author has definitely observed the presence of a fine muscular stalk on all 5 Japanese genera of Agalmidae examined. The position on the stem from which the petal-like forms develop is similar to the connecting lamella of the nectophore and the growth of laterally flat connecting lamella is like the pages of a book on both sides of the stem as can be seen when the 4 bracts are aligned on one side as is the case in *Agalma*. However, the bract and the connecting lamella attach themselves longitudinally along the stem but never by the pointed end of bracts as Haeckel described. Such a structural arrangement is easily understandable. If examined more closely under a magnifying glass, it can be easily seen without dissection.

The developmental stages of the bract are well known and have been described by such investigators as Claus and Agassiz for siphonophores in this family. But the findings of the author on these same species were not of as simple nature as had been reported. First of all, at the upper end of the siphosome many new cormidia grow one after another, so that bracts in various stages of development can always be seen on close examination. At first, the bract is vesicular with ectoderm and endoderm as is usual in any polyp and protrudes from the stem into the water. This bud is shaped like a nipple, but gradually extends to form a spindle. Later, the inner end develops a stalk with a pointed outer end. From this, as in nectophores a

gelatinous substance develops rapidly in the inter-dermal space. Finally the mature form is reached. However, the growth of the gelatinous substance is not uniform. At first, the inner half of this spindle-shaped process attained a longitudinal form as it is pressed from right and left while the outer half gradually moves downward so that the process resembles long boots. The coelenteron in the developing bract spindle-like in form is connected with the stem through contact with the coelenteron of the supporting lamella on the inner side of the bract. Then, at the parts simulating the back and both sides of the foot part of this "boot", the growth of gelatinous substance becomes exceedingly vigorous but its "toes" appear to be cut off. This surface becomes divided into 6 smaller sections.

In the development of a bract as in the case of a nectophore, the endoderm is lifted up as the gelatinous substance increases and the ectodermal cells arranged like paving stones sometimes attach themselves to the surface of the gelatinous substance. Furthermore, here and there are scattered wart-like processes with groups of nematocysts. By this time the size of the canal inside the bract is not uniform, inflating like a spindle near the outside. And the outer ectodermal layer lining the coelenteron [??] can be seen very clearly. However, when the bract completes its growth, these inner and outer cells completely disappear without trace and the canal is thread-like. But the growth of the gelatinous substance is quite vigorous near the upper and lateral surfaces while weak on the lower side. Consequently, this canal runs near the under side of the bract. Finally, therefore, the pointed process present in the beginning is comparable to the lower and to the median line of the 3 longitudinal ridges seen from the outside.

When all the bracts attached to the siphosome are removed, other individuals can be clearly seen among which the most numerous and conspicuous are the palpons.

Located on the ventral side of the stem are the small, transparent, spindle-shaped palpons with extremely thin layers. These contract vigorously and have other movements. The pointed end is surrounded by numerous nematocysts and the small palpon filament grows from its base. This small filament is covered by many small bunches of nematocysts equally spaced. These have been observed on the tentacles of other siphonophores, but they have not been recognised on the palpon filament before insofar as the author is aware. In an earlier report, it is stated that "there is perhaps a palpon filament on various species of *Agalma* but it has not been possible to detect it so far". No one, as yet, has detected this growth [?] This is probably due to its extremely small size and in addition it is also very difficult to detect the presence of such a structure in a preserved specimen which may have lost it either partially or completely. Usually, the growth of the palpon and the palpon filament [is] horizontal and toward the ventral side, but this does not necessarily limit its development in other directions. The number of palpons on a cormidium does not ordinarily exceed 15, including both young and old individuals. However, the distribution of the palpons is more or less orderly, divided into 2 groups one group encircling the upper, right and left sides of the siphon while the others cover the similar sides of the male and female gonophores. Each cormidium has a slightly larger siphon, with a short stalk, a cylindrical basal part, a wide, easily expandable stomach and a proboscis able to open and close with the capacity to contract and expand readily. Inside of the stomach are 8 lines of hepatic ridges [English words used in text].

The young siphons can be identified quite easily as they are, in the early stages of development most conspicuous with their processes common with the polypoid individuals. Then the ectoderm suddenly starts to grow, attaining its thickness, during which numerous nematocysts are seen to develop. Subsequently,

after the completion of the basal part, the stomach and the proboscis are developed as the ectoderm and endoderm extend forward.

A tentacle develops from the upper side of each siphon stalk, the tentacle is long and narrow with knots (tied parts) [**nodes**] equally spaced, from whose individual nodes lateral branches grow. Each lateral branch has a small elongated stalk, the cnidoband encased in an involucre, a terminal ampulla and two lateral horns. The cnidoband is a beautifully red colour, narrow felt-like part which turns 7 to 9 times in a spiral fashion. On this not only countless number of nematocysts are arranged but on the half near the base exceedingly large nematocysts are found attached along the sides. On the lateral horns, too, many small nematocysts are scattered and the involucre is formed by an assemblage of colourless, transparent, polygonal cells.

On the development of the cnidoband a more detailed discussion will be made with *Physophora* at a later date. However, at this time, a brief account of developmental stages of this particular genus will be given below. When a siphon gradually attains its length after budding, other slightly smaller long and slender buds can be seen growing at the base of this siphon, which is actually a tentacle on whose dorsal part found attached in a row are bead-like processes that subsequently become the lateral branches. As one of these processes grows into 3 different parts after attaining an elongated cylindrical shape the first part simply continues its growth in the original form finally becoming the stalk while the second part commences to hold numerous nematocysts on one side of its ectoderm, gradually bending into a spiral shape and finally forming a cnidoband in band-like fashion. The end of the third part longitudinally separates into 3 sections, the middle one becoming the terminal ampulla and the other two the lateral horns. However, the involucre is developed through the growth of the ectoderm developing near the first and the second parts, as it simply covers the cnidoband at first like a temple bell but later it encloses the cnidoband attaching itself between its original position and the 3 previously described terminal branches.

Numerous male gonodendra develop a pair of male sexual gonophores on the ventral side of the stems. A mature male gonophore is spindle-shaped, 3 mm in length [**check in original**] 9 mm in width [**check in original**] and its short stalk is connected to the stalk of the male gonodendra. It is a complete medusoid individual in the spadix of which are found the sex cells, and on its external bell a part analogous to the umbrella, quadriradial and circular canals are situated, but it is extremely difficult to recognise these parts on a live specimen.

A single female gonodendron on which female gonophores are attached is longer than the male gonodendron and on this numerous female gonophores are found, those at the end are most mature. The adult gonophore [**gonodendron**] is oblong (cylindrical) reaches a size of 21 mm in length and 1.2 mm in width, within which is a single coloured egg which develops on the stalk of the medusa - the coelenteron which, ordinarily should, passes through the stalk, becomes like mesh and encloses the egg. Like the male gonophores it has a quadriradial and circular canal. As far as the development is concerned it will be discussed at another time.

Crystallomia

6 rows of bracts; 2 longitudinal ridges [**? one on each side**] on the lateral surface of the nectophore.

Crystallomia polygonata Dana [**? juvenile form of A. okeni**]

Plate 16; Figs 1-12 [**9-14**], Vol. 22

most common names given; [is this translation of Kawamura?]

Agalma breve Huxley [1.8 cm. a juvenile specimen of *A. okeni* (only 1 vert. ridge on each lat. facet of nect.)]

Crystallodes rigidum Haeckel

Crystallodes vitrea Haeckel

Stephanomia incisa Schneider

Agalma pourtalesii A. Agassiz and Mayer

Agalma virida Mayer

(Translators remark: above names are referred to Japanese name.)

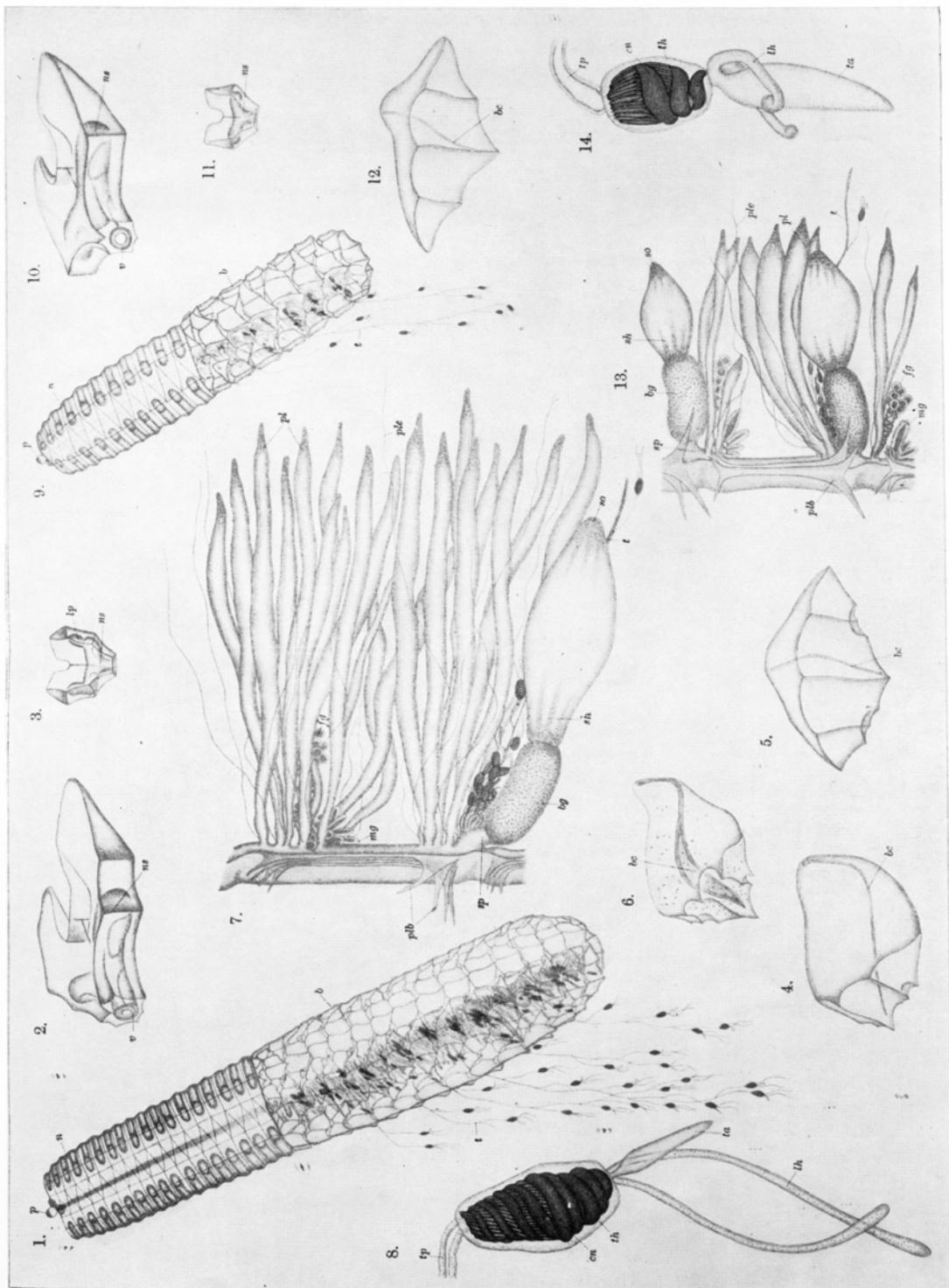
This species does not occur as often as the previous species. The general shape is similar to *Agalma okeni* but smaller. The specimens studied by the author were approximately 5 to 8 cm in length and 1.5-2 cm in width. The species has one ridge on its [nectophore] lateral surface and two rows of nectophores constitute the nectosome forming an octagonal column.

When the nectophore [nectosome] is observed from either the ventral or dorsal side, the smallness of the longitudinally running ridges in comparison to *Agalma okeni* can be easily recognised. These differences are extremely helpful in identification of the 2 siphonophores discussed herein.

The various stages of growth are generally identical to the previous species and the only difference is that this species does not develop a temporary inflated part on the 2 lateral radial canals of the nectosac. Consequently, the inflated part is difficult [impossible] to detect even on the young nectophores at the apex of the nectosome. The siphon is formed with a group of 6 to 10 stems [?palpons] and the exterior surface of 6 rows of bract which encircle the siphosome are divided into 4 small areas by 3 ridges. However, 2 further divided areas of the surface as in the case of *Agalma okeni* is not common. The most outstanding distinction between these siphonophores is the differences in the structure of the tentacular lateral branches. With this species, the spiral turn of the cnidoband does not exceed more than 4 to 5 times and the terminal ampulla has a ciliary growth and the lateral horns do not reach the length of the terminal ampulla, having nematocyst only on one side. The number of palpons, too, is smaller in comparison with the previous species, generally not more than 10.

The discussion in reference to the relation of these two species of siphonophores and of other genera of this family will be made later.

PLATE IX



[Copied from Totton, 1965, Pl. IX]

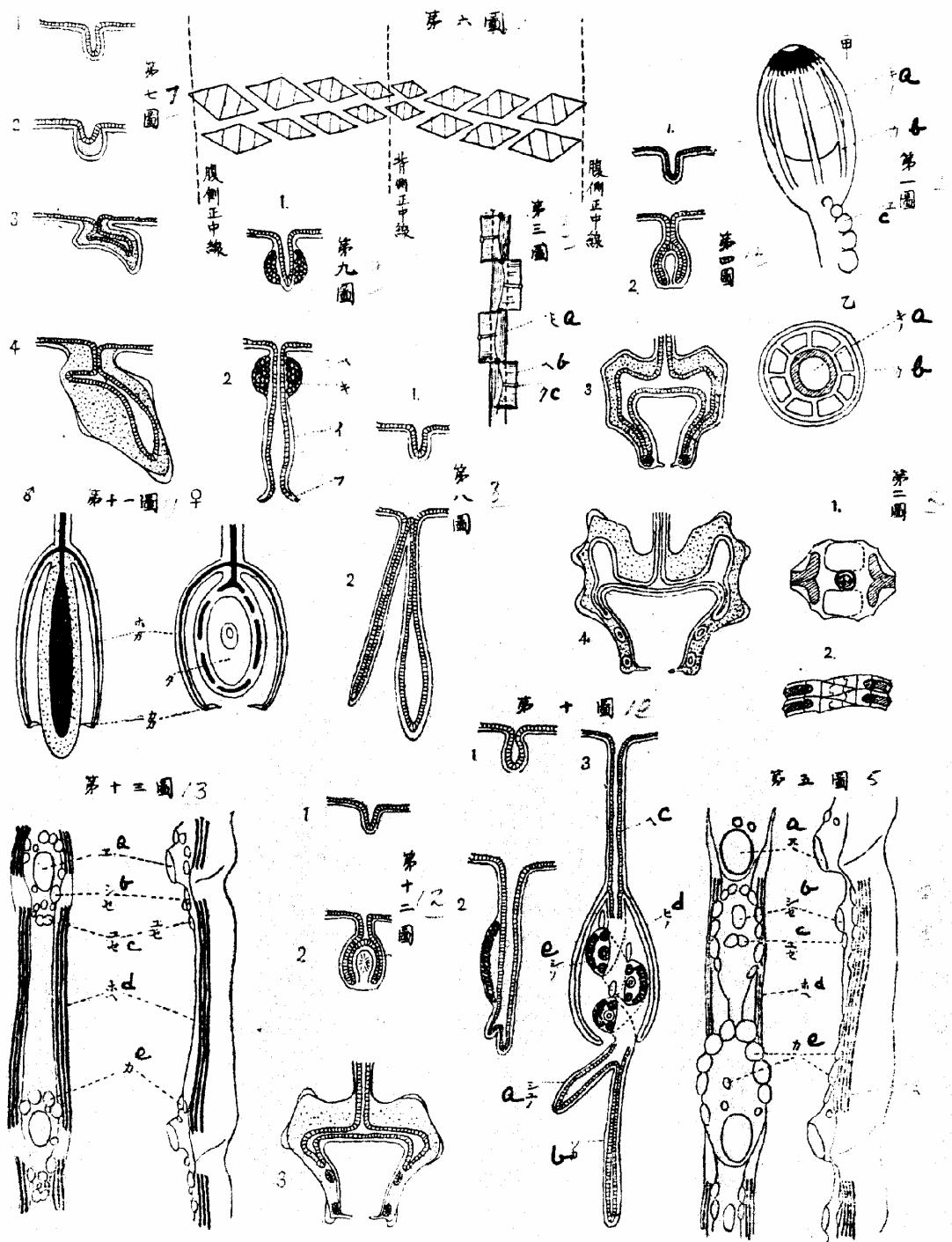
Legend to Plate 16, Vol. 22
[This legend appears on p. 10 of Vol. XXIII]

Agalma okeni Eschscholtz

- Fig. 1 Natural size seen from left. p. pneumatophore; b. bracts; t. tentacles. Small beads seen under pneumatophore are young nectophores.
- Fig. 2. Nectophore seen diagonally from above slightly to one side (x3 approximately). ns. nectosac; v. velum.
- Fig. 3. Young nectophore seen from above (x 3). ns. nectosac; lp. inflated (expanded) pouch-like part of the right and left radial canals. About this time, the median line of the upper side forms a groove (a depression) and at the same time the upper side becomes larger than the lower side. Consequently, both lateral sides can be seen from above.
- Fig. 4. Lateral view of bract (x 3). bc. bracteal canal.
- Fig. 5. Same seen from ridged side to the left (x 3).
- Fig. 6. Young bract seen diagonally from side (x 3). bc. bracteal canal. Black spots seen scattered on the surface are nematocysts.
- Fig. 7. Cormidium without bracts seen from the right (x 8). plb. bracteal lamellae; pl. palpons; ple. palpon filament; sp. siphon (stalk); bg. (siphon (basal part); sh. siphon (stomach); so. siphon (proboscis); t. siphon (tentacles); fg. female gonophore; mg. male gonophore.
- Fig. 8. The terminal cnidoband of a tentillum (x 15). tp. stalk; cn. cnidoband; the. involucre; ta. terminal ampulla; lh. lateral horns.

Crystallomia polygonata Dana

- Fig. 9. (Natural size). Siphonophore seen from left. Symbols same as Fig. 1.
- Fig. 10. Nectophore seen diagonally from above, slightly to one side (x 3). Symbols same as Fig. 2.
- Fig. 11. Young nectophore seen from above (x 4).
- Fig. 12. Bract seen from outside (ridged side) (x 3).
- Fig. 13. Cormidium, seen from the right side, without bracts (x 8). Above and below the next cormidia are partially shown. Symbols same as Fig. 7.
- Fig. 14. Cnidoband on the end of tentilla. Symbols same as Fig. 8.



Legend for Vol. XXIII, Figs 1-13 [on p. 10]

[? all figs except 10, 12, 13 appear from translation to refer to
Agalma okeni. 10, 12, 13 refer (?) to *Crystallomia polygonata*]

Fig. 1. Pneumatophore - side view and section. a. pneumatosac; b. septum; c. young nectophore.

Fig. 2. Shows nectophore viewed from above and in lateral view.

Fig. 3. a. stem; b. peduncular lamella; c. connection of coelenteron with nectophore.

Fig. 4. Development of nectophore (shaded area gelatinous; hatched area endoderm).

Fig. 5. Arrangement of individuals on cormidia. a. siphon; b. female gonophore; c. male gonophore; d. bracteal peduncular lamella; e. palpons.

Fig. 6. Showing arrangement of the bracts.

Fig. 7. Development of bracts.

Fig. 8. Development of palpon and tentacle.

Fig. 9. Development of siphons. a.; b.; c.; d.; (No translation).

Fig. 10. Development of tentacle. a. lateral horn; b. terminal ampulla; c. stalk; d. involucre; e. nematocyst.

Fig. 11. Male and female gonophores. a.; b.; c.; (No translation).

Fig. 12. Development of nectophore (see No. 4).

Fig. 13. Showing distribution of individuals on cormidia (refer to Fig. 5). a. siphons; b. female gonophore; c. male gonophore; d. bracteal peduncular lamella; e. palpon.

“Shidarezakura Kurage” and “Nagayoraku Kurage”
Cupulita picta Metschnikoff and *Agalmopsis elegans* Sars
 by
 Tamiji Kawamura
 Dobutz, Z. Tokyo, 23 (No. 273), 359-363, 1911 [pl. 7]

“Shidarezakura Kurage” is the Japanese name given to the genus *Cupulita* by Prof. Tijima. “Nagayoraku Kurage” is the name given to the genus *Agalmopsis*. These genera belong to the order Physophorae, suborder Physonectae, family Agalmidae, as did the previously discussed *Agalma okeni* and *Crystallomia polygonata*. However, the latter group belongs to the subfamily Crystallominae, while the 2 species in question are of the subfamily Anthemodinae. Of these, the genus *Cupulita* is more common. Therefore, the author wishes to call this [?] subfamily “Shidarezakura Kurage” (or subfamily “Cupulitae”). The characteristics of this family and the subfamilies have already been discussed in No. 267 of this volume pages 1-10, so they will not be repeated here.

1. Genus *Cupulita* - *Halistemma*.

Only the upper part of the nectophore band is covered in a bell-like hood (involucrum). The terminal filament of the tentilla consists of one terminal ampulla and 2 [NO] lateral horns [Is this the translator's mistake? No. Kawamura is confused about the 2 'parts' of Sars' *Agalmopsis* hence his mistake about trifid tentilla]

Since this genus most commonly occurs in the Mediterranean and in the Atlantic, it has been known for a long time and has been described in many publications as a representative species of the suborder Physonectae. The generic name was given by Quoy and Gaimard in 1824 and the genus *Halistemma* named by Huxley in 1859 is now considered to belong to the same genus.

Cupulita picta [*Nanomia bijuga*]

Plate 7. No. 1-10, Vol. 23

The author was able to study many specimens of this species while staying at Misaki Marine Experiment Station during January and February. Of these, eight are at present kept in the zoological class room of our school (the station). It addition it was also possible for me to examine a perfect specimen preserved by Prof. Iijima.

The body of this siphonophore is extremely small and long [13.5 cm] appearing exceedingly weak. The animal, when alive, vigorously expands and contracts. The length of the siphosome is 4 to 6 times greater than that of the nectosome.

The nectosome consists of a pneumatophore on the apex of the middle axis and numerous nectophores arranged in 2 rows around the same axis. There are 10 to approximately 50 nectophore [? in all] [?8-25 in each row]

The pneumatophore is small and egg-shaped, 1.8 20 2 mm in height and 1 to 2 mm in width, having 8 partitions. The light brown of the apex is very conspicuous and several juvenile nectophores are usually attached directly to the underside of the pneumatophore in the budding zone of the nectosome.

Although the exterior shape of the nectophore is a little confusing, it maintains a perfect symmetry and when viewed from the front, it forms a square whose sides are about 2 to 3.5 mm. On the other hand, the side view gives an irregular hexagonal shape, and its arrow-like axis [?the facet between 2 ridges] curves downward convexly forming approximately a 60° angle with the axis of the nectosome. The

outer surface of the nectophore is round and consists of the opening of the nectosac with a wide velum. Its lower margin is rarely extended into a process [**'mouth plate'** - **but there are two little UU**]. The dorsal surface of the nectophore is slightly depressed, ladder-like [?], and in the natural position it faces above outwardly [**up and out**]. Its surface is wide and divided into two small surfaces by a median groove which, connected to its interior [**ventral**] surface, form a large, extremely shallow curve. These small surfaces each have a diagonally reclining edge [**ridge**] near their inner side, by which they cut the shape of a triangle. [**This is 'the anomalous ridge' of Villefranche specimens 52.9.23.4-5. Often it has a fork - but is v. variable**]

Inasmuch as the outline of the ventral surface of the nectophore is nearly square, the central part protrudes conspicuously, and from its apex a ridge runs to each of the 4 corners like a four-cornered drill. The lateral sides of the nectophore are flat and form a slight irregular rectangle like a modified "S" (of a long axis).

The nectosac is comparatively very large and has, in general, the shape of the nectophore. That is, as seen in the other siphonophores of the same family, the nectosac of this species does not show the central part [**when viewed from dorsal side**] and the lateral branches distinctly. It simply has a wide flat cavity and an opening, almost vertical to this cavity, and the blind end of the former has a pair of conical processes [**the lateral horns**] on its lateral sides. Also one stalk-canals, 4 radial and one circular canals are found on the nectosac. Of these radial canals, the one on the ventral surface is short measuring about 1/4 of the dorsal (radial) canal while both the right and left canals are extremely long and form a very marked curve. [**The exact and characteristic run of these is not completed**]

The axis of the siphosome is slightly larger in comparison to that of the nectosome and freely expands and contracts. On the siphosome, generally more than 10 cormidia are scattered at equal distances.

Each cormidium has a siphon 3 to 6 mm in length. Its proboscis has 8 stripes of muscular bundles on its wall, by which it freely expands and contracts. The stomach is exceedingly long and cylindrical with a large bead-like (ball-like) basal part and a very short stalk. A tentacle extends from its dorsal side. The tentilla of the tentacle has a reddish cnidoband with the upper half hooded by a bell-like cover (involucrum) which is connected with a long narrow stalk. On the end of the tentilla is a simple filament which sometimes becomes elongated or shortened. The cnidoband has 3 to 4 coils and its height and width are 8 and 2 mm respectively.

On the axis between 2 connecting siphons, numerous palpons are regularly distributed and the further down the stem each siphon is, the greater the age of the individual. The distribution of the palpons has already been mentioned with the discussion of the cormidia of *Physophora hydrostatica* volume of this publication [**we have not got translation of this**]. This discussion will, therefore, be omitted in this paper. Each palpon is fusiform and has a very thin wall. It ends blindly. At the end is an elliptical nematocyst mass. Although the palpon ordinarily is narrow and long, 1.5 to 0.3 mm in width, it sometimes becomes large, short and spindle-like with a linear dimension of 3.5 mm and a lateral dimension of approximately 2 mm. Each palpon grows a simple palpon filament on its stalk. Near it, are attached one male and one female gonodendron. However, at the top of the siphosome, the gonodendra are immature while on those near the lower end (of the siphosome) numerous gonophores can be seen.

The siphosome is entirely covered with bracts. Those of the dorsal part are extremely large, thin and leaf-like, and are convex on the dorsal side. At the middle and lateral sides of the end of the bract are conspicuous cylindrical processes. The

bracts which cover the palpons by attaching themselves to the nodes of the stem, also have a leaf-like shape but are much wider and shorter than those previously mentioned and the 3 terminal processes, too, are not as distinct. Each bract has a canal running on the ventral side along its median line. Young bracts are like a flattened cone whose exterior, that is, its bottom side [**?distal end**] is deeply concave. Their manner of attaching themselves are by a membranous peduncular lamella as in the Agalmidae.

However, the interpretation given by many investigators in the past that the bracts develop on the upper side of each palpon from its median line (stem) is incorrect. In fact, the peduncular lamellae for 2 longitudinal lines, on each side of the stem even though slightly irregular. Thus, the bracts are generally attached in 4 lengthwise rows around the stem. Inasmuch as the number of these rows may vary, such a distribution of the bracts in this species can be said to be similar to others of the same genus in the same family. In any case, the siphon and the palpons are hidden by one or several bracts and protected by them. Especially with the siphon, one of the bracts is always extremely large and long. However, the question of whether this large bract develops on the left or right side, reciprocally, or irregularly on both sides is not definitely established. That is because the arrangement of the peduncular lamellae is barely distinguishable after the removal of the bract, so that it is absolutely impossible to determine the size of a bract from the stump of the peduncular lamella.

The number of siphonophores belonging to this genus reported by many scientists is not small [**it is**]. For example, Haeckel has 7 species in his "Challenger Report".

1. *Cupulita bowdichii* Quoy and Gaimard [1824]
2. *C. Sarsii* (= *Agalmopsis elegans* Sars partim) [= *Nanomia cara* (No. 4)]
3. *C. canariensis* (= *Anthemodes canariensis* Haeckel) [*N. bijuga*]
4. *C. cara* (= *Nanomia cara* A. Agassiz) [= No. 2]
5. *C. fragilis* (= *Agalmopsis fragilis* Fewkes)
6. *C. picta* (= *Halistemma pictum* Metschnikoff) [*N. bijuga*]
7. *C. tergestinum* (= *Halistemma tergestinum* Claus) [*N. bijuga*]

Of these, one, No. 1 the author cannot offer a conclusive opinion without the original description, but No. 6 probably is probably the same as the species discussed here, while No. 2 is identical with the species discussed below. Therefore, it undoubtedly belongs to a different genus. [**Kawamura is confused. Haeckel's No. 2** *Cupulita sarsi* **is distinct from the Agalmopsis part Haeckel's No. 2 and maybe the same ???**] Nos. 3, 5, 7 like No. 6 do not show any different characteristics. Therefore, the names given here are in al probability other names given to the species in question. Only No. 4 [**same as Haeckel's No. 2**] appears to be different. In addition two species *Halistemma rubrum* Huxley (= *Agalma rubra* Vogt) and *Halistemma punctatum* L. Agassiz (= *Agalmopsis punctata* Kölliker) which Huxley classified in the genus *Halistemma* are both clearly [NO] identical [NO] to *Cupulita picta* Metschnikoff [NO!!!!!!!!!!!!!!]

Nagayoraku Kura Zoku (*Agalmopsis*) [*Agalma*]

The cnidoband is encased in a perfect sac (involute). The end of the tentilla consists of a terminal ampulla and 2 lateral horns.

The genus *Agalmopsis* was originally created for a [**two species of which Haeckel selected the one with trifid tentilla as the type species**] North Atlantic species by Sars in 1846. However, at present it [**the name**] belongs to the genus *Cupulita* [NO] as mentioned above. The ideal representative species of this genus is

the one given below. Specimens of this species found in both the Atlantic and in the Mediterranean are the same as the species occurring in our Japanese waters. Our name was given on the basis of its greater length in comparison to *Agalma* although the former in general resembles the latter genus. (Translator's remark: Nagayoraku Kurage - Naga = long, Yoraku Kurage [?medusa] = *Agalma*, hence "long *Agalma*") However, it varies from *Agalma* conspicuously in one respect, namely, that its siphosome is exceedingly long and loosely covered with the leaf-like bracts. In this point, the genus rather closely resemble the genus *Cupulita* but when considering the structure of its tentilla, it, on the contrary, agrees with *Agalma*.

Naga Yoraku Kurage *Agalmopsis elegans* Sars
Plate 7, figs. 11-17

The author was able to obtain a perfect specimen of this species as Misaki Experiment Station on January 29 of last year and at that time, had a chance to observe a number of much larger forms but it was impossible to catch them since the depth was too great.

The nectosome of the species consists of a pneumatophore on the apex of a narrow stem, generally forming an octagonal drill. The nectosome measured approximately 45 mm in length and 13 mm maximum diameter. Its pneumatophore did not differ at all from that of the previously discussed *Cupulita picta*. As far as its nectophores are concerned it resembles *Agalma okeni* more than *Cupulita picta*. The shape is symmetrical - the dorsal and the ventral sides, that is, the upper and lower sides, are flat and have 1/3 of their inner sides wedge-shaped (cuneiform). On its median line there is a deep arch. The outer 1/3 of the nectophore becomes outwardly progressively smaller from the left and right (of the median line), forming a decapitated four-cornered drill (see Fig. 12 of plate). The upper surface of the nectophore is slightly convex with a large rounded process from its centre. This process further appears to fit together with a depression on the underside of the corresponding nectophore lying above it. The lateral side is divided into two surfaces by a longitudinal ridge - the inner side triangular and the outer side four-cornered. The outer surface is small and square, being occupied by the nectosac opening, which has a wide velum.

The nectosac is comparatively very small occupying the outer half of the nectophore. The cylindrical part along its median line is almost the same size as the blind sac-like parts to the right and left, situated on the same horizontal surface but at a right angle.

The canal enters the nectophore at the bottom end of the curved median line and immediately shoots out a short, simple branch above and below. Then it reaches directly over the median surface of the nectosac where it branches out into 4 radial canals. Of these, 2 above and below, are short and only run along the nectosac wall over the median surface while the other two on the lateral sides (left and right) are extremely long and coil around this wall. These canals are connected to a circular canal at the basal part of the velum of the nectosac mouth.

The siphosome is slightly larger than the nectosome and very long and cylindrical. Its dimensions measured approximately 21.5 cm in length and 1.5 cm in width. The siphosome consists of cormidia situated on a narrow axis and numerous leaf-like bracts which surround it entirely.

The mature bract is 10 mm long and 6 mm wide. Its upper surface is convex while its lower surface is concave. Particularly, since it follows along the longitudinal axis, its general appearance is like a small inverted boat. On the extreme end none too

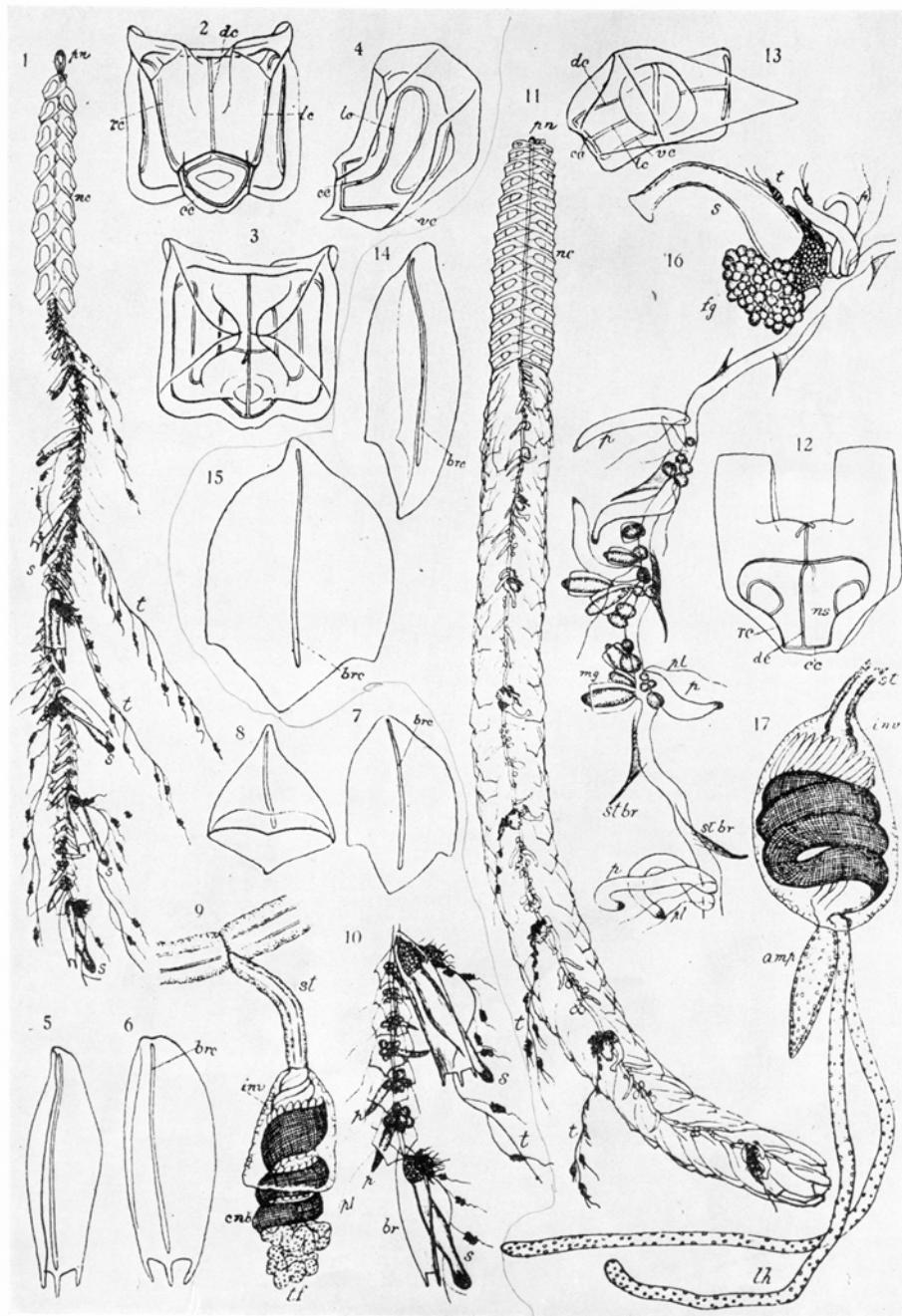
conspicuous (slightly conspicuous) processes [**ridges**] are found in the middle and at both sides. A canal which runs on the underside of the bract develops at the leading end of the inner side, terminating near the extreme end (extremity) of the median line. The bracts are, in general, symmetrical and although those on one side differ slightly from those on the other side that are all relatively similar in shape. The manner in which the bracts attach themselves to the stem is, of course, by the peduncular lamella. However, the author regrets very much not having had a chance to study this on a live specimen or on a preserved specimen because of its torn condition. This particular species has been recorded in detail by Sars [**tentilla only**], Kölliker, Fewkes, etc. in the past, none have as yet clearly described the arrangement of the bracts. But it may, perhaps, have 2 rows each of bracts on the left and right as in the case of *Cupulita picta*.

Excluding young cormidia, there were approximately 12 cormidia found on the stem of the specimen. The basal part of the siphon is well developed and a tentacle extends from the stalk. The lateral branches of the tentacle are equipped with a large tentilla on the top of a long stalk, with a reddish cnidoband coiled counter-clockwise 3 or 4 times and completely encased in a transparent sac (involucrum). On the upper part of the cnidoband spindle-shaped nematocysts are attached forming a line. There is, however, one point which must be born in mind, that the lower end of the cnidoband turns clockwise in contrast to the other parts of this structure. This fact has not been reported for *Agalmopsis elegans* (C. sarsi) or for other siphonophores belonging to this family. It is the only difference existing between this species and those of the Atlantic. However, if such a structural variation is actually true, we can well accept the former as a variety of the latter. Yet, according to illustrations made by the past master, in which the cnidoband simply coils around several times it is difficult to determine whether it is clockwise or counter-clockwise. There is reason for some doubt on the direction of the turns. The terminal filament of the tentilla consists of a spindle-shaped terminal ampulla and 2 cylindrical lateral horns. The latter are exceedingly narrow and long - almost 4 times greater in length than the former. Both have small nematocyst over the entire surface.

The palpons are irregularly distributed over the stem. This characteristic is one of the specific differences between this genus and the genus *Cupulita* = *Halistemma*. Each palpon is long, spindle-shaped with a palpon filament growing from the base of its narrow stalk. Its blunt tip is protected by a group of nematocysts, quite similar to common palpons.

A female gonodendron is found directly below the siphon, and numerous male gonophores are scattered over the middle 1/3 of the internodal section of the stem without forming a cluster (gonodendron). [**An arrangement shown clearly, though crudely, by Kölliker 1853**]

PLATE X



[Copied from Totton, 1965, Pl. X]

Legend Vol. XXIII, Plate 7. Figures 1-17

Cupulita picta Metschnikoff [= *Nanomia bijuga*] Figs. 1-10

Fig. 1. Entire animal a 1 1/3 [**13.5 cm**]

Figs. 2-4 Nectophores x 7.

Figs. 5-6. Bracts x 7.

Fig. 7. Internodal bracts x 15.

Fig. 8. Young bracts x 15.

Fig. 9. Tentillum x 15.

Fig. 10. Cormidia x 2 2/3.

Agalmopsis elegans Sars. Figs. 11-17.

Fig. 11. Entire animal x 2/3.

Figs. 12-13. Nectophores x 6.

Figs. 14-15. Bracts x 4.

Fig. 16. Cormidium (without bracts) x 4.

Fig. 17. Tentillum x 15.

nc. nectophore; pn. pneumatophore; t. tentacle; s. siphon; cc. circular canal; lc. lateral

canal; rc. radial canal; vc. ventral canal; brc. bracteal canal; st. stalk; inv. involucre;

cnd. cnidoband; tf. terminal filament; p. palpon; br. bract; fg. female gonodendron;

mg. male gonophore; pl. palpon filament; st.br. peduncular lamella; amp. ampulla.

Calyconectid Siphonophorae (I)
by Tamiji Kawamura
Dobutz, Z. Tokyo 27, 135-142, 1915

The author has reported in this publication several species of "Misaki" siphonophores during the past year. At the same time it was planned to consider other genera as well. However, for unforeseen circumstances the writing had to be discontinued. Therefore, the following report is to fulfil his past hope by simply reassembling the old manuscript on the subject. Now, among siphonophores, the Calycophorae (Calyconectae) are a group which is comparatively minute and often found in plankton nets. They are readily distinguishable from other siphonophores because they lack the pneumatophore and palpons. It, therefore, seems appropriate to give a general explanation of the pertinent developmental and morphological aspects of the various groups of this family before proceeding with the discussions of the individual species.

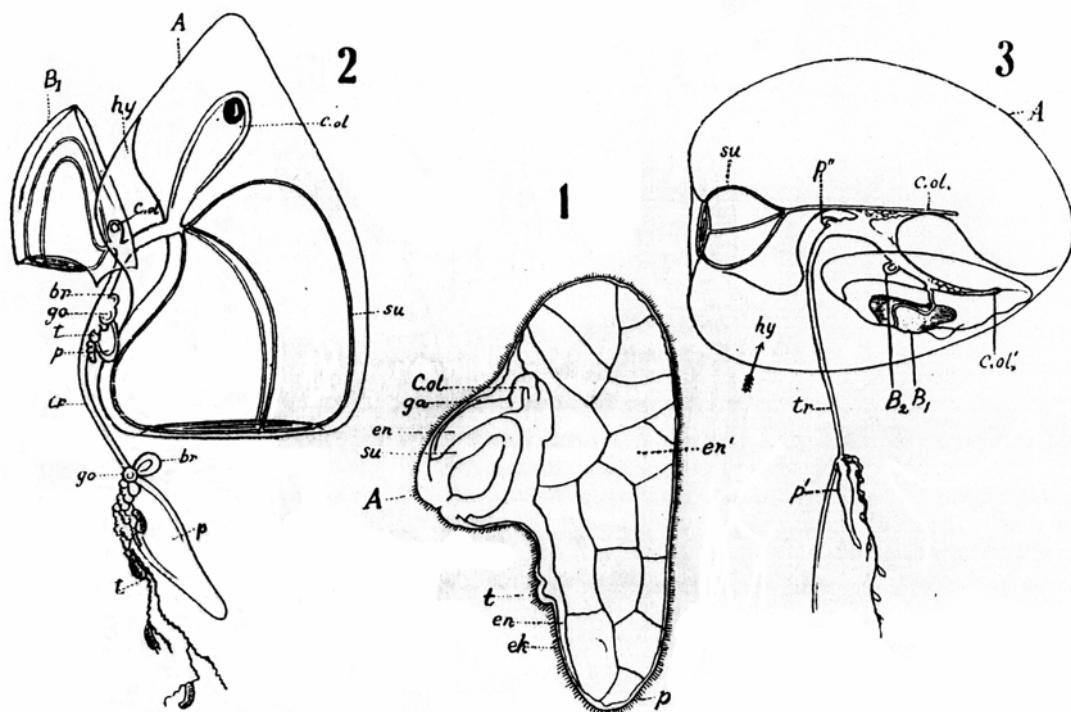


Figure 1. Larva of *Muggiaeae*. [after Chun, 1882, Taf. XVII, fig. 6]
Figure 2. Already developed secondary nectophore of above. [*M. kochii*]
[Rearranged from Chun 1882 Taf XVII, fig. 4]
Figure 3. *Hippopodius*, young larval stage [poor copy of Chun 1888]

Legends

- a. primary nectophore; b1. secondary nectophore; br. bract; c.ol. somatocyst; en. endoderm; ek. ectoderm; ga. gelatinous part; go. gonophore; hy. hydroecium; p. siphon; su. subumbrella layer (nectosac); t. tentacle; tr. stem.

1. Development.

The larva develops from the egg-shaped form as illustrated in figure 1 - the ectoderm consists of cilia, the external "covering layer" while the endoderm is composed of

large polygonal cells. On one side of the upper half of the young organism, the bud nucleus which eventually becomes the subumbral cavity of the nectophore is developed. And its lower end stretches downward, finally making an opening at its pointed end. As this ruptured cavity comes in contact with the outside, a siphon is developed. The tentacle that accompanies this growth is also recognisable in the early stages as a process on the lateral side of the larva. About the time the upper half of the larva becomes a nectophore, the connecting section between it and the siphon grows into a stem by becoming long and narrow. At the top of the stem second and third nectophores, etc. bud off upward from a point of growth at the centre and many cormidia downward.

However, the initial nectophore developed from the upper half of the larva, is not, in many cases, a permanent growth but rather a temporary one. Thus, this is called the primary nectophore and all those appearing subsequently are called secondary nectophores. Inasmuch as they are quite similar structurally, the difference in their shape is very pronounced. The identification, on the other hand is not at all difficult. For example in *Muggiae kochi*, the primary nectophore is hood-shaped and the secondary growth is pentagonal as illustrated in figure 2. But in this case, as soon as the secondary nectophore completes its growth, the primary one drops off. Therefore, for many years, this species having only one nectophore has been considered as belonging to the Monophyidae. On the other hand, in the genus *Sphaeronectes*, the nectophore that remains permanently is not the secondary nectophore but rather the primary one. Consequently, in this case, the organism has only the first primary nectophore that began its growth in the larval stage of the organism. We thus know that the secondary growth does not take place at all in this case.

It is common that the very first growth of the secondary nectophores (that is, the one that develops immediately after the primary nectophore) differs in its internal structure from the others which develop later. For this reason in a case such as *Diphyes* with both upper and lower nectophores, the superior and inferior nectophores are not structurally similar. On the other hand, genera with two nectophores having an identical structure are not at all uncommon. In such cases, this results from regeneration as the older ones drop off and are replaced by newer growths. Often more than three nectophores are seen simultaneously, because the new ones grow before the older ones are completely detached.

Even in a genus such as *Hippopodius* with many nectophores, the primary and secondary nectophores are different in shape as illustrated in figure 3. However, in this group, the secondary nectophores are identical, whether an earlier or a later growth. Hence no regeneration takes place between nectophores.

Thus, the animal swims about in the plankton with one to several nectophores which develop as previously described and as it grows older (matures), its stem on which are many cormidia, becomes long. When a cormidium is sufficiently mature consisting of either female or male gonophores respectively - each cormidium is the sexual generation of calyconectid siphonophores. The parent animal that buds out this generation is the asexual generation. On the base of each cormidium there is also one siphon and on the parent animal there are many cormidia. These are thus sometimes called monogastric and polygastric generations, respectively. Such a distinction is more obvious among the general in which a cormidium freely enters into the planktonic life for a time after it is separated from the stem of the parent animal. This planktonic cormidium is generally called the eudoxid. Among many investigators of the past generations, there were many who thought several eodoxids to be altogether

different siphonophores and wrongly classified them in different genera. During Haeckel's (1888) time, even though this morphological relationship was known, the eudoxids were classified in different taxonomic groups as eudoxids paralleling their parent animal, similar to the situation in the hydromedusae, because there were many genera which had not been clearly defined as to the genetic relations of the parents and the offspring. Even today, this relation, as a whole, has not been clearly established and the analytic theory varies with different scientists. Some believe that an eudoxid, for example, is of a certain "A" parent, while others claim it to be different "B" parent. Thus it is not possible to remove this doubt.

The sex cells that are ejected from a eudoxid or the gonophore of a cormidium, first begin their growth by settling, in all case, to a deep layer and become egg-shaped larvae as has been described previously.

II. Shape and structure (Anatomical).

First, let us begin with those having a single nectophore. For example, of the family Sphaeronectidae (*Sphaeronectidae* was heretofore classified as Monophyidae but as the results of combining the genera *Monophyes* and *Sphaeronectes*, the classification was changed according to taxonomic rules) the shape of the genus *Sphaeronectes* generally resembles the larval stage of *Muggiaeae* as shown in figure 2, without its secondary nectophore. The reason is that the nectophore of *Sphaeronectes* is the primary one that remains attached. At its upper end is a bell or hood-shaped nectophore with a smooth surface in the dorsal half, of which a subumbrial cavity or nectosac is situated. Along its walls, four radial and one circular canal are found. The velum is located near the circular canal around the nectosac opening. The radial canals converge around the apex of the hydroecium which is situated in the middle of the ventral side and at this point the canals become connected to the inner cavity of the stem. Consequently, the stem extends outside thereof. A sac called the somatocyst is buried in the gelatinous substance on the upper side extending from the hydroecium inwards and filled with oil granules. This, of course, acts as a buoy. However, it is an organ within the nectophore and should never be compared to the pneumatophore seen in *Hippopodius* or *Agalma*, etc. A cormidium consists of such parts as bracts, tentacles, siphons, and gonophores and becomes an eudoxid by breaking loose.

Within the genus *Muggiaeae* which should be included in the family group, the primary nectophore, previously discussed, drops off and is replaced by a secondary nectophore. This can be seen in figure 2 by assuming its upper part "A" completely taken out and the part "B" inflated. In the drawings above, figure 1 was made from the scale model of this genus. Next, the genus *Nectopyramis* has a nectophore whose external shape is smooth and its canal system, comparable to the somatocyst, is complicated, having branched out. Whether this nectophore is the primary one or the secondary growth is extremely difficult to determine without actually studying its growth. However, Bigelow claimed it to be the secondary nectophore despite the smoothness of the exterior and considered it to be the most advanced form in this family.

The structure of the eudoxid in all genera varies very slightly and consists of several gonophores which successively grow one bract, tentacle, and siphon respectively. The gonophores are medusiform resembling the shape of the nectophore. In certain genera, a gonophore remains permanently without the stalk in which the sex cells are developed. This is called a special nectophore. As far as the external shape of the bract and special nectophore of the eudoxid is concerned, they are like those of the parent. When the latter is smooth and bell-like, the former takes a similar form. Likewise if the latter is many-ridges (polygonal, drill-like shape) the former takes the

identical external appearance. In the centre of the bract, the eudoxid has a somatocyst like the one seen in the parental nectophore, in which oil granules are stored. The lower end of the somatocyst is connected to the apex (too) of a shallow groove (or a special nectophore) and at this point it becomes extremely short stem which ends in a siphon. However, the gonophore (or a special nectophore) is extremely large in size occupying the entire lower half of the eudoxid. Consequently the right siphon with the tentacle and successively growing young buds appear hemmed in the space between the right gonophore (or the special nectophore) and the bract. Actually, this space forms a convenient hydroecium between the depression (groove) of the superior bract and that of the gonophore situated below and facing the former. The siphon and the tentacle are drawn within when the necessity arises. With the genus *Nectopyramis*, the somatocyst of the bract changes into a branched canal system, and is quite similar to the parent nectophore of this genus.

Next, let us move on to the family Diphyidae. As has been previously described in the discussion, some embryological differences exist between the first and second growth of the secondary nectophore. This is due to the presence or absence of a somatocyst. Therefore, if "A" has nectophores remaining permanently attached there the superior and the inferior nectophores are dissimilar. But with "B" if regeneration takes place between these parts, there is, for example, obviously some structural variation but soon they become alike. Actually the former type of structure can be seen in such genera as *Diphyes*, *Diphyopsis*, *Abyla*, *Galeolaria*, etc., and the latter structural variation is obvious with *Amphicaryon*, *Praya*, *Stephanophyes*, et. There is another interpretation of the variations in the case of "B". That is, with this group the fact that the first and second nectophores, etc., of the secondary nectophore all have identical structure can be described in the case of the family Hippopodiidae. On the other hand, with *Praya*, etc., there is the canal system that may possibly be interpreted as a metamorphosis of the somatocyst of the nectophore although it is already known that the nectophore still undergoes regeneration even after the animal reaches maturity. In the final analysis, the question of whether the first growth of the secondary nectophore is identical to the second and successive growths or not, as the case may be, is quite difficult to answer without having a young specimen and no conclusive judgement can be given. In the past, it was rather preferred to classify "B" and "A" groups as sub-families according to the first interpretation but recently Bigelow recognised the dissimilarity between these two groups to be quite fundamental in thoroughly scrutinising the latter consideration. He subsequently named the "A" group as Diphyidae and the "B" group as Prayidae. This author therefore shall follow his classification.

The superior nectophore of Diphyidae does not differ at all structurally from the nectophore of the Sphaeronectidae. For this reason, for example, a young siphonophore of the genus *Diphyes* or one that lost the inferior nectophore is almost indistinguishable from some species of the genus *Muggiaeae*. Only when there is a trace of the bud or point of severance of the inferior nectophore evident on the upper part of the stem can the difference be identified. This holds equally true in the genera *Diphyopsis* and *Doromasia*. Consequently, as a result of this confusion in the structure of some organisms, there were until recently many animals belonging to genera of the Diphyidae which had wrongly been classified in the family Sphaeronectidae. However, even the superior nectophore of the family changes its shape from a drill-shape to a form slightly polygonal and likewise the somatocyst, the hydroecium and the nectophore too change their shape to a certain degree. It is

therefore not uncommon at all to fail in the identification at a glance of a specimen of this family. The genus *Abyla* is a good example of this type.

The inferior nectophore is a large one which has developed at the base of the stem. Ordinarily its size is approximately the same as the superior one, but it may attain a far greater size. Unlike the superior nectophore, this structure lacks a somatocyst or a canal system in contrast to the superior nectophore. This may be compared with the relation between the gonophore and the bract of the eudoxid. The external form of the inferior nectophore is smooth bell shape, drill-like or polygonal, thus resembles the superior nectophore in shape. Its dorsal surface, the side where the cormidium passes, is almost like a canal, having a deep groove that extends upwards and downwards. The stem is drawn within it when necessary. This is comparable to the hydroecium of the superior nectophore.

As far as these two nectophores are concerned, the dorsal and the ventral sides often face each other as in the case of the genus *Galeolaria*. On the other hand, they sometimes place themselves back to back.

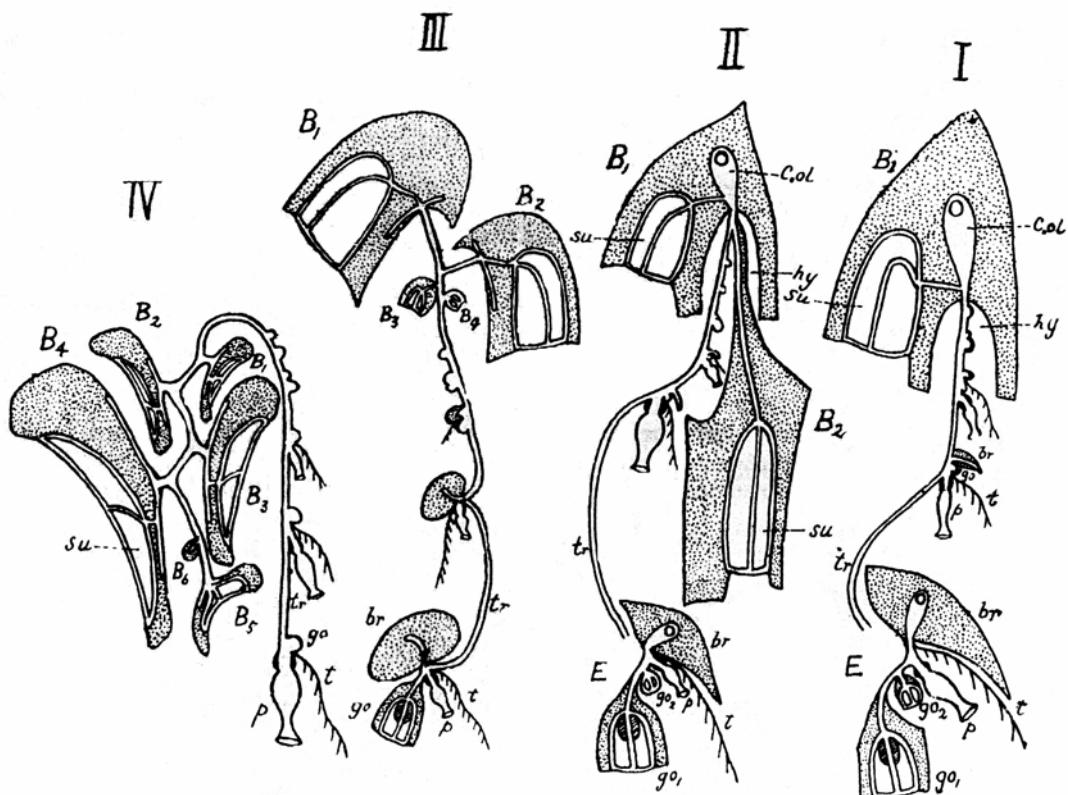
The structure of the eudoxid is similar to that of the family previously discussed.

Several genera of this family are divided into three sub-families by the shapes and the sizes of the superior and inferior nectophore and also the characters of the cormidia. In the *Galeolariinae*, both nectophores are smooth and almost identical in size; in the *Abylinae*, they are polygonal and the superior nectophore is extremely small; in the *Diphyopsinae*, both are also polygonal and are of the same size. However, in the first sub-family, the cormidia do not become free, while in the second and the third group, they become eudoxids, the second having an angular columnar bract and the third with a round bract. The scale model drawing 2 was mostly made from the *Diphyopsinae* and describes the structure of this family.

Next, we shall move on to the family *Prayidae* which has two or more nectophores of identical structure. Although between the two nectophores in members of this family, there is some difference in age and in vertical position of the basal point from which the stem starts. As far as their positions are concerned they are situated side by side instead of being one over the other. Chun, therefore, named this group, sub-family *Oppositae* and the family discussed previously as the sub-family *Superpositae* (the reason for his sub-classification of these groups is clearly understandable from the developmental aspect). In such generic groups as *Praya* and others, the two large functional nectophores are situated actually back to back at the upper end of the animal, even when many nectophores have developed all at once through some irregularities in their regeneration. But in the genus *Stephanophyes* many nectophores grow side by side like a wreath and in the genus *Amphicaryon* without undergoing regeneration, the older one of the two nectophores through metamorphosis takes the shape of a bract. In this family (*Prayidae*), the nectophores are all smooth and round. None of them are polygonal like those of the other families. The structure of the nectophore, as described already, is comparable to the superior nectophore of the previous family group (considered as the inferior nectophore according to the older theory). It has canals as well as a nectosac, a hydroecium and a somatocyst. The cormidia either break loose or remain attached.

This family is again divided into three sub-families. In the sub-family *Amphicaryoninae*, the older one of the two nectophores metamorphose to a bract-like shape and the cormidia become eudoxids. With the sub-family *Prayinae* both nectophores always undergo regeneration and the cormidia do not become eudoxids. However, in the sub-family *Stephanophyinae*, many nectophores develop side by side

in a wreath-like fashion and the cormidia remain attached without breaking loose. The scale [? diagrammatic] drawing III mainly based on the Prayinae describe the structure of this family.



The last family to be discussed is the Hippopodiidae. Although this group is identical with the previous family described in the structural characteristics of having many nectophores of the same structure, it is definitely a family by itself, although lacking bracts. These nectophores form two rows facing back to back in an orderly manner and the cormidia remain permanently attached. However, the position at which both nectophores bud are in reverse to those of the other three families and the farther away it is from the cormidia, the later it buds out. This is, as I have described in an issue during the past year. The scale drawing was made from *Hippopodius* sp. showing the structure of this family.

III. Taxonomic relations.

Hitherto, siphonophores have been classified into three major families of Monophyidae, Diphyidae and Polyphyidae. However, recently, Bigelow divided the second group into two other families. Therefore, we have four families at present as:

I. Sphaeronectidae - Monophyidae.

II. Diphyidae - Suprapositae.

III. Prayidae - Oppositae.

IV. Hippopodiidae - Polyphyidae.

The reason for reclassifying hitherto known Diphyidae and treating Prayidae (= Oppositae) and Diphyidae (= Superpositae) independently have already been discussed in the previous pages. Therefore, the author shall not repeat the same thing again. It is without doubt true that the family Sphaeronectidae Monophyidae is a most primitive form but it is significant that there is obvious evidence of the character of

the nectophores and the cormidia of this and other families being parallel. That is among the nectophores of the family Sphaeronectidae Monophyidae there are smooth, polygonal shapes and smooth but with branched somatocyst. These are equally common among the other families. Further, the similarity is so great that with some species even the untrained eye can detect the difference. For example, the following resemblance is most common:

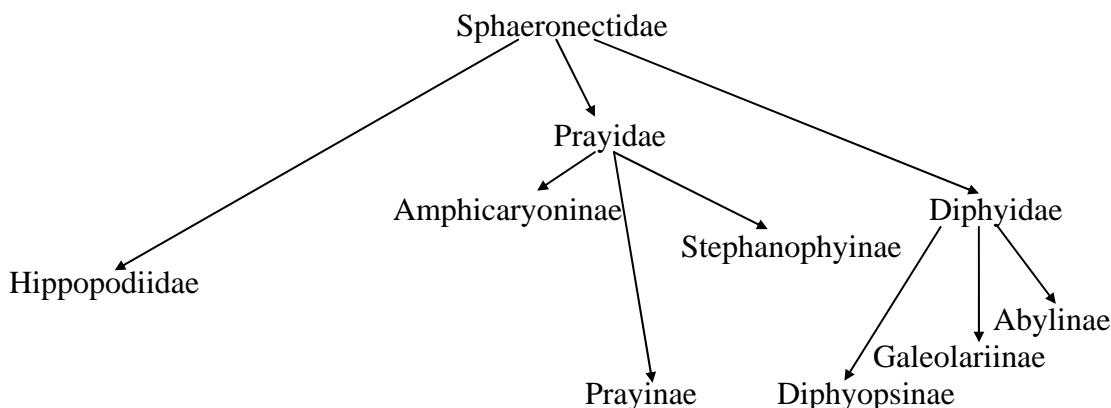
Sphaeronectes to several genera of Prayidae

Cuboides to several genera of Abylinae

Muggiaeae, Doromasia to several genera of Diphyopsinae

Nectopyramis to Stephanophyinae.

This fact is to obvious to be a coincidence. Therefore, it should immediately taken into serious consideration as undoubtedly having a bearing on the systematic embryology. That is, it is clear that from several types of Sphaeronectidae Monophyidae, three other families have each developed in different directions. When Haeckel and Chun presented the theory that several genera of Sphaeronectidae (≡ Monophyidae) were the most primitive forms from which other families developed, Schneider (1898) concurred in that *Sphaeronectes* was a primitive form but not in others, for example, in the case of *Muggiaeae*. He further insisted that this is nothing more than the result of metamorphosis of such a "two-bell" type of *Diphyes* losing the inferior nectophore. However, Bigelow stated, on the other hand, that since *Muggiaeae* showed no trace of having had an inferior nectophore, *Diphyes* should have originated from *Muggiaeae* rather than vice versa. With a consideration on the few aspects pointed out above Bigelow gave the following relationships:



Schneider's interpretation of the anatomical structures are very different from those of others and his taxonomy too is extraordinary. An introductory note of his general discussion was made in an article in this publication under the title of "On Siphonophores" during the past years but a short remark on Calycophorae shall be included here at this time. He generally classified Calycophorae in two groups realising the extreme importance of differentiating varied nectophores - one with the somatocyst and the other without, stating that the one without the somatocyst is a true nectophore and the other with it is a combined growth of the bract and the nectophore. For instance:

(I) Prayinae - the two nectophores are true to form.

(II) Diphyidae - one of the nectophores is a combination of a bract and a nectophore.

In the former group he has classified *Sphaeronectes*, prayids, *Hippopodius*, etc., and in the latter species of diphyids, abylids (*Muggiaeae* is a product of metamorphosis of abylids). However, in this theory it is a question whether the presence of a so-called somatocyst comes from a bract and Schneider's explanation too is insufficient. Thus, Chun has presented a paper strongly refuting this theory. This author shall continue with a discussion of each generic species from this point.

Calyconectid Siphonophores (II)

by

Tamiji Kawamura

Dobutz, Z. Tokyo, 27, 191-198, 1915

Translated by Rodney Notomi

Although the number of siphonophore specimens collected by the author is negligible, if we take into account the distribution of these animals, based on reports made by many investigators in the past, we strongly believe we may yet find in the waters off our coasts at some future time, not only those species occurring in the southern Pacific and the Indian Ocean but also the species said to be exclusively endemic in the Atlantic. The author, therefore, will attempt to give a systematic view of the siphonophores with some supplementary notes on the characteristics of the major sub-families and genera in addition to the discussion on the specimens studied by him. Several specimens collected at Misaki, and studied by the author, are in the specimen room of the Department of Zoology, College of Science, Tokyo Imperial University. Each anatomical part of many of these specimens was purposely removed from the stem. Some specimens have, therefore, lost the usual appearance of the animal as a whole but each part was carefully preserved in individual bottles for further detailed studies.

Sub-order (or Order) Calycophorae

(Calycophora Leuckart, 1854 (Calyconectae Haeckel, 1885)

The order (or sub-order) has neither a pneumatophore nor palpons. One or many nectophores are found on the upper end of a very thin, long stem and are capable of withdrawing the stem. The cormidia which are evenly arranged on the top of the stem are provided with a siphon, a tentacle, gonophores and, in some cases, with a bract. Some cormidia break loose and become eudoxids.

I Family Sphaeronectidae Huxley, 1859

(Monophyidae Claus, 1874, Sphaeronectinae Chun, 1892)

This family has a single nectophore that does not undergo regeneration. Its cormidia have bracts and become eudoxids.

I Sub-family Sphaeronectinae Haeckel, 1888

(Sphaeronectidae Chun, 1892)

The smooth nectophore undoubtedly is the primary nectophore. Originally this sub-family had two genera, *Sphaeronectes* and *Monophyes*. Although the shape of the hydroecium and the somatocyst differ, Schneider claimed that the difference in shape of the nectophore only indicates the extent of its growth and that other characteristic differences serve to identify the species. The familiar genus *Monophyes* eventually went out of existence rather than being united into the former genus.

(Tamakurage Zoku) Genus *Sphaeronectes* Huxley, 1859

This genus includes 3 definitely recognised species at present. These are *Sphaeronectes truncata* (Will) Schneider (Figure 1); *S. irregularis* Claus; *S. princeps* Haeckel. Each species has a number of synonyms. The second species differs from the first by the greater size of its nectophore and the curved lateral radial canal. The third is distinguishable by its hydroecium being ditch-like instead of a conical depression. None of these species, however, have been found as yet in our waters.

The eudoxid of this genus was previously called *Diplophysa* (figure 2).

II Sub-family Mugiinae Bigelow, 1911
 (Cymbonectae Haeckel, 1888)

As the smooth primary nectophore breaks loose, it is permanently replaced by 4 or 5 pentagonal drill-like secondary nectophores. This sub-family has 3 genera, *Muggiaeae*, *Doromasia*, and *Cubooides*. *Cymbonectes* and *Halopyramis* known in the past are considered at present as belonging to the first and third genera respectively.

Genus *Muggiaeae* Busch, 1851

The nectophores are pentagonal and drill-like in shape. A special nectophore is not present in the cormidia. There are at present 4 species in the genus *Muggiaeae atlantica* Cunningham; *M. kochi* (Will) Chun; *M. pyramidalis* Haeckel; *M. (Cymbonectes) huxleyi* Haeckel. The author has been able to collect only the first species. The second species with a short somatocyst barely extending half way up the height of the nectosac and the third with a tall hydroecium extending half the height of the nectosac, both differ from the first. The characteristic structures of the last species are not quite clear and there are today many scientists who doubt the validity of the species.

The eudoxid of this genus was mostly separated in the genera *Cucubalus* and *Ersaea*.

Muggiaeae atlantica Cunningham

Muggiaeae pyramidalis Haeckel, 1888, p. 139

Cucubalus pyramidalis Haeckel, 1888, p. 109 (eudoxid)

Muggiaeae atlantica Römer, 1902, p. 172; Vanhoffen, 1906, p. 13, figs. 8-9; Bigelow, 1911, p. 187, pl. VII, fig. 7, Pl. IX, figs. 7-8.

The nectophore is drill-like with an inflated middle and five unbranched ridges that begin at the apex. Of these, one on the inner dorsal side and one pair on the dorso-lateral side are approximately the same length. They end in extremely inconspicuous teeth which encircle the dorsal side of the nectosac opening. The remaining pair of the ventral side are slightly longer and end in a weak tooth on the ventral side of the nectosac. Near the dorsal of this tooth, and midway to the ventro-lateral tooth each side is an additional tooth which is far stronger than the other five teeth and extends further downward at the lateral side of the hydroecium opening. The five ridges of the nectophore and the circular margin of its lower end are smooth but have extremely weak saw-teeth.

The nectosac is conical with an inflated middle. Around its lower opening is a wide velum and circular canal. The length of the four radial canals is not equal; the ventral canal is exceedingly short, while the dorsal canal is very long. It loops about the apex of the nectosac, runs nearly the entire length of the median line extending from the dorsal to the ventral side. A pair of lateral radial canals are located on the side wall of the nectosac are parallel to the dorsal canal. Thus, the point at which the 4 radial canals converge is somewhere on the ventral side of the nectosac, very near the lower side. This point and the apex of the hydroecium are connected by a short stalk canal.

The hydroecium is bell-like and extends about 1/3 the length of the nectosac. Half of it lies above the nectosac opening. The lower part of the dorsal wall of the hydroecium, that is, the part forming the partition between the hydroecium and the nectosac opening is slit in the median line; consequently, the dorsal wall is equally divided to left and right in the form of petals.

The somatocyst is a long column; its dorsal side and lateral wall are composed of large polygonal cells. Its lower end is somewhat small and attached directly to the hydroecium. The apex of the somatocyst is at the same height as that of the nectosac or a little higher in smaller specimens. At the apex is an oleocyst. The stem and the cormidia are a light yellowish brown. The bract, siphon, tentacle, and gonophores are attached to the stem. However, the specimens examined by the author all had a short stem, and no mature cormidia were seen. No one has yet been able to see clearly the cormidia of this species. The cormidia themselves are known to break loose, but whether they occur as eudoxids or not is uncertain. Vanhöffen has called it *Ersaea eschscholtzi* (*Eudoxia eschscholtzi*) but this identification is questionable - Haeckel's *Cucubalus pyramidalis* too is only found in synonymy.

This species is very common at Misaki - particularly in winter. The length of the nectophore is from 3.5 to 4 mm and the maximum width of the dorsal and ventral sides is 1.3 to 2 mm. However, according to other reports on the Pacific form of this species, there were some specimens whose nectophore attained a length of 8 mm.

Genus *Doromasia* Chun, 1888

The nectophore is pentagonal and drill-shaped. A special nectophore is found on the cormidia. Chun described *Doromasia bojani* and *D. picta*, but recently the former was found to have an inferior nectophore, at present only the latter remains in this genus. [both same species]

Doromasia picta (Pl. VII, fig. 2) *Diphyes dispar*

Doromasia picta Chun, 1888, p. 14; 1892, p. 115, Pl. VII, figs. 3-5, Pl. IX, figs. 5-10, Pl. X, figs. 1-9; 1897, p. 1; Günther, 1903, p. 428.

Ersaea picta Chun, 1892, p. 122, Pl. VII, figs. 4-5, Pl. IX, fig. 10; 1897, p. 1 eudoxid

Muggiaebojani Schneider, 1888, p. 98 (partim)

Diphyopsis picta Mayer, 1900, p. 75.

Ersaea hispaniana Mayer, 1903, p. 77, Pl. XXIX, fig. 100 (Eudoxid)

The nectophore is pentagonal drill-shaped with five unbranched ridges which diverge from its apex. These ridges are convex in the lower half of the organism while at the upper they become concave and near the apex they again curve outwardly. This elongated shape is as if the upper half of a drill had been pulled out. The upper 1/3 of these ridges are extremely sharp, appearing like wings. Consequently, the degree of concavity of the surface is very great on this part of the organisms. Along the lower 1/3 slightly noticeable serrations are found. All five ridges end in five tooth-like processes at the lower end. Of these, the one on the dorsal side is like a four sided drill and the pair of slightly weaker three sided drill-like processes on the dorso-lateral sides, together surround the nectosac dorsally and laterally. The remaining ventro-lateral pair have a three sided drill-like shape and are situated at the ventral side of the opening of the hydroecium. Their pointed ends are slightly below the level of those on the dorsal side. In addition to the five tooth-like processes, a pair of extremely strong three sided (drill-like) teeth are found laterally on the lower side of the nectophore, the nectosac and the hydroecium openings. Therefore, the pair of pentagonal "drill" surfaces on the ventro-lateral sides are trapezoidal while the other three surfaces are all equilaterally triangular.

The nectosac is a long column whose upper 1/3 is like a small canal. Near the apex of the nectophore, the nectosac ends blindly. This canal is, however, increasingly larger in diameter toward the lower part, forming a cone, by which it becomes connected to the columnar part. (Chun stated this transitional part often bends slightly toward the ventral side.) A weak constriction occurs dorsally near the

nectosac opening. This opening is round with a well developed velum. The four radial canals are quite uneven in length, because the stalk canal reaches almost to the lower end of the nectosac. The ventral canal is extremely short and runs in a straight line only for a short distance while the dorsal canal runs upward almost the full length of the ventral median line and passing over the apex turns downward along the dorsal median line. The pair of lateral canals run up and down parallel to the dorsal canal but since they do not enter the canal part of the upper half of the nectosac their length is much shorter than the dorsal canal. There are seven bright yellow spots on the nectosac wall - one each on the apex, slightly above the centre on the ventral side, and on the centre of the dorsal side; one pair ventro-laterally at 1/4 distance below the apex; lateral pair near the nectosac opening. (According to Chun, the Pacific species have three spots - one at the apical ventral side; another in the lower part of the dorsal side and the third in the lower part of the ventral side respectively.)

The hydroecium is bell shaped, occupying the lower 1/3 of the nectophore on the ventral side. The lower opening is trapezoidal and ends in four strong pointed teeth as previously described. Of the four sides of this trapezoid, the lateral ones are almost straight and the dorsal bilateral pair are in a conspicuous arc, curving upward.

The somatocyst is columnar, slightly smaller at the lower side, and the dorso-lateral wall has large bubble-like cells. It occupies the centre 1/3 of the nectophore on the ventral side and its apex which stores the oleocyst is situated at about the height of the lower end of the canal-like part of the nectosac.

The stem is short and ordinarily has either 2 or 3 well developed cormidia. (the author's specimen had one cormidium and thus follows Chun's description.) The upper end, that is, the cormidium budding zone is slightly inflated with numerous small buds. From the ventral side where the stem is connected with the somatocyst, a stalk canal comes out and runs downward paralleling the ventral wall of the nectosac along the dorsal wall of the hydroecium. Slightly above the opening of the nectosac it becomes connected with the four radial canals.

In this case, the stalk does not immediately branch out into the four radial canals but first develops into a simple net-like canal system (according to Chun this may be an exceedingly complex system), between which come the radial canals, a characteristic of this species. Each cormidium is composed of one bract, siphon, tentacle, special nectophores and many buds of numerous gonophores. On the bract are three sharp teeth - one on the median line and the other two laterally. The bract itself is attached to the stem at a point somewhere within the upper concavity and covers other parts of the cormidium like an officer's cape. Adjacent to the point of contact, the bract has a small kidney-shaped sac within the bracteal gelatinous material, and appears to encircle the ventral side of the stem on its concave side. About the time the cormidium becomes an eudoxid it should have an oil drop within. The siphon is columnar and consists of an extremely short, thin stalk, a short, thick walled basal part, an inflated stomach with a thin wall, and a well developed muscular proboscis. The tentacle grows from the upper side of the siphon stalk and has countless branches, that is, tentilla. The stem and cormidia are light yellowish brown while the tentilla are a very beautiful yellow. With the author's specimen, it was not possible to see a reasonably well developed special nectophore and gonophores but as described by Chun, they are not different from the corresponding parts of an eudoxid *Ersaea bojani*.

This species [*D. picta*] was classified by Chun (1888) from his catch at the Canary Islands and differs from our specimen [*D. dispar*] on the position of the

yellow spots found on the nectosac wall - such a characteristic, however, does not fully warrant further reclassification.

Chun, at the same time classified *Doromasia bojani* from the Pacific species collected by the "Vettor Pisani" and claimed that this and the previous species are the Atlantic and Pacific forms respectively [of one species]. However, at present, *Doromasia bojani* is placed in the family Diphyidae. Furthermore since *Doromasia picta* [*D. dispar*] was caught at Misaki, presumably the occurrence of the latter is not limited to the Atlantic Ocean. Thus, it definitely points out an error in Chun's theory on this question. [Kawamura's error in identification of his species]

Our specimen was found in plankton off Misaki on December 29, 1907 - length and width of the nectosac were 9.5 and 3 mm respectively.

Supplement

Ersaea bojani (Eschscholtz) Chun

Eudoxia bojani Eschscholtz, 1825, p. 743, taf. 5, fig. 15; 1929, p. 125, taf. 12, fig. 1

Eudoxia bojani Huxley, 1859, p. 59, Pl. II, fig. 7

Cucullus gracilis Haeckel, 1888b, p. 100

Ersaea dispar Haeckel, 188b, p. 361

Ersaea bojani Chun, 188, p. 1154; 1892, p. 108, fig. 7

Ersaea picta Chun, 1892, p. 98, p. 101, fig. 6, pl. XI, fig. 8

Ersaea bojani Lens and van Riemsdijk, 1908, p. 6, figs. 1-6; Bigelow, 1911, p. 264, pl. XI, figs. 7-8.

This organism is not clearly a member of this genus and its scientific name was originally given to a monogastric generation (an eudoxid) whose parent had not been definitely identified. However, since the species has been once identified as the eudoxid of *Doromasia picta* by Chun, it is included here for convenience. Chun defined two monogastric species *Ersaea picta* and *Ersaea bojani* in preference to placing them in the genus *Doromasia*. Their structural characteristics are nearly the same. The only positive difference between them is the shape of the somatocyst. Actually, the only difference between them was that the somatocyst of *Ersaea bojani* is wide, protruding upward in a blind sac in the right upper corner while that of *Ersaea picta* is almost oval. In 1908, A.D. Lens and Th. van Riemsdijk reported as a result of studying various specimens caught of the "Siboga" expedition that between the somatocysts of the species discussed above there are many transitional forms which in reality link these two forms together. Thus any differentiation between them is impossible. Simultaneously, these investigators reclassified one of the parents, *Doromasia bojani*, under a different family group in the genus *Diphyes*.

Consequently, this eudoxid became a lost child between the families Monophyidae and Diphyidae. However, in this case, had either one of the relations been *Doromasia bojani* and *Ersaea bojani* or *Doromasia picta* and *Ersaea picta* been defined before, this eudoxid would have probably been classified in the right genus. Unfortunately, such was not the case. Chun, himself, who should have been in a position to find the missing link, based his classification of these species on various analogous characteristics of bracts, tentacles, etc. and not on certain indisputable facts.

Consequently, today, it can only be called a eudoxid whose parent is unknown.

Ordinarily, as has been mentioned in several reports, the genera *Doromasia* and *Diphyes* or *Diphyopsis* are quite similar in a number of respects and even the parents are exceedingly difficult to distinguish. Therefore, it is not at all strange that their eudoxids resemble each other so closely. Even among the specimens of *Ersaea bojani* mentioned above it is not known whether "a" is an offspring of the genus *Doromasia*

and "b" of the genus *Diphyes* or some other genus. So at present we can only accept the specimens for what they are.

The bract of this species has the shape of a dagger without a hilt and appears to be egg-shaped when seen from the dorsal side. Its length is about twice its width with the thicker upper half gradually tapering toward the lower end. It finally terminates in a thin, leaf-like form. The dorsal surface is convex and its upper margin is a smooth arc while its lower margin has three teeth, one situated on the median line while the other two are lateral. The tooth on the right side is not conspicuous but there are several serrate teeth between it and the centre process. The ventral side is wide, shallow and slightly concave. Especially, in the lower half, this concavity appears to coincide with the depression on the upper surface of the special nectophore which faces it. This provides a space for expansions and contractions of the siphon and the tentacle. The wide oval somatocyst is situated in the centre of the bract. At its right end there is a slight protrusion that bends upward. The oleocyst is commonly found either at or near its blind end. The inner wall of the somatocyst is made of many bubble-like cells. The lower part has an ordinary outer covering layer and the upper part is thicker. The somatocyst itself becomes connected to a short, thick stem at its under side. Around this is a ring of thick cortical cells. Each cell contains numerous granules. This is the first characteristic Chun observed and is very interesting histologically. The siphon is short and columnar. Its large stalk is connected to the stem without distinction, the basal part is thick, the stomach is a yellowish-green with a pyloric constriction at the base, and a well developed muscle is found on the proboscis. The tentacle grows from the dorsal side of the stalk. Its structure is of the usual type. The stem and cormidia are a light yellow.

The special nectophore is on the lateral side of the bract and the siphon. Because it is firm and shaped to these parts, the general shape of the eudoxid does not vary too greatly on expansion or contraction. Its shape is roughly square drill-like with four sharp ridges. When it is well developed, it resembles a square pillar whose upper end appears to have been cut diagonally. On its surface is found a slight four cornered drill-like process in the centre. In an older specimen the lateral symmetry is more or less lacking. This may easily be ascertained from the fact that the paired ventral ridges are sharper than the dorsal ones. At the lower end they end in strong teeth. All four ridges are serrated on the lower half. Of four borders which enclose the lower surface of the special nectophore the ventral one is almost straight, but the other three prominently curve upward. In all case the strong serrate teeth are present. The nectosac of the special nectophore is columnar and its length is approximately three times greater than its width. Its opening is round, with a well developed velum. The stalk canal leaves the stem at the left lower part of the somatocyst and enters the gelatinous part of the nectophore on the middle of the upper surface. After running in a short straight line to the upper ventral side of the nectosac, this canal branches into the dorsal and ventral radial canals. Of these, the dorsal shortly branches again into lateral canals to the right and left. Thus, these four radial canals finally become connected with a ring canal at the opening of the nectosac. However, these radials canals, especially the dorsal canal, run counter-clockwise, spiralling downward.

The eudoxid is either male or female. The first gonophore and those that develop subsequently are always the same sex. The gonophore grow attached to the ventral side of the stem. Generally, they are situated on the right side of the special nectophore. As far as their sizes are concerned, even a fully mature gonophore is far smaller than the special nectophore. The form and structure of the gonophores are, as a whole, similar to those in the Calyphorae.

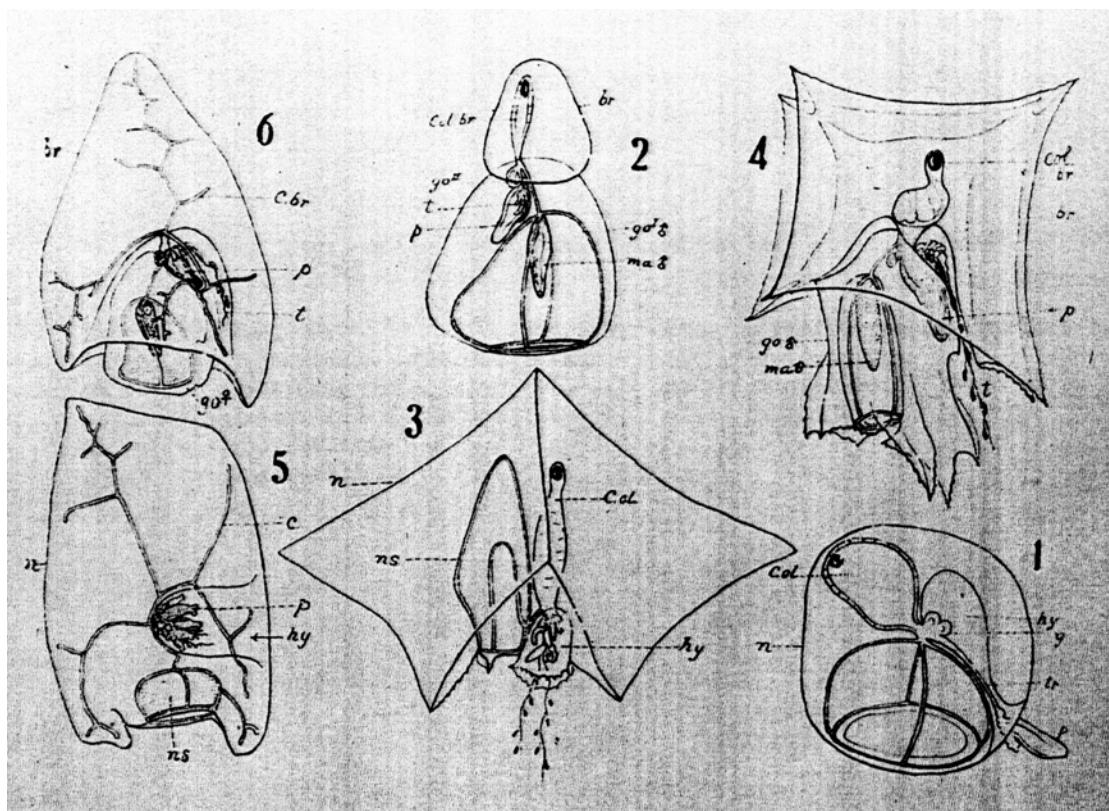
The author was able to collect many specimens of this species in the spring of 1908 to add to the plankton collections of the Misaki Marine Experiment Station. Many of them, however, were so-called species "picta" type or had a somatocyst similar to this species. One has a species "bojani"-type somatocyst.

The overall length of the colony was between 4.5 and 8 mm and a maximum width of approximately 2.5 to 4 mm.

Genus *Cubooides* Quoy and Gaimard, 1827

This generic name was commonly given to the monogastric generation and *Halopyramis* was given to the polygastric generation. Heretofore, a tremendous number of species have been reported in this group but, at present, all of them are recognised as one species, that is, *Cubooides vitreus* Quoy and Gaimard (drawings - fig. 3 and 4) and *Cymba cuboides* Eschscholtz, *Abyla vogtii* Huxley, *Halopyramis adamantina* Chun, *Cubooides crystallus* Haeckel, *Enneagonum hyalinum* Schneider etc, are all synonyms. Until recently it has been called by the generic name *Halopyramis*. Bigelow, however, claimed that, in the strict taxonomic sense, the name of any part even of a eudoxid, may have priority and hence adopted the name *Cubooides*.

Although this species has not yet been caught by use, it probably does occur in our local waters since it has already been reported as occurring in the Indies, Malayan waters and the Eastern Tropical Pacific.



Legends

Vol. XXVII, Plate 7, Figures 1-6.

Figure 1. *Sphaeronectes truncata* Chun

Figure 2. eudoxid.

Figure 3 *Cubooides vitreus* Chun

Figure 4. eudoxid.

Figure 5. *Nectopyramis diomedaeae* Bigelow

Figure 6. eudoxid

br. bracts; c.br. bracteal canal system; col. somatocyst; col.br. bracteal somatocyst; go. gonophore; hy. hydroecium; mas. gonophore manubrium; n. nectophore; ns. nectosac; p. siphon.

III. Sub-family Nectopyramidinae Bigelow, 1911

In this sub-family the branched canal system within the smooth nectophore corresponds to the somatocyst. There is only one genus which was described from a specimen caught on the "Research" cruise of 1900.

Genus *Nectopyramis* Bigelow, 1911

This genus has only two species, *Nectopyramis thetis* Bigelow, and *Nectopyramis diomedaeae* Bigelow (figs. 5 and 6). The former occurs in the Bay of Biscay and the latter in the Southern Pacific. However, it is not yet known in Japanese waters.

Calyconectid Siphonophorae III

by

Tamiji Kawamura

Dobutz, Z. Tokyo, 27, 317-324, 1915

Translated by Rodney Notomi

II Family Prayidae Kölliker, 1853 (Diphyidae)

(= Pragomorphae Chun, 1888 = Oppositae Chun, 1892)

There are two (occasionally 3-4) identical nectophores facing each other. In most instances, these undergo regeneration. Bracts are found on the cormidia, which, for the most part, do not break loose but remain attached to the stem.

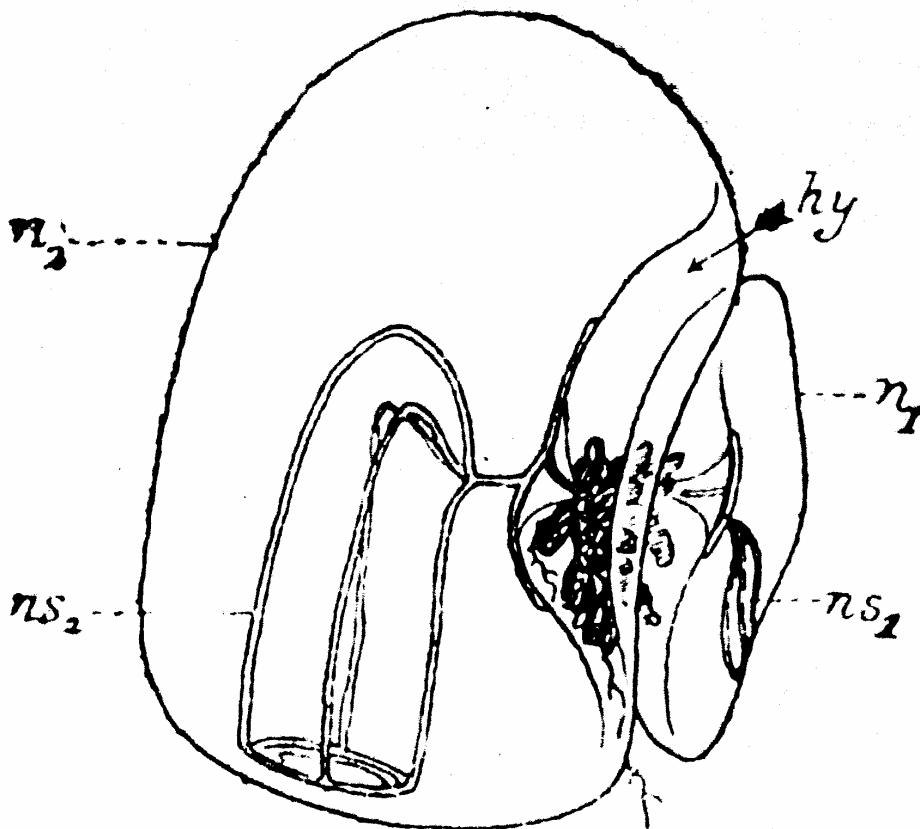
I Sub-family Amphicaryoninae Chun, 1888

the two nectophores of siphonophores in this sub-family are dissimilar because the older one becomes a shield-like bract. Regeneration does not occur in the nectophores. "Free swimming" eudoxids are budded off.

The last two characteristics are only true for this sub-family and indicate a close relationship between this sub-family and the previous family. This group, however, has only one genus, as follows:

Amphicaryon Chun, 1888

Only one species from the Canary Islands, *Amphicaryon acaule* is known (fig. 7). *Mitrophyes peltifera* which was reported by Haeckel in the past is believed to be this species [NO].



II Sub-family Prayinae Haeckel, 1888

The two nectophores present are almost identical in size and are replaced by nectophores that bud out from behind. The cormidia appear to remain on the top of the stem permanently. Three genera of this sub-family, *Rosacea*, *Lilyopsis*, and *Praya* were described many years ago. Numerous species of these genera are now on record but these are rather confused. In recent years many scientists have combined *Lilyopsis* with *Rosacea*. Bigelow has added the genus *Nectodroma*. Both *Desmalia* and *Desmophyes* are old genera created by Haeckel.

Praya Blainville, 1834

No special nectophore on the cormidia.

Only one [2] species is recognised at present.

Praya cymbiformis (delle Chiaje) Leuckart [**not a Praya**]

Praya dubia Blainville, 1834, p. 137, Pl. Vi, fig. 4 [Not]

Diphyes prayensis Quoy and Gaimard, 1834, p. 106, Pl. III, figs. 37-38 [**Not**]

Physalia cymbiformis delle Chiaje, 1842, tab. 33, fig. 1

Praya diphyses Lesson, 1843, p. 144

Praya cymbiformis Leuckart, 1853, p. 2, tab. 1, fig. 4; 1854, p. 286, Pl. XI, figs. 18-24; Huxley, 1859, p. 30; Keferstein and Ehlers, 1861, p. 20, Pl. I, fig. 28; Haeckel, 1888b, p. 146; Chun, 1897b, p. 66, fig. 8; 1897b, p. 102; Bigelow, 1911, p. 200, Pl. II, figs. 1-6.

Praya maxima Gegenbaur, 1854, p. 19, Pl. XVII, figs. 1-6: Haeckel, 1888b, p. 146: Lens and van Riemsdijk, 1908, p. 17.

Praya galea Haeckel, 1888a, p. 35; 1888b, p. 146, Pl. XXXI, XXXII.

Praya (Huxleya) californica Gravier, 1899, p. 87, figs. 1-4.

Two identical nectophores face each other ventrally. Between them hangs the stem with many cormidia. However, there is a slight difference in shape between the two if observed critically. The larger (and younger) one with its lateral wing-like processes embraces the corresponding part of the smaller one which, on the other hand, encases the basal part of the stem. The large groove passing vertically between these "wings" is comparable to the hydroecium of other Calycomorphae. The triangular lamella longitudinally attached to the median line of the hydroecium is the part by which the nectophore attached itself to the stem. Both dorsal and lateral sides are smooth. The overall shape of a nectophore is a column whose longitudinal axis curves inward, that is, it is kidney-shaped.

The nectosac is an extremely small cone occupying the lower 1/3 of the nectophore. Its opening is round, slanting obliquely toward the lower dorsal side. The velum is wide.

The short stalk canal enters the gelatinous part (of the nectophore) from the stem, through the muscular lamella and extends in a straight line toward the apex of the nectosac. Branch canals [**upper and lower pallial canals**] bud out above and below. The branches turn upward and downwards following the median line of the hydroecial groove and terminate in blind ends near the upper and lower ends of the nectophore. The four radial canals may be grouped into two pairs. The dorsal and ventral canals are simple and run directly toward the nectosac opening while the lateral canals are extremely long and form very complicated sinuous curves along the nectosac wall.

A thin but long stem carries countless cormidia. Each cormidium consists of one bract, one siphon, one tentacle, and one or more gonophores. Many buds surrounding the base of the stem give the appearance of beautiful cobalt beads.

The bract is a thick, muscular kidney-shape. Its dorsal and lateral sides are smooth. A deep depression on the ventral side forms a bracteal cavity which covers the other parts of the cormidium. The “cavity” canal running parallel to the axis of the stem [? in fig. 5, i.e. c.br + dorsal canal] becomes connected to an arrow-like canal. The canal toward the front ends blindly while towards the back it not only forms a dorsal canal which curves slightly, but it also branches out for half its length [divides into two (half its length)] into lateral canals [commonly called longitudinal (paired)] to the wing-like parts on both sides of the bracteal cavity. All four canals are inflated slightly at their blind ends and give the appearance of a club. Furthermore, the lateral [longitudinal] canals each have a short, symmetrical branch that turns upwards. In some specimens only the terminal part of the dorsal canal appears to reach the surface. This, however, is a case of abnormal growth (Pl. VII, fig. 5)

Once Haeckel considered the short branch budding from the right lateral canal comparable to the somatocyst [phyllocyst] seen in the bracts of other genera. But since he overlooked identical growth on the left lateral canal this so-called “somatocyst” is comparable to the dorsal canal. This is quite obvious when compared with the following genus *Rosacea*. [He is referring to *Desmophyes* (see pl. VII, figs. 6-8)] The older bract is slightly bent toward the stem, its [latero-]lateral axis parallels the stem when attached.

The siphon is connected to the stem by an extremely short stalk from which the tentacle grows. There are eight clear red hepatic ridges on its spindle-shaped stomach. The bright yellow nematocyst clusters [cnidosacs] have a readily contractile terminal filament.

All seven specimens were caught at Misaki during the spring and summer. The smaller nectophores were 13 to 30 mm in length and 8 to 20 mm in width while the larger ones were generally 1.25 times greater in length and width. The bracts were, in the largest measures, 5 to 8 mm in length and 3.5 to 6 mm in width. On [polygastric stage] taken in perfect condition had the stem reaching approximately 3.03 dm. It expanded and contracted vigorously. When alive it was exceptionally beautiful but being extremely delicate it separated easily.

As far as the distribution of this species in the Pacific is concerned it had already been found in the Indian Ocean, Torres Strait, Malayan waters, Lower California and the Eastern Tropical Pacific. Recently, it has also been seen in the waters of our coasts. Therefore, it evidently occurs widely in the tropical and temperate zones.

Genus *Rosacea* Quoy and Gaimard, 1827

(= *Lilyopsis* Chun, 18850

[*Desmophyes* sp. judging by his figures]

A special nectophore is found on the cormidia. Many animals of this genus were finally classified in the following two species as *Rosacea plicata* Quoy and Gaimard or *Rosacea medusa* (Metschnikoff). In this report, however, only the former species will be discussed. The latter, *Rosacea medusa* is nearly three angle [triangular] drill-like [i.e. conical?], and its nectosome is comparatively large. On the nectophores and special nectophores there is a [are many] rudimentary tentacle at the base of the velum, which is characteristic of this species [*R. medusa*].

Rosacea plicata Quoy and Gaimard

Pl. VII, figs. 6-8

Rosacea plicata Quoy and Gaimard, 1827, p. 177, pl. IVB, fig. 4; Schneider, 1898, p.

78; Bigelow, 1911, p. 201, Pl. II, figs. 7-9 [**This is another species (i.e. not Desmophyes sp.) now known as “Rosacea plicata sensu Bigelow”**]

Rosacea ceutensis Blainville, 1834, p. 140, Pl. VI [**? ctenophore**]

Praya diphyses Kölliker, 1853, p. 38, taf. IX; Vogt, 1854, p. 99, Pl. XVI, XVII; Bedot, 1882, p. 122.

Diphyes bragae Vogt, 1851, p. 140

Diphyes filiformis Keferstein and Ehlers, 1861, p. 20, taf. V, figs. 8-11

Lilyopsis diphyses Chun, 1885, p. 280; 1897b, p. 102; Lens and van Riemsdijk, 1908, p. 17, Pl. II, fig. 16

This species [**Desmophyes sp. - not all above synonymy**] is [**somewhat**] similar in shape and structure to *Praya cymbiformis* discussed previously. Only it is smaller (in size) and shows slight structural differences in the nectophores, bracts, etc. First the stalk [**pallial**] canal of the nectophore, on entering the gelatinous part, buds out an upper [**no mention of descending branch**] branch which runs upward only a short distance and whose end becomes a slightly conspicuous egg-shaped inflated part, curving a little toward the dorsal side. The four [**straight**] radial canals are of equal length and run along the nectosac wall directly to the circular canal. At this point four dark red ocellar spots are found. The round nectosac opening is on the lower dorsal surface and has a velum.

The bract is kidney-shaped and has a smooth dorsal surface. On the ventral surface running like an arrow [**? Y-shaped**] toward the lower back side, forming the bracteal cavity. The stem enters the gelatinous part at the apex of the bracteal cavity, turns at once toward the dorsal surface, and expands into a rather large oval somatocyst [**vesicle**] in the centre of the bract. This is not the dorsal canal of the previous genus. {NO. It is not found in *R. cymbiformis*, but K does not describe any other ‘dorsal’ canal} The somatocyst divides at its base into three canals [**c⁴ and pair of longitudinal**] of equal length - the median frontal canal [**? c⁴**] extends toward the front while the pair of the back [**longitudinal**] canals turn backward towards [**along**] the processes [flaps] forming the bracteal cavity. However, each of these again turns toward the front and have short lateral branches. These canals all end in club-like expansions. The cormidia have a special conical nectophore [**special swimming bell**] in front of the siphon within the bracteal cavity. The nectosac, too, is a comparatively large cone. The straight stalk [**pedicular**] canal reaches the apex of the nectosac entering from the point of attachment with the bract and branches into four radial [**? not 2 and 2 (see Moser 1917)**] canals. Like other nectophores [**polygastric**] it has a velum and ocellar spots.

The structure and colours of the siphons, tentacles, and the gonophore are the same as in *Praya cymbiformis* (delle Chiaje) Leuckart.

Of the two specimens studied by the author, one was obtained by Prof. Iijima in January 1907 at Misaki and the other was caught at the same locality on December 26 of that year. Specimen “A” was preserved in formalin. The primary nectophores measured 22 mm in length and 16 mm in width, the secondary nectophore, 25 mm in length, 18 mm in width, and the largest bract 5 mm in length, 4 mm in width. Specimen “B” (when alive) was about 1/3 the size of specimen “A”.

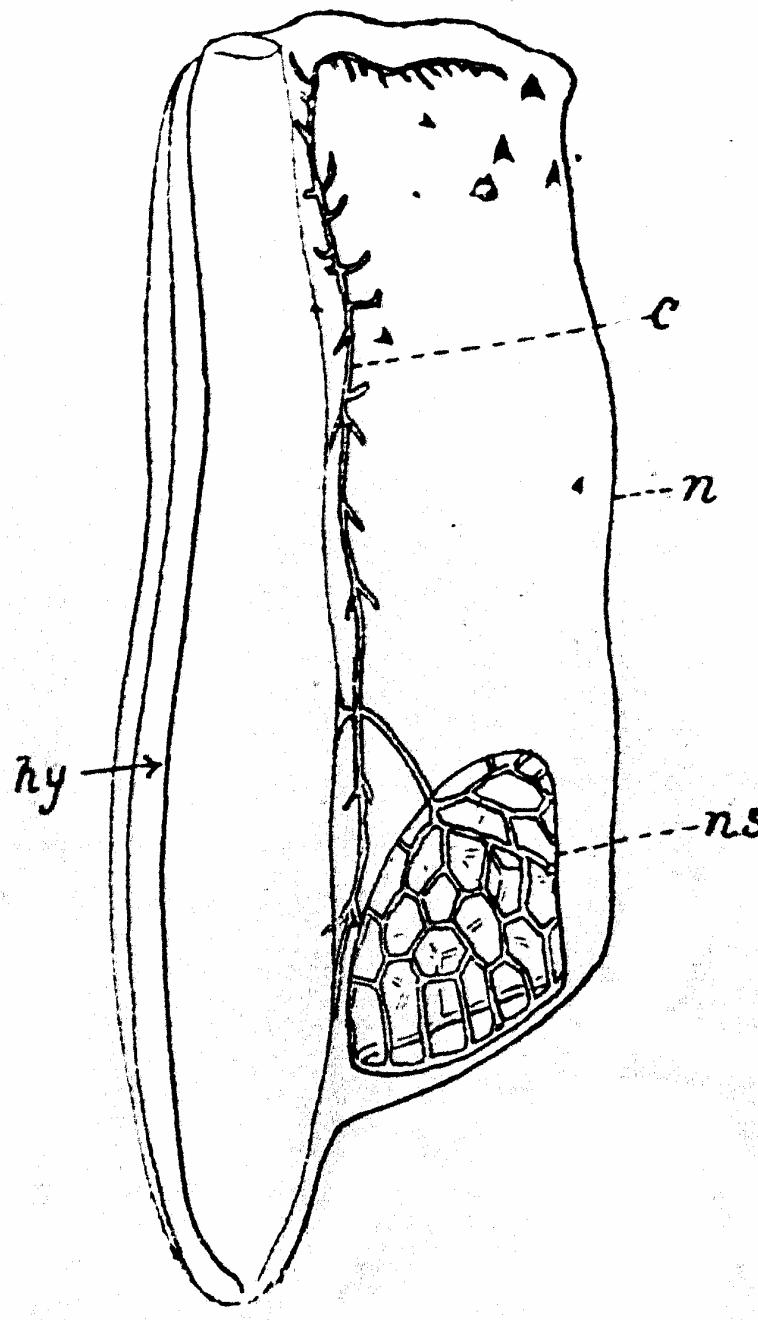
This species, too, is apparently common [**?! Described only 4 times**].

Confusion of 2 or more spp.] all over the world. However, in some specimens of the Atlantic form [**different species**], the dorsal bracteal canal often ends blindly and

lacks the ovoid expansion. [? not homology of dorsal bracteal canal, but of 'central organ' in *Nectopyramis thetis*]

Genus *Nectodroma* Bigelow, 1911

The canal comparable to the somatocyst branches out. There are more than four radial canals on the nectosac which all become connected to form a network. The two species *Nectodroma dubia* (Quoy and Gaimard), *Nectodroma reticulata* Bigelow (fig. 8) are known. Both are tropical Pacific forms. The latter has a more intricate net-like radial canal than the former.



Genus *Desmalia* Haeckel, 1888

Has a total of four nectophores in two rows but no special nectophore on the cormidia. The description of this genus is insufficient.

Genus *Desmophyes* Haeckel, 1888

Has six nectophores arranged in two rows. A special nectophore is present on the cormidia. There is one species *Desmophyes annectens* Haeckel. However, the structure of the nectophores and the cormidia, as in the previous genus, *Desmalia*, resemble those of *Praya* and *Rosacea*. Therefore, many scientists doubt this genus to be distinct from these.

III Sub-family (Stephanophyinae)

There are numerous nectophores arranged in a ring. The part comparable to the somatocyst is a branched canal system. The cormidia do not break loose.

Single genus and species

Genus *Stephanophyes*

Stephanophyes superba Chun

Stephanophyes superba Chun, 1891

Stephanophyes superba Chun, 1888, p. 1164; 1891, p. 3, Pls. I-VII; 1897b, p. 102

Rosacea dubia Schneider, 1898, p. 76 (partim)

The two specimens studied by the author were in rather bad state of preservation as each part was either broken off or separated. It was, therefore, not possible to describe them as they appeared when alive. However, Chun's original report of this animal was given in great detail and accompanied by drawings. The structure of the nectophores, bracts, special nectophores and tentacles of the author's specimens agreed well with these drawings and description. From this, the author assumes that the general shape and position of the parts differed but little. Inasmuch as the author included the entire animal [fig. 9] as well as the cormidia [fig. 10] on the plate [VII] for the reader's convenience, he wishes to state that there is some discrepancy between the drawings of these, unlike those [**most of sketches of other spp. in life**] for other species, because these drawings [? **cormidium - fig. 10**] were not sketched from life. Further the discussion [? **description**] of the structure [**of gonophores and tentacular nematocysts**] has been supplemented [**taken from**] with Chun's description as far as the detailed comparison of the overall shape of the structure of the male and female gonophores (the gonophores on the stem are not yet fully developed) and the tentacular nematocysts are concerned.

The structure of this species can be said, probably, to be the most beautiful of all Calycophorae despite its small size. On the upper end of the body, there are four nectophores arranged with the dorsal side outwards. Consequently, the stem, which connects these nectophores is suspended from the centre. At the upper end of the stem many cormidia are scattered at equal distances. Because its special nectophore is pressed close from above and below (by the cormidia), the stem does not freely expand and contract as in the case of other Calycophorae. Its appearance closely resembles *Agalma*. There are many cormidia and the length of each cormidium [? **total stem**] reaches many tens of times greater than that of the nectophore. A cormidium spotted with red, yellow and orange is very beautiful.

The nectophore is hood-shaped and, in its natural position, its outer surface corresponds to its dorsal side and the lower surface. This is because the apex of the nectosac extends towards the ventral side. Hence, the lower surface of the nectophore, that is, the opening of the nectosac, changed its position to the dorsal side. Therefore, the shape of the nectosac, viewed from the outside, appears to be rectangular, twice as high as it is wide, or, when viewed from the side, as a parallelogram with rounded corners. When seen from the dorsal side the nectosac is comparatively smaller and is egg-shaped with its long axis placed horizontally. But if seen from the side it is columnar with its axis arched slightly from the inner side toward the outer side.

Precisely, the opening with the velum is slanting almost perpendicular instead of being horizontal. The stalk canal which is nearly horizontal as it enters the gelatinous part through the muscular lamella (attaching the nectophore to the stem) reaches the nectosac at its upper ventral median line. There the canal branches into four radial [subumbrial] canals. Of these, both the ventral and dorsal canals simply run along the median line while the lateral canals form an S on the nectosac wall. They enter the circular canal near the ventral canal. The velum is slightly wider on the dorsal side.

The part corresponding to the somatocyst is a canal system which branches repeatedly. When the stalk [pallial] canal enters the gelatinous part, two branches run upward and downward. The lower branch ends in a sac a short distance below the wall of the hydroecium and the upper branch has several forked branches. These branched canals extend (spread) into the gelatinous upper and the lateral sides of the nectosac. The end of each branch is slightly inflated and is a clear red.

The hydroecium is found on the ventral surface of the nectophore, that is, it is represented by an extremely weak groove situated on the lower half of the natural inner lower surface. The stem is attached slightly above the upper side instead of by the bottom of the groove [hydroecium].

Each cormidium consists of a bract, a siphon, a tentacle, special nectophores and gonophores. In addition, there is a different shaped siphon and another kind of tentacle attached at the internodal part. At the upper end of the stem a young nectophore bud is seen.

The smooth bract is attached on the dorsal side of the stem and has a complicated shape. Roughly, it has the form of a saddle which straddles the stem, the right and left sides expanding around toward the ventral side, like a pair of thin wings. However, these "wings" are not symmetrical, the right wing is wide and flat wrapping the special nectophore like a sleeve, while the left wing is rather long, thick and muscular [?], having a groove inside which is a passage for the extension and contraction of the siphon and of the tentacle. In the gelatinous part of the bract there are six rather long canals that enter from the stem. They are situated in the following manner [**This translation of the Japanese account of the bracteal canals does not help one to understand the pattern (common to Rosacea, etc), but when "the pattern" is understood one can understand K's account, which is poor.**] - two on each wing [see Chun taf. III, fig. 4], one facing upward [**one of latitudinals, Chun's '4'**] and one ["c³" also Chun's '3')], and one toward the dorsal side. [**This obscures the significance of the arrangement (1 & 2 on one side, 4 & 6 on the other)**] Each canal ends blindly with a slight expansion filled with small oil droplets. Some of them are clear red. The longest canals of the six are two [**the two longitudinals 5 & 6**] on the left wing [side] and the shortest is one on the dorsal side ["c³"]. The latter canal does not develop directly from the stem but branches out from the one [**Chun's 4, a lateral**] which turns upward along the median line.

The structure of the siphon does not differ from that of other calycophorid siphonophores. However, the distinctiveness of divisions of its four parts are quite different from others. Particularly in the characteristics of a long and narrow stalk. The tentacle is attached to the upper surface of the basal part of the siphon.

The special nectophore is situated slightly above the gonophore, close to the lower left side of the siphon. Slightly large in size and protruding from the stem towards the ventral side, it is in alignment with the cormidia above and below it. Its gelatinous part is well developed on the side near the stem. The nectosac occupies half of the ventral side of the cormidium as a whole. The stalk canal runs a very short distance through the muscular lamellae and, bending at a right angle, becomes

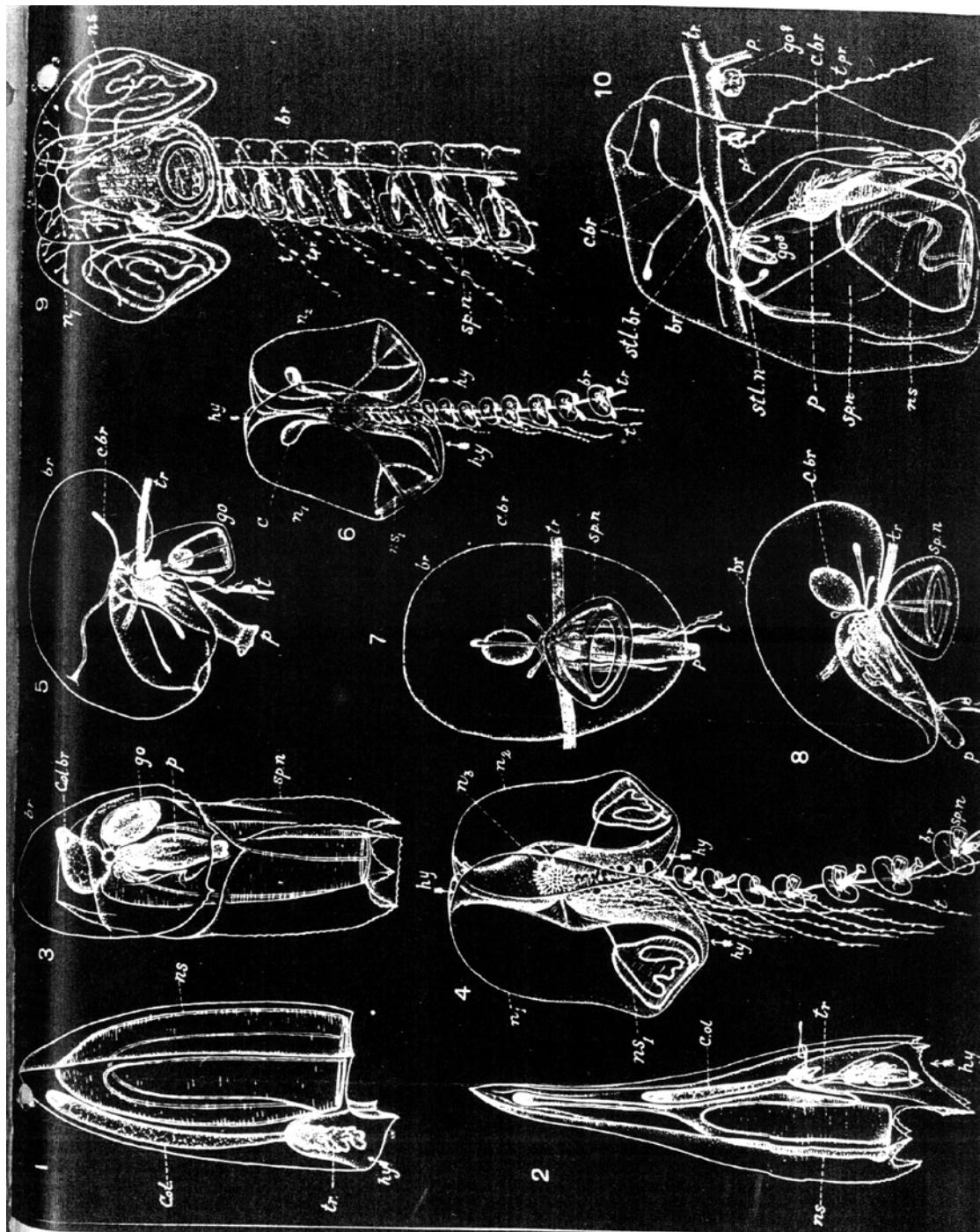
connected to [?2] branches running upward and downward. Then, midway, the lower canal gives off a branch which goes directly to the nectosac apex. The two lateral canals (of the four radial canals) curve conspicuously before joining the circular canal.

According to Chun, this species grows both male and female gonophores at the base of the siphon. (Chun has observed two each of male and female gonophores when examining the cormidia from one side). The male gonophore develops a long, narrow, spindle-shaped manubrium with sex cells. The velum too is definitely present. The female gonophore has a manubrium which is a bit shorter than the male form. Its umbrella is like a shallow saucer but its manubrium is inflated. In this there are stored several large egg cells. The direction of growth of the radial canals is similar to those of the male gonophore.

In conclusion there are two component parts which must be discussed and which are not common with other calycophorid siphonophores, namely, the polyp attached to the node of the stem and a primitive tentacle which grows from the base of the stem [?]. The polyp is a small-spindle shaped growth whose tip is closed and whose function is unknown. This occurs on practically all siphonophores and has been considered as a palpon. However, there are some inactive types which are hardly thought to have any function of their own. Haeckel, on the other hand, on finding an individual with an opening at the end, considered that such an opening has an excretory function. Yet a true palpon as seen in the Physophorae is accompanied by a narrow palpacle which develops at the base without lateral branches. If the type seen on *Physalia physalis* with tentacles is considered, this too, can be given a similar interpretation [?].

The small tentacles which bud out from the polyp [**attached to the node - ? larval tentacle for each polyp**] are one to three in number (according to Chun), with acorn-like nematocysts. These abnormal tentacles are supposedly primitive like the temporary tentacles found in the embryonic stages of *Agalma* and other genera. Following this, however, a kidney-shaped nematocyst common to the Calycophorae appears to replace this earlier growth. This has already been explained by Haeckel (in 1869). In short, in *Stephanophyes* a more primitive tentacle from the embryological standpoint, develops at the same time as the normal tentacles generally found in Calycophorae.

Of the two specimens studied by the author, one is an old specimen belonging to the Misaki Marine Experiment Station and was not in good condition. The time of catch and the name of the collector was not recorded. The other was a live specimen caught by the author near the station. However, before a close examination could be made, nearly all parts became separated and the stem contracted irregularly. At any rate, the largest nectophore measured 8.5 mm in length and 5 mm in width. The larger special nectophore measured 10 mm in length (in the natural horizontal position) and 3 to 4.5 mm in width (in the natural vertical position).



Legend Plate VII, Vol. XXVII, 1915

- Figure 1. *Muggiae atlantica*, lateral view x 16
 Figure 2. *Doromasia picta*, lateral view x 8. [*Diphyes dispar*]
 Figure 3. *Ersaea bojani*, dorsal view x 12
 Figure 4. *Praya cymbiformis*, lateral view x 5/8
 Figure 5. Cormidium of above, lateral view x 8
 Figure 6. *Rosacea plicata*, lateral view x 4 [? *Desmophyes* sp]
 Figure 7. Cormidium of above, dorsal view x 16
 Figure 8. Cormidium of above, lateral view x 16
 Figure 9. *Stephanophys superba*, lateral view x 4 [a reconstruction from loose parts - see text]

Figure 10. Cormidium of above, left lateral view x8.

br. bract; c.br. bracteal canal system; c.ol. somatocyst; col.br. bracteal somatocyst; go. gonophore; hy. hydroecium; n1. nectophore; n2 nectophore; n3 nectophore; ns. nectosac; p. siphon; p!. siphon without opening; stl.br. bracteal stalk lamella; stl.n. nectophore stalk lamella; t. tentacle; tr. stem; t.pr. primitive tentacle.

III Family Hippopodiidae Kölliker, 1853
 (Polyphyidae Chun, 1882)

When the smooth primary nectophore drops off numerous secondary nectophore identical in shape takes its place, and are aligned in two rows. No bract is present on the cormidia which remains permanently attached to the stem.

At present, two genera *Hippopodius* and *Vogtia* are known

Genus *Hippopodius* Quoy and Gaimard, 1827

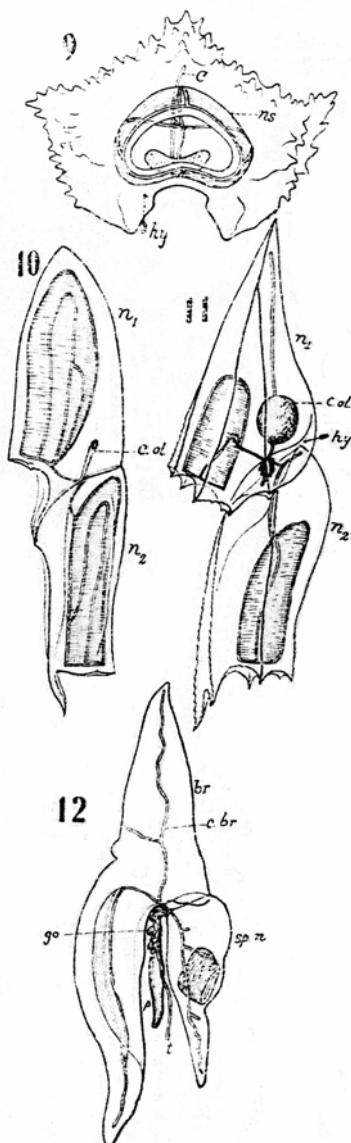
The nectophore is smooth and horse-shoe shaped.

Those that are thought to belong to this genus are *Gleba*, *Protomedia*, *Elaphantopes*, *Polyphyes* etc. The old “family” name was derived from the last generic name listed here. In the past various species such as *Hippopodius lutes*; *H. mediterraneus*, *H. neapolitanus*, *H. gleba* etc have been described but at present they are all thought to belong to the same species. Thus, *Hippopodius hippopus* (Forskål) Schneider will be used in this paper. However, the specimen caught by the author at Misaki last year and subsequently reported in Col. 22, No. 264 of this publication is a different species and identified of *Hippopodius ungulatus* (Haeckel). The best characteristic for distinguishing this species (from *Hippopodius hippopus*) is by the six tooth-like protrusions around the nectosac opening of the nectophore. This difference, however, Schneider (1898) has insisted, does not justify the separation of the two species. Bigelow (1911) recently that inasmuch as the former (i.e. *Hippopodius hippopus*) shows some sign of developing a similar growth, it is still better to refrain from identifying it (*Hippopodius ungulatus*) positively. Therefore, it is reasonable to consider these two as different species.

Calyconectid Siphonophorae IV
 by Tamiji Kawamura
 Dobutz, Z. Tokyo, 27, 428-440, 1915

Hippopodius ungulatus (Haeckel) Chun
Polyphyes ungulatus Haeckel, 1888b, p. 179, Pl. XXIX, figs. 1-8
Hippopodius ungulatus Chun, 1897, p. 103
Hippopodius hippocampus Schneider, 1898, p. 82

Since this species has already been reported in Vol. XXII, the discussion will not be repeated here again.



Genus *Vogtia* Kölliker, 1853

The nectophore is pentagonal

Schneider, following the example, combined this genus with the preceding one but no other investigator seems to agree with this classification. The genus has two species *Vogtia spinosa* Keferstein and Ehlers (figure 9), *Vogtia pentacantha* Kölliker. None has been found in our country. However, during the "Albatross"

Expedition, the first species was found at several stations in the eastern Pacific, thus, subsequently Delage mentioned its occurrence in Pacific waters.

IV Family Diphyidae Eschscholtz, 1829

When the smooth primary nectophore is cast off, it is replaced by a polygonal secondary nectophore. Regeneration of the nectophore is possible in this case. Two nectophores are always present simultaneously, but they differ in structure and are arranged vertically, one above the other.

I. Sub-family Galeolariinae Chun, 1897

The nectophores are smooth. The superior and inferior nectophores are almost the same in size; the cormidia do not become separated (from the stem). There is only one genus, *Galeolaria*.

Genus *Galeolaria* Blainville, 1834

At present there are four recognised species, *Galeolaria truncata* (Sars) Huxley, *G. australis* Quoy and Gaimard; *G. quadrivalvis* Blainville and *G. monica* (actual spelling) Chun each having several synonyms. Identifications of the species are mostly based on the position and shape of the somatocyst of the superior nectophore, and on the shape of the teeth and the wing-like part at the opening of the nectosac of the superior and inferior nectophores. The hydroecium is extremely shallow and practically does not show at all. This is a common characteristic of the species. The specimen seen by the author at Misaki belonged to the first species.

Galeolaria truncata (Sars) Huxley

Diphyes truncata Sars, 1846, p. 41, Pl. 7, figs. 1-12

Galeolaria truncata Huxley, 1859, p. 38; Haeckel, 1888b, p. 151; Chun, 1897b, p. 17; Vanhoffen, 1906, p. 15, figs. 1-10; Lens and van Riemsdijk, 1908, p. 57; Bigelow, 1911, p. 346

Epibulia truncata Haeckel, 1888a, p. 35

Diphyes appendiculata Schneider, 1898, p. 85 (partim)

The superior nectophore has a smooth apex. It is a cone that appears to have been pressed from the side, having a lateral longitudinal ridge that does not reach either the apex or the lower end. This is generally inconspicuous. The greater part of the nectophore is occupied by a comparatively large nectosac, with a large lower diameter and with a constriction at one point on the dorsal side. The velum is well developed. The stalk canal of the nectophore grows from the lower dorsal corner of the somatocyst, and runs almost horizontally towards the dorsal side. It branches into four radial canals on the ventral side of the nectosac. Of these, the ventral canal is very short. The dorsal one is the longest and runs along the median line of the nectosac wall. The two lateral canals run along the lateral wall parallel to the dorsal canal. The four canals enter the circular canal near the nectosac opening.

In addition there are two diagonal canals running to the right and left of the ventral wall. These enter the lateral canals half way up the nectosac and they enter the dorsal canal at one third of the length from the bottom. Although the diagonal canals are common in some other species, the position of their convergence varies in each species.

The hydroecium is visible but only on the ventral half of the lower surface of the superior nectophore, that is, the bottom surface which tilts slightly toward the ventral side, shows a very slight depression. The rim of this depression is somewhat

convex ventrally and on the sides, but dorsally it is slightly concave. Weak, inconspicuous teeth are present on the dorso-lateral corners.

The small egg-shaped somatocyst is situated above the hydroecium. Its long axis is at an angle of approximately 45° to the bottom surface of the hydroecium.

The specimen taken by the author had only a superior nectophore measuring 6.5 mm in length and 3 mm in width on the dorsal side. A perfect specimen with an inferior nectophore has not yet been found. According to a few earlier reports, it is believed that the characteristic opening of the hydroecium on the dorsal wall of the superior nectophore and the opening of the nectosac without protruding at all, is also characteristic of the inferior nectophore. The author, however, regrets not being able to include the entire animal on the "Plate". Therefore, a rough sketch of another species, *Galeolaria australis*, has been inserted as Figure 10. The species discussed here, when compared with *Galeolaria australis*, differs in the fact that it has an egg-shaped somatocyst and lacks previously mentioned process.

This species has hitherto been known to occur only in the Atlantic Ocean. However, some of them apparently occur in the Pacific as well.

III Sub-family Diphyopsiinae Haeckel, 1888

The nectophore is drill-like. The upper and lower nectophores are identical in size. The cormidia become eudoxids with smooth bracts.

A great many genera have been classified under this sub-family but at present only four, *Diphyes*, *Diphyopsis*, *Chuniphyes* and *Archisoma* are definitely included. The two latter are both new genera that are not easily confused with the others. However, the first two genera are confused and they are also quite similar to *Muggiaeaa* and *Doromasia* of the sub-family Sphaeronectinae. The structural character differentiating *Diphyes* from *Diphyopsis* is the presence or absence of a special nectophore. The question of whether special and inferior nectophores exist in *Muggiaeaa* and *Doromasia* may be due to imperfect specimens.

Genus *Diphyes* Cuvier, 1817

The nectophore is pentagonal drill-like. Special nectophores are not present on the cormidia. Recently, Bigelow recognised the following ten species, *Diphyes appendiculata* Eschscholtz, *D. spiralis* Bigelow, *D. contorta* Lens and van Riemsdijk, *D. bojani* Chun, *D. fowleri* Bigelow, *D. arctica* Chun, *D. steenstrupi* Gegenbaur, *D. serrata* Chun, *D. subtilis* Chun, *D. subtiloides* Lens and van Riemsdijk. However, in the past a still greater number of species was named. Therefore it is a very difficult task to distinguish one species from another.

For example, only three years prior to Bigelow's list of species Lens and van Riemsdijk named six new species. Yet only two of them are included in the above group. From this one can well understand the situation is somewhat confusing. The author has seen only the first four species of the group recognised by Bigelow. The identification of species are based on the characteristics of the ridges and the tooth-like processes of the superior and inferior nectophores, the somatocyst, the nectosac, the hydroecium, etc.

Diphyes appendiculata Eschscholtz
(Pl. 12, fig. 14)

Diphyes appendiculata Eschscholtz, 1829, p. 138, fig. 7; Huxley, 1859, p. 24, Pl. I, fig. 2; Schneider, 1898, p. 85; Bigelow, 1904, p. 265; 1911, p. 248, Pl. VII, figs. 5-6; Pl. VIII, figs. 7-8, Pl. IX, fig. 6, Pl. X, fig. 6, Pl. XI, fig. 1

Diphyes bipartita Chun, 1888, p. 1158; 1897b, p. 24; Mayer, 1900, p. 74, Pl.

XXXIV, fig. 114: Römer, 1902, p. 175.

Diphyes acuminata Gegenbaur, 1860, p. 375

Diphyes sieboldii Kölliker, 1853, p. 36, Pl. XI, figs. 1-8; Gegenbaur, 1854, p. 453.

Diphyes gracilis Gegenbaur, 1853, p. 309, Pl. XVI, figs. 5-7

Eudoxia campanella Müller, 1870-71, Pl. XI, figs. 1-4, Pl. XIII, fig. 10; Lens and van Riemsdijk, 1908, p. 48, Pl. VII, fig. 62 (eodoxid).

Eudoxia messanensis Gegenbaur, 1853, p. 285 (eodoxid)

Eudoxia sagittata Huxley, 1859, p. 50, Pl. IV, fig. 1 (eodoxid)

Cucullus gegenbauri Haeckel, 1888b, p. 110 (eodoxid)

Cucullus elongatus Haeckel, 1888b, p. 110 (eodoxid)

Cucullus campanula Haeckel, 1888b, p. 111 (eodoxid)

The superior nectophore is symmetrical pentagonal drill-like, with five prominent ridges. Of these five, the pair of ventral ridges are weaker than the other three but they are wing-like and protrude further than the other ridges in the upper quarter of the nectophore. The dorso-lateral and ventral surfaces of this pentagonal nectophore form narrow isosceles triangles while the ventro-lateral surface is quadrilateral.

The lower part of the five ridges do not end in teeth-like processes, but those of the dorsal side are very sharp. The cylindrical nectosac is comparatively large with a small dull pointed upper end. The length is twice its diameter. Its apex almost reaches that of the nectophore. In young specimens it sometimes takes the shape of a spindle with a somewhat inflated middle section.

The stalk canal of the superior nectophore develops from the dorsal side at the base of the stem and runs dorsally and slightly downward. It branches into four radial canal as it reaches the ventral side of the nectosac. Consequently, the ventral canal is extremely short while the dorsal canal is very long. At the base of the circular canal the nectosac has a wide velum.

The very shallow hydroecium is bell-like with its apex slightly bent toward the ventral side. Its upper two-thirds is situated above the level of the nectosac opening. Although the upper half of the hydroecium is conical, its lower half becomes a flat surface with a wide dorsal wall extending below the nectosac opening, forming a partition between the hydroecium and the nectosac opening. A slit in the middle of the partition divides it into a pair of bilateral wings which end in somewhat sharp teeth. The four ridges surrounding the hydroecium opening take three different shapes - the one on the dorsal side is concave downward, the sides are straight, and the ventral side is outwardly convex.

The somatocyst is a small canal that develops from the apex of the hydroecium and gradually increases in diameter. It turns diagonally towards the upper ventral side. Further bending upward it becomes a long cylinder along the ventral side of the nectosac. Finally at a little less than one-fourth from the apex of the superior nectophore, it ends in a round head.

The cormidia consist of a bract, a siphon, a tentacle, and a gonophore. The bract forms a conical bracteal cavity. The author, however, has not yet seen a cormidium sufficiently developed to make the study of the shapes of bracteal somatocyst possible. The siphon is spindle-shaped.

The author has had the good fortune of obtaining several very active specimens in the summer of 1907 at Misaki. However, nearly all were juvenile and lacked inferior nectophores or were mutilated. Since in calyconectid siphonophore the inferior nectophores cannot exist alone and are not seen in the plankton, the animal

with cormidia attached to the superior nectophore alone in many cases, has not yet developed its inferior nectophore. On the other hand, the cases in which an inferior nectophore has already been lost are not infrequent. Thus, the lack of inferior nectophores apparently does not seem to interfere with the existence of the animal. The length of the superior nectophore is 4 to 10 mm and the width is 2 to 4 mm. Larger ones are apt to be long and narrow while shorter ones tend to be short and wide.

According to reports, the inferior nectophore is somewhat more than two-thirds the length and width of the superior nectophore. The grooved canal corresponds to the hydroecium. It has strong teeth on the lower left and right ventro-lateral sides. The eudoxids of this species have been reported by various scientific names (see synonyms above) in the past. The bracteal somatocyst is long and cylindrical with the middle section slightly inflated like a spindle.

Diphyes spiralis Bigelow

(Pl. 12, figs. 15-16)

Diphyes spiralis Bigelow, 1911, p. 249, Pl. VII, fig. 4, Pl. VIII, fig. 1, Pl. IX, fig. 3, Pl. X, fig. 4

The superior nectophore has a pentagonal drill-like shape which is somewhat spindle-like due to its inflated mid-section. Its five ridges are well developed and have serrate teeth on the lower part. The most conspicuous characteristic is the clockwise twist of the ridges in a spiral at the level of the nectosac opening. The dorsal ridge twists to the left near the apex while the ventral ridge twists toward the right. However, the ventral ridge fuses with the right ventral ridge before reaching the apex. Thus, the apex itself is square drill-like. The lower end of the left ventral ridge, unlike ordinary cases, coincides with a strong tooth on the left ventral side of other species found at the left lower corner of the partition between the nectosac and the hydroecium openings. However, the teeth on the right side, which are symmetrical with the teeth described above are totally unrelated to any of the ridges. The lower end of the ventral right ridge comes exactly to the ventral median line as the ridge itself is twisted and comes into contact with the V-shaped apex of the ventral wall of the hydroecium. The dorsal ridge shows a strong twist and this and the two dorso-lateral ridges do not end in teeth-like processes at their lower ends.

The nectosac is cylindrical with an inflated mid-section. The nectosac is relatively very large. Consequently, the amount of gelatinous substance is exceedingly small. This part also has a clockwise twist similar to the nectophore but as it does not have conveniently recognisable ridges, the twist is not conspicuous as in the nectophore.

The somatocyst is spindle-shaped with a small upper part. Its length is approximately one third the height of the nectophore. Its lower end is situated at the apex of the hydroecium on the median line but the upper end follows the twist of the nectophore by strongly bending toward the left.

The hydroecium slants towards the upper ventral side. Although rather wide and deep, its apex, in many cases, does not extend above the level of the nectosac opening. The opening of the hydroecium is triangular and its angular apex consists of a V-shape cut on the ventral median line and a pair of ventro-lateral side teeth. The dorsal wall of the hydroecium is a flat partition between it and the nectosac. However, as in previous species a slit on the median line at this point forms a pair of wings.

Although this species is a surface form first collected on the "Albatross" Expedition in the Eastern Tropical Pacific, the author, too, obtained a superior nectophore at Misaki in February 1910. From the beginning it had been suspected to

be the nectophore of the genus *Diphyes*, but the author hesitated to make a positive identification since it was impossible to study the cormidia because of the imperfect specimen. The author's specimen was 5 mm in length but according to Bigelow, it reaches from 2-6 mm. Therefore, the species in general must be a small form. Neither the inferior nectophore nor its eudoxids have yet been identified.

Diphyes contorta Lens and van Riemsdijk

[**(Pl. XII, fig. 17)**]

Diphyes contorta Lens and van Riemsdijk, 1908, p. 39, Pl. VI, figs. 48-50; Bigelow, 1911, p. 254, Pl. VII, figs. 7-8, Pl. VIII, fig. 3, Pl. XI, fig. 2

The spiral nectophore is conspicuously twisted in a clockwise spiral, similar to the previous species. However, the somatocyst is strongly bent. By this character alone, the identification of this species is quite possible.

The superior nectophore has a pentagonal drill-like shape with an inflated middle section. Of the five serrate ridges, the dorsal one is somewhat degenerate and does not reach the apex of the nectophore while the other four ridges are well developed. The dorso-lateral surfaces are slightly convex and the remaining three surfaces are somewhat concave and longer. Consequently, the hydroecium opening is situated below the mouth of the nectosac.

The nectosac is cylindrical and comparatively large. Its apex almost reaches the apex of the nectophore. The opening is round and has a wide velum. The stalk canal begins at the apex of the hydroecium and runs straight on the median line towards the lower end of the ventral wall of the nectosac. At this point, it branches into radial canals but as the ventral radial canal completely disappeared by shrinking the circular canal came together with the right branching fork. The course of the other three canals are generally similar to all others.

The somatocyst is in two parts, a thin, stalk-like canal extending from the apex of the hydroecium, and it becomes a kidney-like sac at its upper end. However, this (expanded) portion which follows the bulge of the nectosac falls on the right side without its long axis becoming upright. The apex of the somatocyst appears to be facing the right ventral surface of the nectophore.

The hydroecium is bell-like but extremely shallow. Its opening is surrounded by four teeth. The dorsal wall has a slit on its median line.

Heretofore, this species was caught in Malayan waters and in the Eastern Tropical Pacific. But because of the fact that the presence of the inferior nectophore was uncertain and there was a special nectophore on the cormidia, the species was included in this genus. The author's specimen was similar to others and was obtained at Misaki in February 1910. It consists only of a superior nectophore whose length was approximately 5 mm and width 2 mm at the opening of the nectosac. However, it was not possible to see the structure of the cormidia.

Diphyes bojani (Chun)

Doromasia bojani Chun, 1892, p. 108, fig. 8

Muggiaebojani Schneider, 1898, p. 88

Diphyes indica Lens and van Riemsdijk, 1908, p. 44, Pl. VII, fig. 54

Diphyes malayana Lens and van Riemsdijk, 1908, p. 45, Pl. VII, figs. 55-56

Diphyes gegenbauri Lens and van Riemsdijk, 1980, p. 46, Pl. VII, fig. 57, Pl. VIII, fig. 58

Doromasia pictoides Lens and van Riemsdijk, 1908, p. 3, Pl. I, fig. 1

The superior nectophore is pentagonal, drill-shaped and the lower third is inflated. The five ridges are conspicuous and slightly convex outwardly, ending in tooth-like processes. Particularly, three of the tooth-like process on the dorsal and

dorso-lateral sides are like extremely sharp three cornered drills whose pointed ends encircle the nectosac opening by slightly curving inward. The other two teeth are so weak that they are not worth studying. Also, on the nectophore are found two other very strong teeth which, as in other cases, are situated at the dorsal corners of the hydroecium opening.

The lower half of the nectosac is almost cylindrical while the upper half is conical. Its apex is very near the top of the nectophore. It ends in a smooth blind sac instead of becoming pointed like the apex of the nectophore. This part is tinted yellow when alive. The stalk budding out from the top of the hydroecium, runs downward through the gelatinous part between the hydroecium and the nectosac. When it reaches the nectosac wall slightly above the lower end of the median line of the ventral wall of the nectosac, it branches into four radial canals.

The hydroecium has a long conical shape and occupies approximately the lower dorsal half of the superior nectophore. The hydroecium opening is quadrilateral with short, straight sides dorsally and on both right and left sides, while the ventral side is slightly concave downward. The slit on the median line of the dorsal wall of the hydroecium is absent.

The somatocyst is somewhat arched and cylindrical in shape and is situated on the ventral side of the nectosac about three quarters of the distance from the bottom of its upper half. The arch of the somatocyst follows that of the ventral wall of the nectosac. The basal part, connected to the apex of the hydroecium, is smaller.

Cormidia generally occur in great numbers suspended on a long stem. The bract is relatively large though its gelatinous part is thin and forms a conical bracteal cavity. There are three teeth of which one slightly to the left of the centre is largest followed by the one on the right. The left tooth is the weakest.

The siphon is spindle-like and its basal part is tinted a light yellowish green. There are commonly more than two gonophore buds on a well developed siphon.

This species was originally classified in the genus *Doromasia*, sub-family Muggiinae by Chun (refer to previous series III). The specimen as shown in the author's illustration had such a large hydroecium that it is obvious at a glance that the animal belongs to the sub-family Diphyopsiinae (sub-family of Diphyidae). The species is one of the most common forms occurring at Misaki. The largest superior nectophore exceeded 15 mm in length, and with *Diphyopsis* which will be discussed later it is one of the largest siphonophores. The author has not yet found a specimen with an inferior nectophore. According to Bigelow, it is about three quarters as long and wide as the superior. Its general form resembles the inferior nectophore of *Diphyopsis* but differs in the wing-like part of the hydroecial groove.

Chun had noted that five ridges of the superior nectophore of this species arise abruptly near the upper end as wing-like expansions but such cases are uncommon. Generally this expansion seems to occur throughout the entire length of the ridge.

Genus *Diphyopsis* Haeckel, 1888

Superior nectophore pentagonal drill-shaped; special nectophore present on cormidia. Four species considered to be definitely established: *Diphyopsis chamissonis* (Huxley), *D. dispar* (Chamisso and Eysenhardt), *D. hispaniana* Mayer, *D. mitra* (Huxley). The first two of these were obtained at Misaki.

Diphyopsis chamissonis (Huxley)
(Pl. XII, fig. 19)

Diphyes chamissonis Huxley, 1859, p. 36, Pl. I, fig. 3

Muggiaeae chamissonis Haeckel, 1888a, p. 34; 1888b, Pl. 37; Chun, 1892, p. 89

Diphyes weberi Lens and van Riemsdijk, 1908, p. 53, Pl. VIII, figs. 67-68

Diphyopsis chamissonis Bigelow, 1911, p. 347

Despite the pentagonal drill-like shape of the superior nectophore, this species appear to be more like a five ridged spindle because of the strongly inflated mid-section. Of the five obvious serrate ridges those on the dorsal and the dorso-lateral sides are more prominent than the other two, and their lower extremities, too, end in stronger teeth than do the others. the teeth are triangular, conspicuously pointed, curve inward, and together surround the nectosac opening.

The nectosac is almost spindle-shaped like the nectophore. The stalk canal, radial canals, etc are the same as in other general cases. The dorsal wall of the nectosac opening forms the partition between this opening and the hydroecium, but no slit is apparent on the median line, and lower ends are developed into strong teeth. The hydroecial opening is surrounded by these and two other teeth at the lower ends of the ventral ridges of the nectophore. Of the four margins that connect these four teeth, both lateral ones curve very slightly upward while the other two sides are deeply concave. The dorsal margin, at the same time, is somewhat convex towards the dorsal side. The hydroecium is comparatively large and generally bell-shaped. However, the upper half appears to be a round headed cylinder while the lower half, by itself, is like a truncated square drill.

The height of the hydroecium is slightly greater than the length of the superior nectophore and its width is greater than the widest part of the latter.

The shape of the somatocyst is peculiar being nearly an oval spindle in shape. Its length is slightly less than one third the length of the nectosac and is situated along the mid one third of the nectosac.

The stem is long and, in many cases, it has more than six or seven cormidia.

The bract is leaf-like and partially covers the stem and cormidia. On the dorsal side at the point of attachment with the stem is a nearly spherical bracteal somatocyst, but somewhat elongate vertically. Above the point of attachment, the bract stands up on the dorsal and both lateral sides like a collar, the two margins of the ventral side forming a V-shaped, valley-like depression. The greater part of the bract is below the point of attachment, forming a wide conical bracteal cavity. The lower margin of the bract is the longest as it is diagonally cut from the left and right. On both ends two sharp teeth face each other on the left and right.

The special nectophore occupies the ventral half of the bracteal cavity and its obvious bilaterally symmetrical being a square post, that is, from the length of the four ridges and from the shape of the teeth at their lower end, it is obvious that the sides of this structure are all equal. Although the four sides are more or less convex, the ventral one (Author's note: the side facing the stem is called the ventral side as a whole) has a round gutter-like depression in the gelatinous material and together with the inner lower surface of the bract it forms a passage similar to the hydroecium. The upper surface is diagonally cut off from upper dorsal side to lower ventral side. From the centre of this surface, a conical gelatinous process is developed through which runs a short, straight stalk canal.

The nectosac of the special nectophore is cylindrical and its axis weakly forms an "S". Because the stalk canal branches out into four radial canals at the upper ventral corner, the length of these branches differs somewhat. The lower surface of the special nectophore is quadrilateral and the four ridges terminate in strong teeth. Of the four margins which connect the teeth, only the one on the ventral side is nearly straight. The ridges on the lower two thirds of the special nectophore are serrate.

The siphon and the tentacles are no different in shape from other species.

Of many specimens collected at Misaki, the superior nectophore measured 4.5 to 10 mm in length and 1.3 3 mm in width.

This species was first reported by Huxley as a member of the genus *Diphyes* for a specimen from the east coast of Australia. It was subsequently identified as *Muggiaeae* sp. Bigelow finally classified it under *Diphyopsis*. He based the last reclassification on the assumption that the animal in question is identical with the new species *Diphyes weberi* of Lens and van Riemsdijk although he had not studied the animal himself. However, as far as the author's specimens are concerned, their structural characteristics agree very well with Huxley's description, but upon a more careful study of the cormidia, it proved to have a special nectophore. Therefore this species undoubtedly belongs to the genus *Diphyopsis* rather than the genus *Diphyes*. No definite conclusion can be made as to the occurrence of an inferior nectophore in this species since no one has yet seen one. If such a part is lacking, the species should be classified as belonging to the genus *Doromasia* following Haeckel rather than in *Muggiaeae*. But in the author's specimen, the hydroecium was so large that it gave the impression of belonging to the family Diphyidae. However, this is simply a conjecture. This is also true of Huxley's illustration.

In any case, it would be suitable to accept the present taxonomic arrangement for the time being as Bigelow has suggested.

Supplement
Ersaea chamissonis ?
(Pl. XII, fig. 20)

Although this species is an eudoxid whose taxonomic place is not yet clearly established, it is included at this point in the paper as it appears to be related to *Diphyopsis chamissonis* (Huxley). However, since the generic *Ersaea* has been used for all eudoxids with a special nectophore, the same shall be true in this case as in *Ersaea bojani*.

The assumption that the eudoxid is related to *Diphyopsis chamissonis* is based on the similarity of the special nectophore. It can be safely said, in fact, that they are absolutely identical. However, in other respects, such is not the case.

The bract with a somewhat greater width than the dorso-ventral thickness is shaped like a peach. Dorsally and laterally it is convex and smooth but ventrally it has a deep longitudinal groove in section resembling the letter V. The lower part is connected to the bracteal cavity. The gelatinous dorsal wall of the cavity becomes thinner below and narrower laterally, finally terminating in two teeth-like processes. The bracteal somatocyst is cylindrical with the upper part inflated bulging out at the upper end, toward the upper ventral part. Although the dorso-ventral thickness greatly increases above, the oil drop is not found there but rather in a still smaller apical sac-like process at the dorsal corner.

By comparing this bract with *Diphyopsis chamissonis* (Huxley) the author finds a great difference between the thickness of the gelatinous part and the shape of the somatocyst. To be more exact, the former has a peach-shaped bract with a ball-shaped somatocyst. The bract, however, in all cases is shaped like a thin leaf and later develops the individual characteristics. The somatocysts also increase relatively in their length. Therefore, it would be better to stress the similarity in the special nectophores rather than the differences just mentioned.

One specimen had a length and width of about 5 and 3 mm respectively. A special nectophore had the same measurements as those given above.

Although *Ersaea cordiformis* Quoy and Gaimard was identified as an eudoxid of this species by Haeckel, it belongs to the genus *Muggiaeae*. The author failed to recognise any difference between this and the author's specimen.

Diphyopsis dispar (Chamisso & Eysenhardt)

- Diphyopsis dispar* Chamisso & Eysenhardt, 1821, p. 365, Pl. XXXIII, fig. 4;
Eschscholtz, 1829, p. 135; Huxley, 1859, p. 30, Pl. I, fig. 1; Schneider, 1898,
p. 197; Lens and van Riemsdijk, 1908, p. 42, Pl. VI, figs. 51-52
Diphyes angusta Eschscholtz, 1829, p. 136, Pl. XII, fig. 6
Diphyes campanulifera Eschscholtz, 1829, p. 137, Pl. XII, fig. 6; Gegenbaur, 1860, p.
366, Pl. XXX, figs. 23-26
Eudoxia lessoni Eschscholtz, 1829, p. 126, Pl. XII, fig. 2 (eudoxid)
Ersaea lessoni Huxley, 1859, p. 57, Pl. II, fig. 6; Fewkes, 1881, p. 166, Pl. VI, fig. 89;
Chun, 1897b, p. 26; Mayer, 1900, p. 75, Pl. XXVIII, figs. 96-97; Lens and van
Riemsdijk, 1908, p. 50 (eudoxid)
Diphyopsis compressa Haeckel, 1888a, p. 35; 1888b, p. 153, Pl. XXXIII, XXXIV
Cucullus lessoni Haeckel, 1888a, p. 32; 1888b, p. 110 (eudoxid)
Ersaea compressa Haeckel, 1888a, p. 32; 1888b, p. 123, Pl. 34 (eudoxid)
Diphyopsis dispar Haeckel, 1888b, p. 152; Chun, 1897b, p. 27; Bigelow, 1911, p.
257, Pl. X, fig. 1, Pl. XI, fig. 3
Diphyopsis angusta Haeckel, 1888b, p. 152
Diphyopsis campanulifera Haeckel, 1888b, p. 153; Chun, 1897b, p. 26; Mayer, 1900,
p. 75, Pl. XXVIII, figs. 93-95; Lens and van Riemsdijk, 1908, p. 51, Pl. VIII,
fig. 63.

The superior nectophore has bilateral symmetry, pentagonal drill-like shape, being strongly pressed from the right and left. The mid-section is inflated dorsally but below this section it resembles an angular post. Of the five ridges the three dorsal and lateral ones end in strong triangular drill-like teeth surrounding the nectosac opening. The remaining two ridges also end in strong teeth on the ventral side of the hydroecium. in addition, two somewhat weaker teeth are present at the lower corners on both sides of the ventral wall of the hydroecium.

The nectosac is cylindrical, extending approximately two-thirds the length of the nectophore. This extends into a canal about half the length of the cylindrical part. This in turn extends nearly to the apex of the nectophore where it ends in a blind sac. The stalk canal buds from the apex of the hydroecium, and turns diagonally towards the ventral side of the nectosac where it branches into four radial canals at a point about one fifth the height of the nectosac. The dorsal canal is extremely long as it reaches beyond the apex running along the median line.

The hydroecium has a long bell-like shape and is situated in the lower ventral half of the nectophore. Its opening is quadrilateral, surrounded by four teeth as in the previous case with each side weakly curved upward. The somatocyst is a cylinder with pointed ends and its axis turns diagonally upwards towards the dorsal side away from the apex of the hydroecium.

The inferior nectophore is approximately the same size as the superior nectophore but it is slightly shorter and smaller. The shape of the opening of the inferior nectophore is identical with that of the superior nectophore, but such is not the case with the other parts. Its general appearance is that of a heptagonal drill placed over a pentagonal post. This post-like lower part is exposed, while the drill-like upper part is the section inserted in the hydroecium of the superior nectophore. In the superior nectophore the five ridges are weak and inconspicuous but in the inferior nectophore not only are these definite but in addition to the five ridges there is a

lateral ridge on each side forming the heptagonal drill-like shape. Of the ridges, the mid-dorsal, the two dorso-lateral and the lateral ones end in extremely sharp triangular drill-like teeth. These last two of these and the remaining two ventral ridges enclose the lower opening of the hydroecial groove (Author's note: the part comparable to the hydroecium of the superior nectophore becomes a groove). The inferior nectophore can be almost divided into dorsal and ventral halves by a plane through the pair of lateral ridges. The dorsal half contains the small stalk canal and the tubular nectosac. The stalk canal runs almost perpendicular to the upper end where the inferior nectophore is attached and branches into four radial canals, at the upper ventral corner of the nectosac. These canals differ somewhat in length. The ventral half of this nectophore has somewhat less gelatinous material and is occupied by a cylindrical hydroecial groove as already described. The groove is rolled into a tube by the wing-like parts which extend from its sides, overlapping like a kimono (the left side over the right).

These wings are almost identical in size and are wide from top to bottom. They are characteristic of the species. The upper opening of the groove is diagonal and lower opening is quadrilateral enclosed by four teeth as previously described. All four sides curve in an arc that is most marked on the ventral side.

The stem is extremely long with numerous cormidia. The bract of each cormidium is thin and leaf-like with a conical bracteal cavity below. The author has not yet seen a cormidium with a special nectophore However, it undoubtedly occurs as it has been reported by other investigators.

This species is the most at Misaki throughout the year. The length is 13-17 mm and the width is 3.5-4 mm. Frequently, only the superior nectophore is caught and rarely a complete specimen. Its occurrence is supposedly limited to the Eastern Tropical Pacific but in the Atlantic it occurs in considerably higher latitudes. Considering the abundance of the species, its distribution must be extremely wide.

Supplement
Ersaea lessonii ?
 (Pl. XII)

This name should be used for the eudoxid of the species previously discussed and is included in its list of synonyms. Hitherto, this organism was identified as the monogastric generation of *Diphyes campanulifera*. This in turn was considered as identical with *D. dispar*. Hence it was added to the synonyms of this species. The following description more or less verifies this but there is some ground for doubt because of the bracteal structure. Therefore, it is presented as a separate paragraph.

The bract is a half to two-thirds the total length (of the eudoxid) and has a helmet shape. The apex is diagonally conical. The dorsal ventral surfaces are smooth. The ventral surface has a narrow, long flat area as if it had been cut off. The lower surface connected to this forms a wide concave bracteal cavity. The lateral and dorsal surfaces of the cavity are bordered by somewhat sharp edges on which are found two dorso-lateral teeth.

The thick gelatinous bract has a cylindrical somatocyst in the centre. The somatocyst is vertical and its upper end bluntly pointed. The lower end is connected to the wide stalk of the siphon. On the siphon stomach, eight hepatic ridges are found, and next to the basal part, a constriction can be clearly seen.

The special nectophore is like a square post whose four sides are more or less concave. The two ventral ridges have stronger teeth than the other two. Towards the

slanting upper dorsal surface there is a conical process with its apex at the point of attachment to the stem. On the ventral surface it has a groove similar to a round gutter that forms a passage for the stem. The stalk canal is short and the four radial canals are of equal length.

The gonophores of one colony usually are of the same sex and occur in large numbers. The gelatinous part is a decapitated square drill shape, with the lower surface curved inward as if dug out. The lower part of the four ridges become teeth. The lower half of each ridge is serrate. The nectosac of the gonophores has a similar canal system to that of the special nectophore. Male gonophores have a long spindle-like stalk within the nectosac. The identical part in female gonophores is nearly spherical and stores numerous eggs.

In August and December 1907 many specimens were obtained measuring 6.5-11 mm in length and 2.5-4 mm in width.

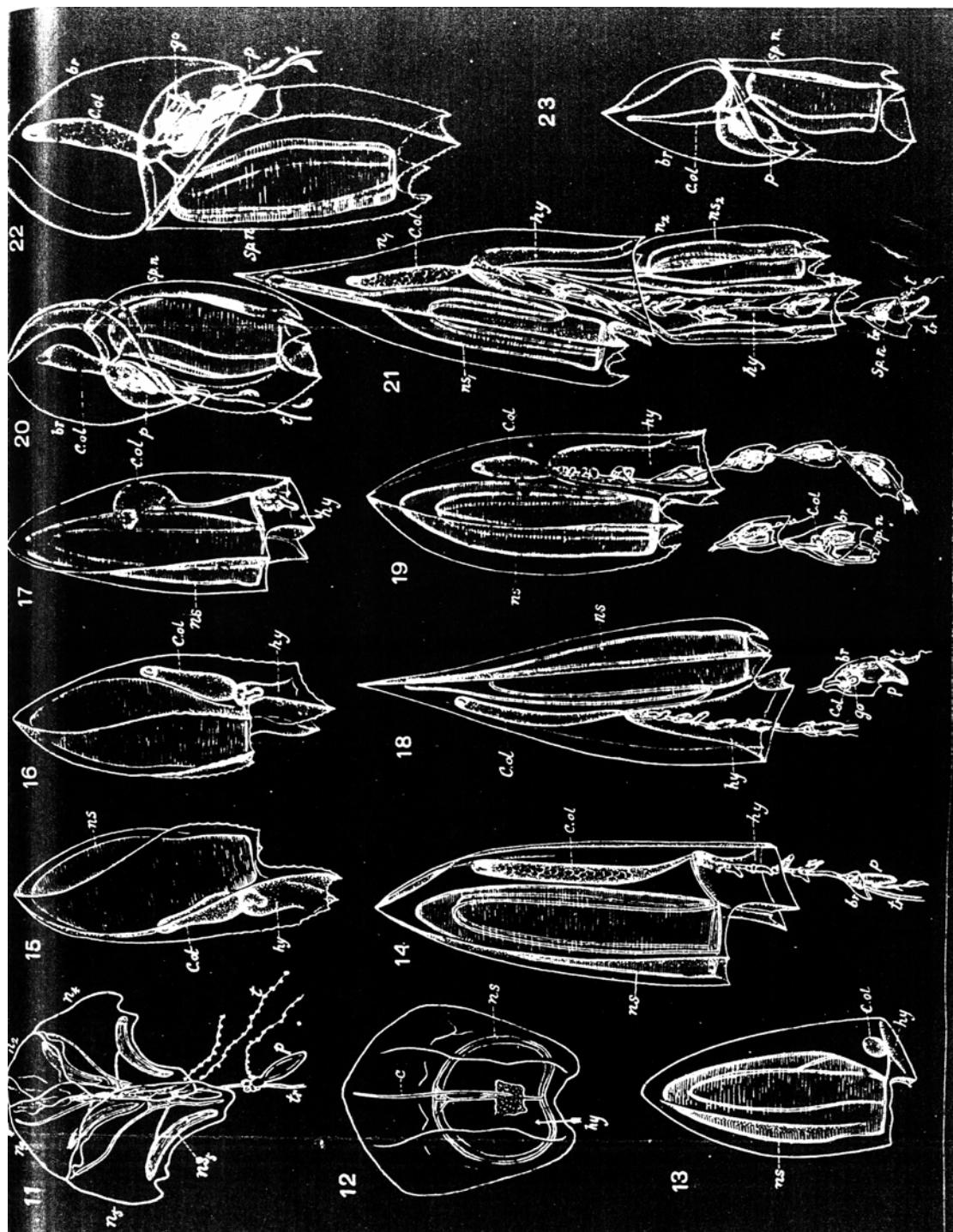
This species does not agree with Huxley's original drawing in that in Huxley's specimen the bracteal s o is larger below and smaller above, with a height of two-thirds the thickness of the gelatinous part. On my specimen, on the other hand, the upper and the lower section of the corresponding parts are the same, and as a whole it is long, almost reaching the dorsal wall.

Supplement

Ersaea sp.

(pl. XII, fig. 23) [? **dispar**]

Although this species was discovered while examining a preserved specimen of the eudoxid *Ersaea lessonii* ? that has been described above, it was obvious that this animal too was still young since the first gonophore bud was barely visible. The significant points, however, are that the apex of the bract was sharply pointed and its somatocyst too had a spine-like point and its somatocyst too had a spine-like point reaching the bracteal apex. But this cannot be considered as the fully mature shape of the bract since the specimen was still in its juvenile stage. Consequently, it is not possible to discuss this species at this time. The total length was 7.5 mm and the width was 2.5 mm.



Legend Plate XII, Vol. XXVII

- Figure 11. *Hippopodius ungulatus* [**hippopus**], lateral view x 4
 Figure 12. Nectophore of above, ventral view x 4
 Figure 13. *Galeolaria truncata*, lateral view x 8 [**?cossack**]
 Figure 14. *Diphyes appendiculata*, lateral view x 8
 Figure 15. *D. spiralis*, lateral view x 12
 Figure 16. *D. spiralis*, lateral view x 12
 Figure 17. *D. contorta*, lateral view x 10

- Figure 18. *D. bojani*, lateral view x 8 [? **dispar**]
 Figure 19. *Diphyopsis chamissonis*, lateral view x 8
 Figure 20. *Ersaea chamissonis* ?, dorsal view x 8
 Figure 21. *Diphyopsis dispar*, lateral view x 8
 Figure 22. *Ersaea lessoni* ?, ventral view x * [? **dispar**]
 Figure 23. *Ersaea* sp., dorsal view x 8 [? **dispar**]

br. bract; c.ol. somatocyst; go. gonophore; hy. hydroecium; n1. ectophore; n2. ectophore; n3. ectophore; n4. ectophore; n5. ectophore; ns. nectosac; ns1. nectosac; ns2. nectosac; n3. nectosac; p. siphon; sp.n. special nectophore; t. tentacle; tr. stem.

Legend, Vol. XXVII, Figures 9-12

- Figure 9. *Vogtia spinosa* (after Bigelow)
 Figure 10. *Galeolaria truncata* (after Bigelow)
 Figure 11. *Chuniphyes multidentata* (after Bigelow)
 Figure 12. *Archisoma natans* (after Bigelow)
 [Kawamura has tried to fit together figs. 1 & 3 of Bigelow (1911a), pl. 6 but has distorted fig. 1 and left no space for appendages. BAD]

br. bract; c.br. bracteal canal system; c.ol. somatocyst; hy. hydroecium; n1, n2. ectophore; ns. nectosac; sp.n. special nectosac.

Genus *Chuniphyes* Lens and van Riemsdijk, 1908

The superior nectophore is heptagonal drill-like, with a small canal attached to the top of the somatocyst. One species *Chuniphyes multidentata* Lens and van Riemsdijk (illustrated as figure 11) described from a specimen collected on the "Siboga" Expedition is known. Its seven ridges run the entire length (of the nectophore). The hydroecium is exceptionally shallow, the nectosac is short but the somatocyst is long. It is an exceedingly unusual organism. However, the classification of this genus is still indefinite and quite different. Therefore, there is a possibility that it belongs to this genus, but perhaps it belongs to the sub-family Diphyopsiinae Haeckel. hence, the entry was made here in this writing. A special nectophore has not been found.

Genus *Archisoma* Bigelow, 1911

The structure of the nectophore is not known. The somatocyst is a branched canal system. A new species, *Archisoma natans* Bigelow (figure 12) is known. Having only one eudoxid the polygastric generation is not clear but its nectophore is singular and it must be akin to the genus *Nectopyramis* Bigelow. Since the length of the bract measured 37 mm it presumably must have been an extremely large form.

Calyconectid Siphonophorae (V)
by Tamiji Kawamura
Dobutz, Z. Tokyo, 27, 577-586, 1915

No. III Sub-family Abylinae A. Agassiz, 1862

Nectophore angular post-like, the superior nectophore is conspicuously smaller in comparison with the inferior nectophore; the cormidia break off to become eudoxids.

Several genera of this sub-family are more confusing than the members of the previous sub-family. In 1888 Haeckel recognised three genera, *Abyla*, *Bassia* and *Calpe* but later Chun substituted *Abylopsis* for the genus *Calpe* stating that that name had been given to Lepidoptera. Furthermore, he made these three genera sub-genera of the genus *Abyla*. Although Schneider has combined these genera into one, they are at present treated as three separate genera by many scientists. Later the genus *Diphyabyla* was added. This genus is readily distinguished by its resemblance to the previous sub-family.

Genus *Diphyabyla* Lens and van Riemsdijk, 1908

The superior nectophore is angular drill-like and resembles the sub-family Diphyidae.

A species *Diphyabyla hubrechti* Lens and van Riemsdijk was named for a specimen in the "Siboga" collection and later another specimen was collected on the "Albatross" Expedition. However, in our country it has not been known to occur.

Genus *Abyla* Lens and van Riemsdijk, 1908

The superior nectophore has a polygonal apical plane, the inferior nectophore is like a pentagonal post and the h is like a pentagonal post and the h opens to the outside without becoming a canal. Three species are known, *Abyla haeckeli*, *A. trigona*, *A. leuckartii*. From the specimens obtained at Misaki, the author learned that they all occur in our adjacent waters.

Abyla haeckeli Lens and van Riemsdijk

(Pl. XV, figs. 24-26)

Abyla haeckeli Lens and van Riemsdijk, 1908, p. 32, Pl. 15, figs. 39-41; Bigelow, 1911, p. 222, Pl. 13, figs. 1-2

Abyla trigona Huxley, 1859, p. 47, Pl. 3, fig. 1

? *Amphiroa angulata* Huxley, 1859, p. 64, Pl. 5, fig. 2 (eudoxid)

? *Amphiroa alata* Haeckel, 1888b, p. 156 (eudoxid)

? *Amphiroa dispar* Bedot, 1896, p. 373, Pl. 12, figs. 5-6 (eudoxid)

The superior nectophore is an almost bilaterally symmetrical hexagonal block. Six surfaces occur on the dorsal and the ventral sides and the entire clock is flattened laterally. The dorsal surface is a long perpendicular rectangle and is divided into an upper and a lower part by a straight horizontal ridge. The upper surface is rectangular, diagonally facing upward. The lower surface ends in a process where both lateral ridges join the lower margin and is shaped like inverted isosceles triangle with a height three times its width. The dorso-lateral surface is hexagonal and surrounded by two parallel longitudinal ridges, an upper and lower ridge running from the upper ventral surface toward the lower dorsal surface. The upper ventral margin is perpendicular to the latter and has a strongly arched lower dorsal margin. Next the ventral lateral surface is divided into two sections - the lower half is square and surrounded by two longitudinal ridges, a nearly horizontal upper ridge and the arched lower margin. The upper half is a slightly larger pentagon, and is situated between the

apical surface, the upper and lower ventral surfaces, the lower half of the ventral lateral surface and the dorsal lateral surface and faces somewhat diagonally upward. The apical plane is the upper surface of the so-called hexagonal block. It is also angular but it is laterally flattened. Also the upper part of the ventral surface is slanted, making it much smaller than the cross-section of the "post". On the other hand, the bottom surface is extremely large and unevenly divided into dorsal and ventral halves by a lateral ridge - the dorsal half is square and contained the nectosac opening while the ventral half is nearly pentagonal and is entirely occupied by the mouth of the hydroecium. Each surface is somewhat depressed. At the lower part of the superior nectophore, the ridges are distinctly serrated.

The cylindrical nectosac occupies the dorsal one-third of the superior nectophore. Its length is four times greater than the diameter. Its lower opening is comparatively small and has a wide velum. Four radial canals and the circular canal are of simple structure. The stalk canal is short and buds out from the upper corner of its ventral side, immediately reaching the apex of the hydroecium.

The somatocyst is an extraordinarily large elliptical sac and is situated along one third of the ventral side of the nectosac. It is filled with large bubble-like polygonal cells. A short canal connects its upper dorsal corner with the apex of the hydroecium.

This species was established for a superior nectophore from the "Siboga" expedition. However, *Abyla trigona* Huxley (1859) does not agree with the description of that species described below but rather to the species in question. As to its inferior nectophore, not much is known at present except that it can be vaguely recognised from Haeckel's report. The author obtained a superior nectophore in July, 1906 at Misaki. The length and the dorsal ventral width measured 5 mm and 4.5 mm respectively. No difficulty was encountered in identifying the species. Its eudoxid is as yet unknown. *Amphiroa angulata*, *A. alata*, *A. dispar* etc, listed as synonyms above were given because Bigelow so classified them.

Abyla trigona Quoy and Gaimard
(Pl. XV, figs. 27-28)

Abyla trigona Quoy and Gaimard, 1827, p. 14, Pl. 2B, figs. 1-8; Eschscholtz, 1829, p. 131; Blainville, 1830, p. 123; Gegenbaur, 1860, p. 337, Pl. 26-27, Figs. 9-12; Chun, 1888, p. 1160; 97b, p. 31; Schneider, 1898, p. 90; Lens and van Riemsdijk, 1908, p. 23, Pl. 4, figs. 34-36; Bigelow, 1911, p. 221, Pl. 13, figs. 3-4.

Amphiroa alata Blainville, 1830, p. 121; 1834, p. 133, Pl. 4, fig. 1: Huxley, 1859, p. 64, Pl. 5, fig. 1; Chun, 1898, p. 1160; 1897, p. 31; Lens and van Riemsdijk, 1908, p. 28, Pl. 4, figs. 37-38 (eudoxid)

Eudoxia trigona Gegenbaur, 1860, p. 349, Pl. 27, figs. 10-12

Abyla carina Haeckel, 1888b, p. 156, Pl. 35

Amphiroa carina Haeckel, 1888a, p. 33; 1888b, p. 114, Pl. 36 (eudoxid)

Amphiroa trigona Haeckel, 1888a, p. 33; 1888b, p. 113 (eudoxid)

The polygastric generation of this species is well known but unfortunately the author had not yet seen it. Although this species, in general, resembles the preceding one, the most readily distinguishable characteristic on the superior nectophore is that the ventral surface of this species is long and narrow perpendicularly. Its mid-portion is slightly convex without being divided into two parts as in the previous species. The inferior nectophore, like the superior one, is a triangular drill-like shape. (Hence, this species name was derived). It is laterally flattened. Although it has three ridges - dorsal, ventral and left lateral - there is another inconspicuous ridge on the right side

[? quoting Bigelow], indicating its original square shape. The eudoxid of this species under the name *Amphiroa alata* is quite familiar and since the catch of the type specimen in Torres Strait by Huxley in 1856, its occurrence in the Atlantic and Mediterranean have often been reported. In 1860, Gegenbaur positively identified this as the monogastric generation of this species. Furthermore, it had been seen already in the Pacific and Malayan waters. The author, too, obtained a specimen at Misaki. Therefore, the description is given below. The bract resembles a square post whose lower end appears to have a deep gouge on its ventral side. The horizontal upper surface is trapezoidal. The ventral margin is longer and somewhat convex outwardly. The dorsal margin is shorter and outwardly concave. The other two margins from the ventral side to the dorsal side join laterally. With this as the upper margin the right and left surfaces are vertical, slightly concave and unevenly pentagonal. The upper and dorsal margins are almost the same length but the ventral margin is shorter. The conspicuously arched lower ventral margin and the lower margin are shortest. The dorsal surface is an elongate rectangle while the ventral margin is a wide rectangle. The dorsal half of the lower surface of the bract is a small, nearly square horizontal surface. However, the ventral half contiguous to this is deeply gouged and forms the opening to a large bracteal cavity. Its approximate shape is a trapezoid and the ventral surface is three times the length of the dorsal surface.

The bracteal cavity is bell-like, slightly flattened laterally. The apex turns towards the upper dorsal side. In the dorsal half of this cavity, the siphon and the tentacle are situated while in the ventral half there are a small number of gonophores (gonocalyx). This terminology is used because in addition to acting as a gonophore, it often functions as a subumbrial nectosac. The word also can be used for members of the preceding sub-family as well. The large somatocyst occupies the dorsal half of the bract and is filled with large, oval bubble-like cells. Two small bracteal canals branch out, close to the apex of the bracteal cavity near the upper ventral surface of the somatocyst. At first horizontal they run radially towards the lateral ventral corners and then diagonally upwards towards an angular corner but without reaching it. They end blindly in club-shaped sacs.

Originally the gonophore is a cone, hanging from a square post but when there are a large number, the connections become arrow-like. Therefore, the shape sometimes becomes symmetrically pentagonal, with only the arrow-like surfaces remaining flat while other surfaces become somewhat depressed. All five ridges are serrate on the lower half and end in sharp teeth. The nectosac of the gonophore is long and columnar, with a round and wide velum. The radial canals and the circular canal are simple.

The specimen studies by the author possessed a bract measuring approximately 5 mm in length and 6 mm in width and the gonophore 5.5 mm in length and 2.5 mm in width.

Abyla leuckartii Huxley
(Pl. XV, figs. 29-31)

Abyla leuckartii Huxley, 1859, p. 49, Pl. 3, figs. 2a-2b; Lens and van Riemsdijk, 1908, p. 34, Pl. 5, figs. 42-46; Bigelow, 1911, p. 216, Pl. 13, figs. 5-8, Pl. 15, figs. 3-4

Abyla trigona Chun 1897b, p. 31

Enneagonum leuckartii Schneider, 1898, p. 93

The shape of the superior nectophore resembles that of the previous species, but it is somewhat simpler. The upper surface is long, hexagonal, slightly convex, and

the dorsal surface is long, rectangular with the lateral ridges ending in strong drill-like processes at the base. Nearly the entire upper part of the lateral surfaces are vertical elongated quadrangles due to a weak process in the middle of the lower margin which constitutes a corned angle, its general shape is pentagonal. However, near the ventral surface on this surface is an arched longitudinal ridge which separates the plane into two uneven parts. The ridge, however, ends inconspicuously some distance above the weak process in the middle described previously. The ventral surface might be called a rectangle but since the lateral ridges join in a weak process at the lower end, it resembles a long, narrow, inverted isosceles triangle. The lower surface is a long pentagon. The dorsal half contains the nectosac opening and ventral half the hydroecium opening.

The somatocyst is extremely long oval, filling one third of the ventral side of the superior nectophore. Its long axis is almost vertical. The nectosac is cylindrical, becoming smaller at the upper end. Its structure is similar to other species. The hydroecium, too, is cylindrical but exceedingly deep. The opening flares out, somewhat resembling a trumpet, and bends slightly towards the ventral side.

Although this species had been known for a long time, its inferior nectophore was never found. The only information available is the discovery of the bud of an inferior nectophore in the hydroecium of a specimen caught on the "Albatross" Expedition. From this its approximately square shape was definitely established. The author's specimen had only a superior nectophore measuring 6 mm in length and 3.2 mm in width, collected at Misaki, 3 January, 1907. The structure of the hydroecium was difficult to study because it contracted. The inferior nectophore was missing. Although Chun has identified this species as identical with *Abyla trigona*, it is quite incorrect. The eudoxid of this species is unknown so far. However, *Ceratocymba asymmetrica* (= *C. sagittata*) caught by Bedot as well as the "Siboga" Expedition may belong to this species. Although this individual generally resembles *Amphiroa alata*, the eudoxid of the species discussed above, has the characteristic of having the lower end of the bracteal somatocyst narrowly pointed and bent like a hook. It has not been seen in our country.

Genus *Abylopsis* Chun, 1888

The top of the superior nectophore has no flat surface but a ridge formed by the junction of both lateral surfaces is present. The hydroecial cavity opens to the outside and is not like a canal.

Two species, *Abylopsis tetragona* and *A. eschscholtzi*.

Abylopsis tetragona Otto

(Pl. XV, figs. 32-36)

Pyramis tetragona Otto, 1823, p. 306, Pl. 42, figs 2a-2e

Calpe pentagona Lesson, 1843, p. 449

Abyla pentagona Eschscholtz, 1829, p. 132; Leuckart, 1853, p. 56, Pl. 3, figs. 1-6; 1854, p. 11, Pl. 11, figs. 1-10; Kölliker, 1853, p. 41, Pl. 10; Vogt, 1854, p. 121, Pl. 20, figs. 407, Pl. 21, figs 3-6, 10-13; Huxley, 1859, p. 40, Pl. 2, fig. 2; Gegenbaur, 1860, p. 349, Pl. 28, figs. 17-19; Fewkes, 1874, p. 318, Pl. 3; Chun, 1897b, p. 30; Lens and van Riemsdijk, 1908, p. 17, Pl. 2, figs. 19-20; Bigelow, 1911, p. 224, Pl. 14, figs. 5, 7, Pl. 15, fig. 2

Aglaisma baerii Eschscholtz, 1829, p. 129, Pl. 12, fig. 5

Diphyes calpe Quoy and Gaimard, 1834, p. 89, Pl. 4, figs. 7-11

Aglaisma pentagonum Leuckart, 1853, p. 150, Pl. 4, figs. 7-11

Eudoxia cuboides Leuckart, 1853, p. 54, Pl. 3, figs. 7-10; Chun, 1885, p. 525, Pl. 2, fig. 11; Bedot, 1896, p. 375 (eudoxid)

- Aglaisma elongata* Huxley, 1859, p. 61, Pl. 41, fig. 3 (eudoxid)
Aglaisma gegenbauri Haeckel, 1888b, p. 119, Pl. 40 (eudoxid)
Calpe gegenbauri Haeckel, 1888b, p. 165, Pls. 39, 40
Calpe huxleyi Haeckel, 1888b, p. 164
Aglaisma cuboides Chun, 1897b, p. 30; Lens and van Riemsdijk, 1908, p. 19, Pl. 2,
fig. 21 (eudoxid)
Abyla tetragona Schneider, 1898, p. 89
Abyla huxleyi Agassiz and Mayer, 1902, p. 166, Pl. 11, fig. 48

The difference in size of the superior and inferior nectophores, which is characteristic of this sub-family, is most conspicuous in this species. The superior nectophore is not one fifth the length of the inferior nectophore. The long axis is at an angle of 60° to the inferior nectophore being attached on the ventral side of the upper end of the latter.

The superior nectophore is a laterally symmetrical, pentagonal post lying sideways with one of its five ridges facing upward. The irregular pentagonal facets form the dorsal and ventral planes. The dorsal facet is small and slightly concave while the ventral facet is larger and somewhat convex. In their natural position they both form approximately at 60° angle with the vertical plane, maintaining one of the five sides below and its apical angle above. A pair of lateral apical facets form a long rectangle extending from the dorsal to the ventral facets or vice versa, coming together at the top like the peak of a roof. Next to these the two corresponding lower lateral facets are extremely large, and the greater part of these facets are rather long rectangles. The lower ventral corner protrudes further to form a still smaller extension. The irregular lower facet is a long, narrow rectangle which is divided into an upper two-thirds and a lower one third by a very prominent lateral ridge. The upper part contains the nectosac opening and the lower the hydroecium.

The nectosac is situated in the gelatinous substance of the dorsal half of the superior nectophore. It is a comparatively small cylindrical sac. The stalk canal immediately turns from the apex of the hydroecium towards the ventral side of the nectosac. The length of the radial canals are not equal. The dorsal canal is the longest and the ventral canal the shortest. The conical hydroecium is in the ventral lower corner of the superior nectophore, with its apex reaching to the exact centre of the nectophore. From this two canals extend upward through the arrow-like surface on both dorsal and ventral sides, and a long stem extends downward through the hydroecium of the inferior nectophore. The large hemispherical somatocyst has a bubble-like cellular wall. At the lower dorsal corner is the entrance of the canal from the hydroecial apex. In addition, there is a narrow blind canal, protruding upward at the upper dorsal corner. The end of the latter is inflated like a ball near the centre of the apical ridge. In this oil drops are stored.

The inferior nectophores are elongate, decapitated pentagonal drills. Although the upper two-thirds of the five ridges are approximately the same, the lower one third shows considerable variation in their development. Also, not only do the teeth at the lower ends differ in size, but each one appears to rotate slightly counter-clockwise. The apical surface of these nectophores correspond to the so-called decapitated part, cut diagonally from the dorsal to the ventral side. At the ventral corner, it abruptly protrudes in a triangular drill-like process which fits into the hydroecium of the superior nectophore and attaches to the stem. The lower surface of this nectophore is irregularly pentagonal, with the round nectosac opening in the centre. Of the five tooth-like processes which surround this opening, the one at the left ventral corner is the largest, the next at the right dorso-lateral corner is nearly the same size, those at

the right ventral and left dorso-lateral corners are much smaller. The one on the dorsal side is weak and inconspicuous.

The hydroecium of the inferior nectophore is not a blind depression but, as in many other cases, it is a vertical canal. However, it does not completely develop into a canal, but rather a pair of leaf-like processes on the left ventral surface overlap as do the collars of a kimono, forming a hollow passage. In every case, the right process overlaps the left. Each ridge of this nectophore has conspicuous serrations on the lower part.

The large cylindrical nectosac of the inferior nectophore lies somewhat dorsal to the central axis. The radial canals as a rule are irregular. The left lateral and the ventral canals do not connect with the circular canal but anastomose near the lower end of the left lateral canal, forming a wicket. The upper end of the right lateral canal bends at a 90° angle at about two-thirds from the lower end and does not converge as do the other three canals. It connects somewhere in the middle of the ventral canal. Thus, at the lower end of the right lateral canal another wicket can also be seen.

The stem entering the hydroecium of the inferior nectophore usually has more than 20 cormidia. These consist of a bract, a siphon, a tentacle, and a gonophore bud. The sex organ apparently matures after the eudoxid breaks away from the parent. In the past it was given the generic name of *Aglaisma*.

This species is the largest and most common one in this sub-family. It has been reported from the Mediterranean, the Atlantic, the Indian Ocean, etc. If our adjacent waters are representative of the North-eastern Pacific, it may well be said that this species occurs in every ocean of the world. The largest specimen studied by the author was collected by the late Professor Misaku, off Okisu, in Suraga Bay. The colony (superior and inferior nectophores) measured 30 mm in length and 9 mm in width. Those ordinarily found near Misaki are about 10-25 mm in length and 3.5-8 mm in width.

Next the author will describe the eudoxid of the species *Aglaisma cuboides* Leuckart. The shape of the bilaterally symmetrical bract is a cube whose lower end is slightly wider and appears to have a wedge-shaped posterior process. The upper facet is almost square; the ventral facet is a rather elongate trapezoid; the dorsal facet is pentagonal, with an additional triangle under the trapezoid. Both lateral facets are almost trapezoidal but the dorsal margin is longer than the ventral margin and consequently the lower margin drops as it approaches the dorsal facet. The lower surface is nearly square, and excluding the process which arises near the dorsal half, it is practically entirely the opening of the bracteal cavity. This cavity is a bell-like depression which slants slightly toward the lower ventral surface. The apex is approximately in the centre of the bract. On the dorsal side of the opening is a wing-like part which is surrounded by three weak tooth-like processes. Each ridge of the bract is nearly straight and serrate. The bracteal somatocyst is located in the centre and consists of a small ball-like part next to the apex of the hydroecium with four blind processes resembling a bird with its wings spread. Of the four processes the upper and lower ones in the true centre plane are small; one is vertical near the upper surface of the bract, and is inflated. The inflated portion is filled with oil drops. The other, running downward along the dorsal wall of the bracteal cavity, terminates blindly at about the level of the lower dorsal corner of the lateral surface. The remaining two lateral processes are conspicuous, extending toward the ventro-lateral surface. They also end blindly with an additional downward bend.

A large flexible siphon with a long tentacle occurs on the dorsal side of the bracteal cavity. The gonophore, that is, the gononectophore, is on the ventral side of

the siphon but when more than two are present, they are lateral. The shape of a mature gonophore appears as a conical process attached to the top of a four cornered post within an inflated mid-section. Four ridges on the gonophore are well developed and conspicuously serrate. They end in four triangular drill-like teeth of approximately equal size. The nectosac opening of the gonophores has a wide velum and is surrounded by teeth.

The four radial canals of the nectosac are simple and of equal length. At the upper ventral corner (the dorsal side, as seen from bracteal side), they converge with the stalk canal which passes through the gelatinous part and enters the inner cavity of the stem near the pointed end of the gonophore. The spadix suspended within the nectosac is comparatively large. Since our specimen is female, about twenty eggs are stored within it. When there are more than two gonophores they are, as a rule, of the same sex. Of many specimens obtained at Misaki in the winter and spring, the vertical dimension of the bract measured 4-5 mm in length and 3-4 mm in width. A large gonophore measured 4-5 mm in length and 3 mm in width.

Abylopsis eschscholtzi (Huxley)

(Pl. XV, figs. 37-38)

Abylopsis eschscholtzi Huxley, 1859, p. 60, Pl. 4, fig. 2; Chun, 1888a, p. 1160; Lens and van Riemsdijk, 1908, p. 25, Pl. 3, figs. 18-31 (eudoxid)

Abylopsis quincunx Chun 1888a, p. 1160; Bedot, 1896, p. 375

Abyla (Abylopsis) quincunx Chun, 1888b, p. 29 (eudoxid)

Aglaisma quincunx Agassiz and Mayer, 1899, p. 180; Mayer, 1900, p. 78 (eudoxid)

Aglaisma cuboides Mayer, 1900, p. 77, Pl. 30, fig. 104 (eudoxid)

Abyla quincunx Mayer, 1900, p. 77, Pl. 34, figs. 115-117; Lens and van Riemsdijk, 1908, p. 21, Pl. 3, figs. 22-27

Abyla tetragona Schneider, 1898, p. 89 (partim)

Abyla pentagona Mayer, 1900, p. 77, Pl. 30, figs. 101-103

Cumia capillaria Mayer, 1900, p. 78, Pl. 27, fig. 90

This species is very like the previous species. Its structural resemblance is most striking. However, as with the previous species, this has been described in comparatively great detail. Hence, the differences can be readily recognised. For example, in the superior nectophore, the lateral canals of the nectosac in the preceding species branch from the stalk canal, turn upward, and then downward while in this species they immediately turn downward. Five teeth-like processes on the lower ends of the inferior nectophores are conspicuously uneven in *tetragona*. On the other hand, they are developed almost to the same extent in *eschscholtzi*. The wing-like processes which surround the hydroecium of these species overlap laterally in the former and the left process has large serrations, but in the latter, the serrations are on the right process. Also, the four radial canals are variable in the previous species but in this species they are constant. As a whole, this species is smaller and the differences in size between the superior and inferior nectophores is not so great as in the other.

Although the author has not obtained specimens of polygastric generation of the species, I collected specimens of the monogastric generation at Misaki and learned of its occurrence in our nearby waters. This is an eudoxid which has hitherto been known under the name *Aglaisma quincunx*. Though it is quite similar to the eudoxid of the previous species it is, as a whole, readily distinguishable from the other by the characteristic shape of its bract. A brief description of this eudoxid is given below:

The bract is a symmetrical pentagon with a flat surface at the top. However, this shape is not entirely different from that of the preceding species. For example, if

the lower inflated part of the latter were to be exaggerated and the suspended cuneiform posterior process greatly enlarged, then it would approach the shape of the bract in this species. The dorsal facet of the bract is regularly pentagonal and its ventral surface is similar to it but is cut off in a fan-like shape at its lower angle. The apical facet of the bract is nearly square and the upper lateral facets are long dorso-ventral rectangles but the remaining lower lateral facets are like a square with one corner cut off in an arc.

The shape of the bracteal somatocyst is identical with that of the previous species, only its position is more dorsal. Consequently, the major axis of the bell-shaped bracteal cavity slants laterally from the dorsal centre to the lower ventral corner. Other parts are not particularly different from those of the previous species.

The bract of the author's specimen measured 5.5 mm in length and 6 mm in width and its largest gonophore (male) was 5 mm in length and 4 mm in width.

Genus *Bassia* L. Agassiz, 1862

The superior nectophore lacks an apical facet. The dorsal ridge is not present on the inferior nectophore, but the hydroecium is developed into a perfect canal. Only one species, *Bassia bassensis* is known. This was also caught off Misaki.

Bassia bassensis Quoy and Gaimard

Diphyes bassensis Quoy and Gaimard, 1834, p. 91, Pl. 7, figs. 18-20

Calpe bassensis Lesson, 1843, p. 451

Abyla bassensis Huxley, 1859, p. 45, Pl. 2, fig. 1; Schneider, 1898, p. 91; Lens and van Riemsdijk, 1908, p. 26, Pl. 4, fig. 32

Bassia bassensis Bigelow, 199, p. 229, Pl. 12, fig. 8, Pl. 14, fig. 9

Sphenoides australis Huxley, 1859, p. 62, Pl. 4, fig. 4; Chun, 1888, p. 1160; Haeckel, 1888b, p. 360; Bedot, 1896, p. 375; Lens and van Riemsdijk, 1908, p. 26, Pl. 4, fig. 33 (eudoxid)

Abyla perforata Gegenbaur, 1860, p. 356, Pl. 29, figs. 20-21; Chun, 1897b, p. 32

Bassia perforata L. Agassiz, 1862, p. 372; Chun 1888,, p. 1190; Haeckel, 1888b, p. 160; Bedot, 1896, p. 374

Bassia obeliscus Haeckel, 1888a, p. 36; 1888b, p. 160, Pl. 37 (eudoxid)

Sphenoides obeliscus Haeckel, 1888a, p. 33; 1888b, p. 116, Pl. 38 (eudoxid)

Sphenoides perforata Haeckel, 1888a, p . 33; 1888b, p. 116: Chun, 1897b, p. 32 (eudoxid)

Since this species is conspicuously different in every way from several other species which have already been discussed, it is extremely easily to differentiate it. The superior nectophore is approximately one third the inferior nectophore in size. The major axis of both nectophores is nearly vertical. While the nectosac of the superior nectophore is horizontal, it is vertical in the inferior nectophore.

Although the shape of the superior nectophore is like a low pentagonal post, its major axis is at right angles to the axis of the post and runs from one edge to one side plane. In the natural position, both ends of the post, that is, the dorsal and the ventral surfaces are horizontal. The nectophore with its dorsal surface upward, is et with its ventral plane on the upper plane of the inferior nectophore. The dorsal surface is pentagonal and slightly concave while the ventral surface is slightly larger and somewhat convex. The two upper lateral facets (dorso-lateral facets as seen from the inferior nectophore) are rectangular, while the lower lateral facets are pentagonal. The uneven lower surface is rectangular and divided by a sharp lateral ridge into a large and a small facet. The large facet of the dorsal side is vertical in its natural position, with the nectosac opening in the centre. The small facet of the ventral side slants

toward the lower ventral side and is entirely occupied by the opening of the hydroecium.

The nectosac is egg-shaped and its lower half opens on the dorsal side. The four radial canals are simple and almost identical in length. The stalk canal is extremely short. The hydroecium is nearly conical and in its natural position is under the nectosac. Although the somatocyst is generally found leaning towards the ventral side in this species, it is in the centre over the ventral and dorsal surfaces directly above the nectosac. Consequently, in its natural position, the globular somatocyst of bubble-like cells is horizontal and parallel to the nectosac. Between it and the apex of the hydroecium there is a small connecting canal with oil drops. The somatocyst does not branch to form blind processes, as is the case in the two previous species.

The inferior nectophore is like a decapitated four-cornered drill. Its upper surface is square and near its ventral margin is a drill-like projection. This fits into the hydroecium of the superior nectophore. It contains the upper opening of the canal of the hydroecium of the inferior nectophore on its ventral surface. In the inferior nectophore like the upper surface, the lower one is square with its four margins curved in an arc. Of the four sides, the two lateral surfaces are smaller than the dorsal one but larger than the ventral. All four surfaces are somewhat convex and the four ridges are minutely serrate, each ending in a three-corned drill-like tooth. The right ventral and the left dorsal teeth are large and strong and the other two are small and weak. The left ventral tooth is especially weak. Also, it is pointed and bends toward the median line instead of hanging straight down.

The nectophore (?? nectosac) is large and cylindrical with an inflated middle. Its height is three times its width. The stalk canal enters the gelatinous conical projection from the stem, branches into four radial canals at the lower ventral corner of the nectosac. The cavity canal corresponding to the hydroecium is formed by a fusion of the upper two-thirds of the lateral wings. It is, therefore, a perfectly cylindrical canal for the stem. But at the lower end of this canal, the right wing overlaps the left.

The author was able to obtain only one specimen at Misaki, in December 1907. Its total length was 9 mm and its width near the lower end, 5 mm.

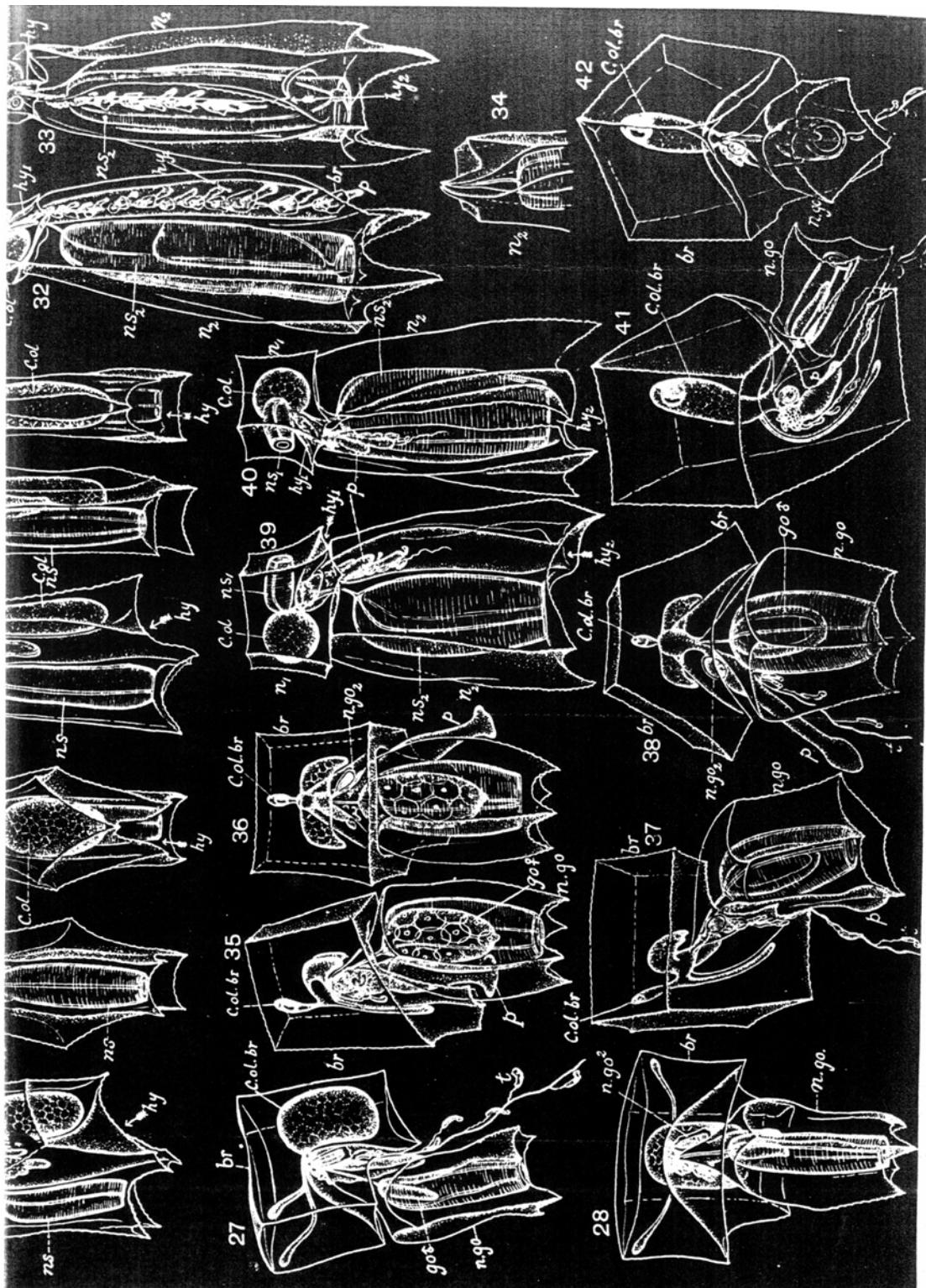
The eudoxid of this species was often found at Misaki. Therefore, the author will describe it below.

The bract of this eudoxid is laterally symmetrical, and its upper and lower halves are each trapezoidal. The dorsal surface is rhombic, the two upper margins of each are slightly longer than the lower two. The pair of upper dorsal facets are nearly square, and are joined by a straight ridge. Contiguous to these are two approximately rectangular upper ventral facets. Their lateral margins are rather smooth and sharp like the other ridges but not serrate. The lower lateral facets are like an irregular pentagonal surface with a concave cut across its ventral margin. It is surrounded by serrate ridges. The ventral surface is almost hexagonal and forms the opening of the bracteal cavity. Six teeth-like processes surround the opening.

The bracteal cavity is bell-shaped with the main axis curved convexly toward the dorsal side. The somatocyst, at the apex of the bracteal cavity, extends towards the centre where the four ridges converge. However, it ends blindly before reaching this point. Large oil drops are stored at the base of the somatocyst on the dorsal side. A small canal branches off in an arc along the dorsal side of the bracteal cavity. It also ends blindly. The shapes and the positions of the siphon, tentacle, gonophore, etc. are almost identical to those of the species previously discussed. Therefore, the discussion of these will be omitted here.

The length of the bract is 3-5 m and the width 1.5-2.5 mm. The length of the largest gonophore is 3 mm and the width 1.5 mm.

The author has completed the discussion of the siphonophores (Calyconectid Siphonophorae). Although the references should be inserted here, it would be extremely uneconomical to do so from the standpoint of printing because there are so many. Therefore, they will be omitted. However, if one wishes to refer to the original publications for the synonyms, etc., one can locate the references in the bibliography of either the "Siboga" or the "Albatross" Reports as the names of the investigators with dates have been given by the author throughout the report.



Legend Plate XV, Volume XXVII

Figure 24. Superior nectophore of *Abyla haekeli*, lateral view x 6

Figure 25. *Abyla haeckeli*, dorsal view x 6

Figure 26. *Abyla haeckeli*, ventral view x6

Figure 27. *Abyla trigona* (eudoxid), lateral view, x 5 (approx)

Figure 28. *Abyla trigona* (eudoxid), ventral view x 5 (approx)

Figure 29. *Abyla leuckartii* (superior nectophore), lateral view x 6

- Figure 30. *Abyla leuckartii* (superior nectophore), dorsal view, x6
Figure 31. *Abyla leuckartii* (superior nectophore), ventral view x6
Figure 32. *Abylopsis tetragona* (superior nectophore), lateral view x6
Figure 33. *Abylopsis tetragona* (superior nectophore), ventral view x6
Figure 34. Upper end of inferior nectophore of above, ventral view x6
Figure 35. Eudoxid of above, lateral view x 6
Figure 36. Eudoxid of above, ventral view x 6
Figure 37. *Abylopsis eschscholtzi*, lateral view x 6
Figure 38. *Abylopsis eschscholtzi*, ventral view x 6
Figure 39. *Bassia bassensis*, lateral view x 6
Figure 40. *Bassia bassensis*, ventral view x 6
Figure 41. Eudoxid of above, lateral view x 6
Figure 42. Eudoxid of above, ventral view x 6

br. bract; c.ol. somatocyst; c.ol.br. bracteal somatocyst; hy, hy1, hy2. hydroecium; n1, n2, nectophores; n.go1, n.go2. “gonophore”, ns, ns1, ns2. nectosac; p. siphon; t. tentacle.