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(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LOUDON AND CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY.')

CONDUCTED BY

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the characteristic engine-turned pattern to which I have alluded, and that any horizontal section through any part of this crust would present this pattern. But this is not the case, inasmuch as the thinnest horizontal section beyond the central plane shows that horizontally these compressed cells are not only very variable in size, but present the utmost irregularity in outline that can be conceived, so that it becomes impossible to trace any *direct* communication between any of them and those of the central plane respectively; while the nearer the columns approach the surface the more these cells (although they intercommunicate with each other throughout by the "minute tubuli" to which I have alluded) become approximated, till at last, in the Alabama species, they are covered in by the smooth homogeneous layer of shell-substance also above mentioned. Hence, like most of the specimens of *Orbitolites marginalis*, the only means of communication externally in *Orbitolites Mantelli* was through the apertures in the margin, the "central plane."

That varieties of the kind typified by *Orbitolites Mantelli* will be hereafter found I have no doubt; and Gümbel has already added two under his subgenus "*Lepidocyclina*," viz. "*L. dilatata*" and "*L. burdigalensis*" (*op. et loc. cit.*).

But that "*Orbitolites*" of Lamarck should be used as the generic name for the type of Morton's *Nummulites Mantelli* of the Claiborne beds in Alabama (as I first proposed) instead of "*Lepidocyclina*" seems to me, on the grounds that I have stated, to be most desirable; while as regards *priority* in nomenclature we find that as far back as 1799 Faujas de Saint-Fond (in his Nat. Hist. de la Montagne de Saint Pierre de Maestricht) stated in explanation of his "fig. 4" respecting *Orbitoides media*, d'Orb., that "Cette numismale n'étant pas formée par des cloisons transversales, rentrerait, d'après Lamarck, dans ses *Orbitolites*."

XXIII.—*The Siphonophora of the Canary Islands.* By Prof. Carl Chun *.

During my residence in Orotava I directed my attention chiefly to the study of the Canarian Siphonophora. I succeeded in discovering, besides the Canarian forms described

* Translated from the 'Sitzungsberichte der königl. preuss. Akademie der Wissenschaften,' 1888, no. xliv. pp. 1141–1173. This is the first section of a "Report upon a Journey to the Canary Islands performed in the winter of 1887–88," and is preceded by a short statement of the cir-

by Häckel, a considerable number of new species, some of which are not without interest, partly on account of their peculiarity of structure, partly because they represent intermediate forms uniting groups hitherto apparently isolated.

During the autumn months up to the beginning of January the pelagic fauna, especially in Siphonophora, was remarkably poor. Nevertheless the numerous Eudoxiæ and the young stages of Physophoridæ furnished me with abundant material for work, which enabled me to ascertain the Eudoxiæ belonging to all the observed Calycophoridæ and to advance the knowledge of the postembryonal development of the Physophoridæ. It was only from January onwards that the adult Physophoridæ appeared, and with them magnificent new Calycophoridæ, which exceeded in beauty and delicacy all the forms known to me.

Although it does not seem to me advisable to discuss the theories as to the organization of the Siphonophora within the limits of a brief report, I am led, with reference to the principles which guided me in the establishment of the system of the Siphonophora, to enter upon certain views which Häckel has put forward in his lately published "System der Siphonophoren auf phylogenetischer Grundlage"*, especially so far as they are in opposition to the opinions maintained by me.

In the primary larva of the Siphonophora Häckel sees a simple Medusan persona, which occurs in the form of a *Siphonula* and a *Disconula*. The latter is octoradiate in structure and becomes subsequently developed into the *Porpitæ* and *Velellæ*; while the bilaterally symmetrical *Siphonula* furnishes the starting-point for all the other Siphonophora. In accordance with this Häckel divides the Siphonophora into two legions, the Disconanthæ and the Siphonanthæ.

In the first place as regards the division of the Siphonophora into two subclasses, of which the one includes the *Velellæ* and *Porpitæ* hitherto characterized as Chondrophoridæ or Velellidæ, and the other the whole of the Calycophoridæ and most of the Physophoridæ, I must maintain

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cumstances under which the journey was undertaken by the aid of the Academy of Sciences.

The author says:—"As I expected that the persistent north-east trade-wind would bring me material in abundance, I resolved to take up my abode on the north coast of one of the islands, and finally selected for this purpose the Puerto de la Orotava, where I found accommodation thoroughly suited to my purposes in the Fonda de la Marina, situated immediately upon the harbour, and also, after the inevitable first difficulties, suitable boats and fishermen."

* 'Jenaische Zeitschrift,' Bd. xxii. (1888).

that Häckel founds his speculations upon two larval forms of very different morphological value. The radiate *Disconula* represents a much altered larva, which was certainly preceded by a bilateral *Siphonula*-stage. Unfortunately we are still unacquainted with the embryonic development of the *Velellæ* and *Porpitæ*; but I have every reason to think that the younger stages closely approach the youngest larval stages of *Physalia* in structure. Young *Rataricæ* observed by me which still possess a simple unchambered pneumatophore show four tentacles, which are bilaterally arranged on one side, or, more accurately, present with one large tentacle three smaller ones asymmetrically distributed. This stage was certainly preceded by a true bilateral *Siphonula* with the rudiment of the pneumatophore, a single tentacle, and the stomachal sac. This stage, which certainly has not yet been observed, must be paralleled with the *Siphonula*; but then one would hesitate *à priori* to recognize a fundamental distinction between "Siphonanthæ" and "Disconanthæ," and to give expression to this condition by seeking a relationship for the Disconanthæ with the Trachomedusæ and for the Siphonanthæ with the Anthomedusæ.

In accordance with previous naturalists I see in the Velellidæ true Physophoridæ, which certainly in their adaptation to a passive movement by action of the wind show very plainly the transformations already stamped upon the *Disconula*. I have repeatedly referred to these adaptations and need only indicate here that I regard as an adaptation to the floating mode of life in the deep sea, *i. e.* at the surface, as a later acquisition, and consequently as an organ *sui generis*, the mantle which was interpreted by Häckel, in agreement with Metschnikoff, as a Medusan umbrella. This limb or mantle, circular in the *Porpitæ*, oval in the clinoradially constructed *Velellæ*, commences in the youngest larvæ as a narrow fold around the still unchambered pneumatophore, and is certainly deficient in the *Siphonula*-stage of the Velellidæ as postulated by me. It originates therefore in the same way as the principal muscular border of the sail in a *Rataria*. If we were to homologize this mantle with an umbrella we should obtain a Medusa which presented upon its exumbrella a richly developed vascular reticulation and a powerful coat of epithelial muscular cells—structural characters which we only meet with in the subumbrella.

There are also some of Häckel's special interpretations of the structure of the Velellidæ with which I cannot agree. Thus he regards the ectodermal parenchyma placed between the hepatic tubes as a gas-gland, which secretes the air into

the inferior open ends of the tracheæ, from which it afterwards passes into the chambers to be discharged outwards through the stigmata. In opposition to this we find that the cushion of tissue in question is quite different in its histological structure from the secondary ectoderm, which, as I have demonstrated *, has the function of a gas-gland, and, further, that the tracheæ which surround the polypes for the most part terminate at spots where the tissue in question is deficient. The latter is rather composed of undeveloped thread-cells, and is precisely homologous with that urticating-pad which surrounds the anterior stomachal portion of the sucking-tubes. By the great development of this urticating-pad the proventriculus is divided into four or five vessel-like canals, which subsequently, in *Porpita*, become increased to eight canals. In the absence of a secondary ectoderm after the development of the chitinous concentric air-chambers the Velellidæ are quite unable to secrete any gaseous mixture, but they are confined to taking the atmospheric air into the chambers and expelling it again through the stigmata. As the colony is subjected to a very intense material change, as is shown by the abundant separation of guanine crystals in the so-called liver, it is clear that sufficient oxygen is conveyed to the polyps by means of the air contained in the tracheæ. Moreover the *Velellæ* and *Porpitæ* perform movements which remarkably resemble the actions of the air-breathing Arthropods for the removal of the air contained in the tracheæ. Thus if we observe a freshly captured *Velella* or *Porpita*, we find that twice in a minute (seldom oftener) the surface turned towards the water and bearing the sexual polyps and the central stomachal sac (siphosoma, polypite) is very energetically pressed against the air-chambers. During this respiratory movement, caused by the contraction of the circularly arranged muscular fibres, the whole of the polyps, with the exception of the tentacles, are simultaneously contracted. The tentacles are moved downwards independently of the above-mentioned movements, either all together or in groups. After the contraction the lower surface of the disk returns slowly into its position of rest, and the polyps begin again to extend themselves, to be again, after the lapse of half a minute, rapidly contracted. For hours this attractive spectacle, which has hitherto been mentioned by no naturalist, may be observed on freshly captured *Velellæ* and *Porpitæ*. The effect of such regularly repeated respiratory movements is perfectly clear; by the energetic contraction of the disk and individual polyps the richly ramified tracheal tufts are contracted, their air passes

* Zoolog. Anzeiger, 1887, nos. 261 and 262.

into the chambers, and out through the stigmata of the latter. On the cessation of the contraction fresh air, richer in oxygen, flows in again. The structure of the chambers, their endowment with stigmata and tracheæ, and the regular respiratory movements serving for the renewal of the air lead me (little as this opinion may harmonize with previous conceptions) *to see in the* Velellæ *and* Porpitæ *Cœlenterata breathing air, and, indeed, breathing by tracheæ.* This notion by no means excludes the occurrence at the same time at all parts turned towards the water of a diffusional exchange with the air absorbed in the sea-water, an exchange which, indeed, plays a part in all air-breathing aquatic animals *.

The Velellidæ certainly represent not only the most complicated in structure, but also the most divergent of the Physophoridæ. But, as I have already expressly asserted, there is no feature in their organization which cannot be explained by gradual adaptation to an existence at the surface of the sea. I think that I fix the position of the *Velellæ* and *Porpitæ* in the system more correctly by proposing to divide the order Physophoridæ into two suborders, of which one includes all Physophoridæ with an unchambered pneumatophore functioning as a gas-gland (*Haplophysæ*), while the other embraces the (partially) air-breathing Velellidæ (*Trachophysæ*) furnished with a chambered pneumatophore, stigmata, and tracheæ.

As regards Häckel's systematic arrangement in other respects I shall take occasion in the sequel to express divergent opinions of subordinate importance. I see with satisfaction that my opinion formerly expressed in these 'Sitzungsberichte' (1882, lii. p. 1170) as to the near relationship between the *Rhizophysæ* and the *Physaliæ*, to which I endeavoured to give expression by the creation of the family Pneumatophoridæ, is not only adopted by Häckel, but also well illustrated by a number of most interesting intermediate forms which were obtained by the 'Challenger' from the deep sea.

As regards Häckel's peculiar "Medusa-theory," which is intended to occupy a conciliatory position between the poly-

* These statements of course do not apply to the interesting "Discalidæ" discovered by the 'Challenger' in the deep sea. These in a certain degree represent Disconulæ which have become sexually mature, and it is to be supposed that in them, as in the young stages of *Porpitæ* and *Velellæ*, the gas-secreting ectoderm persists. At any rate they partly want the tracheæ, which occur only from the third or fourth concentric air-chamber onwards. It is possible that they represent young stages of *Porpitæ* which, as I have found to be the case with many Siphonophora, ascend to the surface at the commencement of sexual maturity.

organ-theory and the polyperson-theory, he regards the larva of the Siphonophora as a Medusa with dislocated organs and assumes in the developed stocks a profound secondary dislocation of the different constituents of the Medusa. Häckel's results so nearly approach the views of Metschnikoff *, who interpreted the Siphonophoran larva in the same way, and who likewise compared the developed colony to a *Sarsia* with the stomach grown out into a peduncular form and gemmiparous, that I must once more adduce all the difficulties which Leuckart †, and subsequently Claus, raised against the views of Metschnikoff and P. E. Müller. Even now, when we possess a sufficient knowledge of the polymorphous Medusæ and their processes of gemmation, there is nothing to support the notion of a dislocation. So long as we have no demonstration that nectocalyx, stomachal tube, tentacles, and bract (hydrophyllium) are produced by dislocation from a single bud, so long as the difficulty is not got rid of that, on the other hand, three or four separate buds, originally quite similar, concur in the formation of a monogastric Siphonophoran, which, *in toto*, is homologous with a Medusa, I must decline to admit the assumption of such a dislocation. On the contrary, when rudiments of tentacles, marginal corpuscles, and manubria make their appearance on the nectocalyces of the Siphonophora, we always see them indicated upon the ordinary spots. How such rudiments, which are observed especially upon the nectocalyces of the genus *Lilyopsis*, established by me, can be brought into accordance with dislocation completed at the same time, is to me just as incomprehensible as Häckel's and Metschnikoff's supposition that the value of individualities belongs only to the genital nectocalyces and the recently demonstrated "aurophores." The genital calyces themselves present such profound retrogressions that, in the form of sporosacs, they left Weismann in doubt whether we have here to do with retrograde Medusæ or Polypes. We never observe such far-reaching reductions in the locomotive elements, which always show their velum, the fine musculature of the subumbrella, the ordinary course of the vessels, and in all cases a nerve-ring at the margin of the umbrella, as I have been able to demonstrate in all the calyces (most distinctly developed in the species of *Abyla*).

To what inconsistencies Häckel's views lead may be further

* 'Verhandlungen der Gesellsch. für Naturk.' (Moscow), vol. viii. 1870 (in Russian), and, further, Zeitschr. für wiss. Zool. Bd. xxiv. (1871), pp. 65–77.

† "Bericht &c.," in Arch. für Naturg. Jahrg. xl. (1874) ii. pp. 183–184, and Jahrg. xli. (1875) ii. pp. 452–459.

illustrated by an example. As is well known, there are Eudoxiæ which, besides the genital calyx, possess a special sterile nectocalyx destitute of manubrium. The latter, according to Häckel, represents a Medusan persona, when he assumes that in it the manubrium has been suppressed by retrogression. But why are we to regard the locomotive elements merely as organs, seeing that they possess exactly the same attributes as the special sterile nectocalyx? I readily admit that it may be a matter of dispute whether in the polymorphic colony we are to regard the bracts and tentacles as individuals or as organs, although Häckel himself cites facts (such as the occurrence of a small umbrella on the bracts of *Athorybia* and *Rhodophysa*) which might support the former notion. If the dispute were to turn only upon the precarious determination of the boundary between individual and organ I would not proceed further in this place; but the special form in which Häckel clothes his statements induces me to test more closely his assertion as to the characteristic attribute of the Physophoridæ, namely the pneumatophore.

I am glad in the first place that Häckel adopts my view as to the homology of the primary nectocalyx of the Calycophoridæ and the pneumatophore of the Physophoridæ. I believe that by the demonstration in the Calycophoridæ of a primary calyx which is thrown off and replaced by heteromorphous secondary calyces, as well as by the homologization of this nectocalyx with a Medusa converted by change of function into a pneumatophore, a step in advance is made with regard to the explanation of the production of that hydrostatic apparatus. As to the fact that the pneumatophore represents a metamorphosed Medusa, *i. e.* umbrella, all observers are in accord; it is only in the special proof that they differ essentially from one another. Metschnikoff, as is well known, regards the pneumatophore as an everted Medusan umbrella, of which the exumbrella has been converted into the internal cavity filled with air. If this conception should be verified, an essential difficulty in the way of the comparison of a Physophorid to a budding *Sarsia*, namely the dislocation of the gemmiparous manubrium, would be got rid of. We should then only have to explain how in this case, in the homologous primary nectocalyx of the Calycophoridæ, the stomachal peduncle with its buds does not hang out from the subumbrella, but appears dislocated upon the exumbrella. But the history of development cannot in any way justify such a view. The ectodermal bud-nucleus, by means of which the pneumatophore is founded, is perfectly homologous with the bud-nucleus which forms the subumbrella of all

Medusæ and also specially the primary nectocalyx in the Calycophoridæ. I am therefore the more surprised that Häckel declares categorically:—"This latter conception is, in my opinion, quite erroneous; the former, in a certain sense, admissible. The comparative ontogeny of the Siphonophora appears to me to prove definitely that the air-sac is an apical gas-gland of the exoderm, which in the Disconula of the Disconanthæ immerses itself into the jelly of the umbrella centrally at the vertex of the umbrella, but in the Siphonula of the Siphonanthæ excentrically near the vertex."

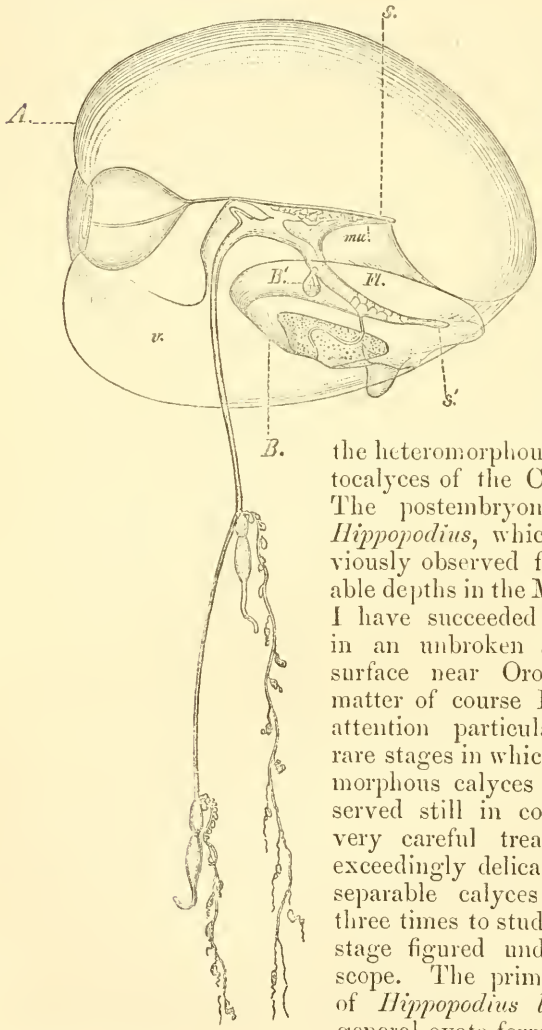
In the first place as regards the last observation, in which the endeavour to establish a fundamental distinction between the Disconula and the Siphonula is revealed, it is not at all correct. In simple Physophoridæ, as, for example, in the larva of *Halistemma pictum*, the pneumatophore originates exactly at the apical (aboral) pole of the ciliated larva, as Metschnikoff has already correctly shown, and as I was able to ascertain in the Canarian species.

While, on the other hand, Metschnikoff leaves us in no doubt as to where, according to his view, we have to seek the subumbrella of the Medusa modified into a pneumatophore, we find in Häckel no indication of a part of the pneumatophore homologous with the subumbrella. Nor does he adduce from the comparative ontogeny of the Siphonophora any fact which can justify his view. I have myself previously appealed emphatically to developmental history, and I can now once more assert that the ciliated larva of *Halistemma* is similar in form to the larvæ of Calycophoridæ of the same age. Why, then, in the one case we should admit that the ectodermal introverted bud-nucleus becomes developed into the subumbrella of the primary nectocalyx, while in the other a part of the exumbrella proceeds from the bud-nucleus, which is introverted in exactly the same manner, is incomprehensible to me, and contradicts all observations upon the comparative ontogeny of the Siphonophora.

I must admit that Häckel's "Medusa Theory," both in its general foundation and in its special working out, seems to me not to be a fortunate attempt to combine the opposite views of Huxley, Metschnikoff, and P. E. Müller with those of Leuckart and Vogt, with the latter of which Häckel also formerly agreed.

Passing now to my statements with regard to the Canarian Siphonophora, which, indeed, must have a modest

appearance when compared with the astonishingly rich and interesting material which Häckel had at his disposal in the Siphonophora captured by the 'Challenger' in the deep sea and those observed by himself in various seas, on the one hand I hope to be able to characterize some forms which may claim to be of general interest, and on the other I believe I have here and there also enlarged our knowledge of the post-embryonal development.



Dealing in the first place with the latter subject, I figure here a developmental stage in the postembryonal evolution of *Hippopodius* which may serve for the elucidation of the above remarks upon the heteromorphous primary nectocalyces of the Calycophoridæ. The postembryonal stages of *Hippopodius*, which I had previously observed from considerable depths in the Mediterranean, I have succeeded in capturing in an unbroken series at the surface near Orotava. As a matter of course I directed my attention particularly to those rare stages in which both heteromorphous calyces are to be observed still in connexion. By very careful treatment of the exceedingly delicate and readily separable calyces I was able three times to study in detail the stage figured under the microscope. The primary calyx (*A*) of *Hippopodius luteus* is of a general ovate form and presents

at the broader pole a comparatively small subumbrella with the velum, the four vessels, and the annular canal. The connecting vascular canal, as also the elongated and very fine fluid-receptacle (*s*) takes a nearly horizontal course. The comparatively large sheath (*v*) reaches exactly to the fluid-receptacle and extends to the inferior margin of the subumbrella. The young colony is now seated with a broad base upon the fluid-receptacle of the primary calyx. As regards the first-formed definitive *Hippopodius*-calyx (*B*) it shows perfectly the characteristic horse-hoof form. As its peculiar form has been sufficiently described by previous observers, I mention only that the upper radial vessel traversing the middle of the subumbrella already shows the characteristic lateral ramifications which lead to the formation of the vascular plate with its numerous anastomoses. The fluid-receptacle (*s'*) runs out into the section of the stem on which the calyces bud between the lateral wings (*Fl*) of the secondary calyx. The rudiment of a second secondary calyx (*B'*) in the form of a rounded bud, at the base of which a small thickening already indicates the formation of a third calyx, is distinctly recognizable. The cushion-like thickening of the stem by which the attachment to the primary calyx is effected consists of endodermic cells rich in fluid, upon which lies an ectodermal muscular layer (*mu*) projecting in the form of a lamella. By the contraction of the latter the secondary calyx is drawn into the superior section of the sheath on the slightest contact. If the two calyces separate from each other the above-mentioned cushion, with the muscular layer, begins to shrivel up; but it may still be recognized for a long time in young colonies.

In the further progress we come first upon the youngest group of polyps, consisting of a young stomachal tube (polypite, *Huxl.*) and a tentacular bud. Two further developed groups, of which the tentacles already show the characteristic urticating batteries with their yellow pigment, hang out of the sheath upon the elongated stem.

I content myself here with the description of this characteristic stage, as I shall shortly give elsewhere a full description of the postembryonic development of *Hippopodius*.

In giving now brief characters of the Canarian Siphonophora, at the same time inserting occasional remarks upon their young stages, I may remark that I cannot approve of Häckel having so extensively replaced the older and often long-established denominations of the orders and families by new ones, which are frequently but little altered and scarcely more applicable (as, for example, Calycophoridæ and Pneumatophoridæ by Calyconectæ and Cystonectæ).

Order I. CALYCOPHORIDÆ, Leuck.

As is well known, a part of the Calycophoridæ is remarkable for the faculty of producing Eudoxiæ. Häckel is of opinion that the two generations, the monogastric (the Eudoxiæ) and the polygastric, must, upon practical grounds, be classified in the system separately and side by side in the same way as the Hydromedusæ and their polyp-nurses. I cannot agree with him in this. A system of Medusæ founded solely upon the sexual animals is so far justified that a great part of the Medusæ are developed directly without any alternation of generations. However, of late noticeable attempts have been made to establish a unitary system of the whole of the Hydromedusæ, taking into account at the same time the Polypes and the Medusæ which remain sessile as gonophores. Besides that the process of *Eudoxia*-formation is not to be paralleled unconditionally with the budding of the Medusæ (even though, like Häckel, P. E. Müller, and Metschnikoff, we were to refer a part of the Eudoxian colony to dislocated organs of a Medusa), there is no Eudoxia which is directly developed in such a manner that a Eudoxia is produced directly from the ciliated embryo. We may recognize all so-called monogastric colonies, after the discovery of Sars, Leuckart, Vogt, and Gegenbaur, as descendants of polygastric Siphonophora. The attempt to establish a peculiar system of Eudoxiæ leads to the citation of the families of the latter as categories equivalent to the families of the parent-colonies. Fundamentally, in Häckel's system three systems of Calycophoridæ run parallel to each other, one of them founded upon the liberated Eudoxiæ, the second upon the nectocalyces of the parent-colonies belonging to them, and the third upon those Calycophoridæ in which the Eudoxiæ remain sessile. Such an attempt leads to the further inconsistency that in the different families of the Eudoxiæ, which are characterized by the form of the hydrophyllia, of the gonocalyces and special calyces, Eudoxiæ are united which originate partly from Monophyidæ and partly from Diphyidæ. As, further, nearly allied species present sometimes liberable, sometimes permanently sessile Eudoxiæ, I prefer to avoid an unnecessary complication of the system and treat of the Eudoxiæ along with their parent-colonies.

Family I. **Monophyidæ**, Claus.

Huxley was the first to describe and figure recognizably a Monophyid under the name of *Sphæronectes*. It possesses

perfectly the characters of the form subsequently described by Claus as *Monophyes gracilis*. I would therefore propose to refer those species which are characterized by an elongated tubular sheath running to the middle of the umbrella to the genus *Sphæronectes*, and, on the other hand, to retain the generic name of *Monophyes* for those species which are distinguished by a short funnel-shaped sheath, reaching only to the lateral walls of the subumbrella (after the type of *Monophyes irregularis*, Claus).

Häckel divides the Monophyidæ into two subfamilies—Sphæronectidæ and Cymbonectidæ. I adopt this division because as yet we have no evidence of a primary heteromorphous nectocalyx in the Sphæronectidæ, whereas with regard to the Cymbonectidæ with angular calyces I have furnished evidence of a primary calyx in *Muggiæa* *. I would, however, remark that the form of the rounded cap-shaped calyces of the Sphæronectidæ is recapitulated in the development of the Calycophoridæ.

Subfam. 1. *Sphæronectidæ*, Huxl.

1. *Monophyes brevitruncata*, sp. n.

Umbrella thin-walled. Oil-receptacle relatively large, ascending almost perpendicularly. Stem abbreviated, presenting, besides the undeveloped buds on the basal portion, only two groups of appendages (*cormidia*, Häck.). The latter are set free as Diplophysæ, which resemble in appearance those of *M. irregularis*. They differ from these by their relatively smaller hydrophyllium, which is traversed by a considerable oil-receptacle, reaching nearly to the top of the hydrophyllium. The gono-nectocalyx is very large, thin-walled, and shows at its base the rudiments of two reserve-calyces. I name it *Diplophysa codonella*. Once I observed a perfectly developed *Diplophysa*-group at the extremity of the stem, a proof that the groups only separate late and that the stem always remains remarkably short.

Monophyes brevitruncata appeared very sparingly with the groups belonging to it in the course of the winter and spring.

2. *Monophyes irregularis*, Claus.

3. *Sphæronectes gracilis*, Claus (*S. Köllikeri*?, Huxl.).

The two last-named Monophyidæ appeared more abun-

* Sitzungsb. Akad. Wiss. Berlin, 1882, ii. p. 1155.

dantly than *M. brevitruncata*, together with the Diplophysæ belonging to them (*D. inermis* and *truncata*) from September to April.

Subfam. 2. *Cymbonectidæ*, Häckel.

Doramasia, g. n.

Nectocalyx Diphyidiform, slender, with a long, tubularly drawn-out apex to the subumbrella. Eudoxiæ with sterile special nectocalyces (*Ersæa Bojani*, Esch.).

4. *Doramasia picta*, sp. n.

Sheath (hydrœcium) elongated, funnel-shaped. Oil-receptacle long, reaching to the tubular constriction of the subumbrella. Stem short, with only two groups of appendages. *The Eudoxiæ become developed into* Ersæa Bojani, *Eschsch.* (Eudoxia Bojani, *Huxl.*).

Doramasia represents a remarkably elegant Monophyid which immediately strikes one by its splendid colouring. The ventral surface of the subumbrella with its tubular portion is of an intense orange or bright yellow colour. Large orange spots also appear on the dorsal and ventral margins of the umbrella, and, further, the siphosoma (polypite) of the oldest group is also very frequently intensely tinged with orange. The lowest ventral cell of the fluid-receptacle is constantly emerald-green (changing by transmitted light to the complementary rose-colour). Frequently at the opening of the dorsal umbrellar vessel into the annular canal there is a vascular plate formed by numerous ramifications and anastomoses, which also has a greenish lustre.

The strict proof that a Siphonophore furnished only with a single nectocalyx really belongs to the Monophyidæ can be obtained, according to my previous statements, only by that of the absence of the rudiment of a second calyx at the base of the stem. I have examined nearly forty specimens of *Doramasia* upon this point at the most different times, and have often preserved and carefully observed the same individual for several days without being able to detect a trace of a second calyx.

Häckel, in his tabular revision, regards *Ersæa Bojani* as the offspring of *Diphyes dispar*, Cham.; but this can only be upon suppositions which are not confirmed. I have traced *Ersæa Bojani* with its characteristic widened oil-receptacle in the scutiform hydrophyllium, in all stages of development,

still seated upon the stem of *Doramasia*. I may further mention that *Ersæa Bojani*, which often presents at the same time four or five small gonocalyces in different states of maturity, is dicœcious. The male calyces when quite mature present a somewhat reddish manubrium occupying nearly the whole cavity of the subumbrella.

Doramasia picta attains a size of 6–10 millim. and appeared pretty frequently during the whole period of my residence in the Canaries. In it the name of the Canarian national hero, Doramas, may be commemorated.

5. *Muggiæa Kochii*, Chun.

Appeared singly during the winter months with the Eudoxiæ belonging to it—*Ersæa pyramidalis*, Will (*Eudoxia Eschscholtzii*, Busch).

Halopyramis, g. n.

The nectocalyx forms a broad, four-sided, tetrogonal pyramid. Hydrœcium infundibuliform, with a projecting denticulate margin. Oil-receptacle very large, situated in the axis of the pyramid. Subumbrella excentric. Stem abbreviated, not protrusible. Eudoxiæ without special nectocalyx, becoming free as *Cuboides*.

6. *Halopyramis adamantina*, sp. n.

The base of the pyramid is octangular in so far that in the inferior third two edges are attached to each of the four widely projecting angles, and these, running downwards obliquely, meet together in four inferior angles which alternate with the four upper ones. The large, fusiform, centrally placed oil-receptacle is furnished on its basal surface with fluid-cells of very considerable size. Stem abbreviated, disciform, beset with numerous groups of buds. The Eudoxiæ, which are liberated in the form of *Cuboides adamantina*, mihi, grow to a considerable size, are monœcious, and usually present at the same time two gonocalyces and several (up to three) reserve-calyx-rudiments.

Halopyramis adamantina is one of the most remarkable Canarian forms, not only on account of its peculiar form, perfect transparency, and comparatively large size (the calyx reaches a height and breadth of 15 millim.), but also on account of the abbreviation of the stem. I never saw this extended, even in specimens which were kept quietly for two

days in glasses. Moreover, no convolutions can be recognized in it, although it is difficult to get a view of it on account of the closely packed groups with their orange-coloured cnidaria. I shall have to call attention to a similar conversion of the stem into a disciform plate in a Diphyid. The genus *Halopyramis* certainly stands near the genus *Cymba*, under which, however, Eschscholtz certainly united creatures of very different kinds. It is possible that *Cymba enneagonum* (*Enneagonum hyalinum*, Quoy et Gaimard *), which has been so frequently determined erroneously, is related to, if not identical with, *Halopyramis adamantina*. Quoy and Gaimard certainly ascribe to it a small inferior calyx, and therefore afterwards referred it to *Diphyes*; but it is conceivable that here we have a confusion with a genital nectocalyx of a Eudoxia already far advanced in development.

Halopyramis is perfectly transparent; in large specimens the eight angles and the umbrellar margin of the calyx are of a yellowish colour; sometimes yellowish spots also appear on the subumbrella. The oval oil-drops, as well as those in the hydrophyllium of the *Cuboides*, have an orange lustre. The polypes shimmer emerald-green beneath the urticating-pad.

Cuboides adamantina represents one of the largest and most splendid Eudoxiæ. The cuboidal hydrophyllium with its aliformly produced edges and concave lateral surfaces attains a size of 10 millim., and the older gonocalyces are of the same length. On the yellowish oil-receptacle the fluid-cells occurring on the ventral surface of the lateral diverticula may be recognized by the naked eye.

Cuboides vitreus, Huxley, resembles it, but is distinguished by the shorter dorsal surface of the hydrophyllium (which is much produced in *C. adamantina*). Favoured by its size and transparency I was enabled to trace out many minute histological details, upon which I will not enter here, better than in any other Eudoxia.

Halopyramis and the *Cuboides* belonging to it appeared singly and rarely during January and February.

From the revision of the Canarian Monophyidæ here given it appears that their Eudoxiæ are remarkably different from one another. They belong to the two families of the Eudoxidæ and Ersæidæ distinguished by Häckel, with the sub-

* 'Voyage de l'Astrolabe': Zool. Zooph. pl. v. figs. 1–6, vol. iv. p. 100; Ann. Sci. Nat. vol. x. (1827), p. 18, pl. ii. D. figs. 1–6.

families of the Diplophysidæ and Aglaismidæ. I mention this circumstance only in order to show how doubtful it is to introduce the progeny of a well-characterized family into the system as representatives of equivalent families.

Family II. **Diphyidæ**, Eschsch.

Subfam. 1. *Epibulidæ*, Häck.

Häckel characterizes the genus *Epibulia* by the absence of an hydrœcium. As, however, indications of such a thing are given by the produced wing-like edges of the inferior nectocalyx, and on the other hand *Diphyes subtilis* has no hydrœcium in the superior nectocalyx, I would note as a further distinctive character from *Diphyes* the maturation of the sexual products on the stem and the absence of a *Eudoxia*-formation. It is true that in freshly captured *Epibulia aurantiaca* the *Eudoxia*-groups rapidly separate, but we never meet with these groups already furnished with mature semen and ova floating freely in the sea. It is also in accordance with this that (at least in the Canarian forms examined by me upon this point) no reserve-gonocalyces occur.

7. *Epibulia inflata*, sp. n.

Umbrellar jelly of both calyces thin-walled. Subumbrella of the superior calyx swelled out. Oil-receptacle comparatively large (from one third to half as long as the subumbrella), ovate, and furnished on the ventral surface with large fluid-cells. Ventral wings of the inferior calyx well developed. Course of vessels simple, as in the calyces of Diphyids; margins of both calyces smooth, without projecting wing-like angles; stem short, monœcious. The last groups of appendages lose the bract, stomachal sac, and tentacles, so that only the gonocalyx remains on the stem.

Epibulia inflata is a small, easily recognizable Diphyid, measuring 10 millim., which appeared singly and in very few examples during the winter. Both the subumbrellas have a delicate rosy tint; only once I found them with orange spots.

8. *Epibulia monoica*, sp. n.

Nectocalyces and course of vessels on the subumbrella resembling those of *E. aurantiaca*; but the diverticula of the subumbrella of the inferior nectocalyx are wanting, and the fluid-receptacle is very small. Stem monœcious; one

female group to every four to six male groups. In the last groups of appendages first the stomachal sac and tentacles and finally the bract become rudimentary.

Epibulia monoica is a very characteristic Canarian form, in which I was able to trace with particular exactitude the peculiar retrogression of the *Eudoxia*-groups. Usually in the older examples we find at the end of the stem from four to six gonocalyces, to which the rudiments of the shrunken *Eudoxia*-constituents adhere. The mature testes are rose-coloured, and, like the mature ovaria, occupy nearly the whole of the subumbrellar space. The species under consideration has in common with *Epibulia aurantiaca* not only the convolutions of the vessels, but also the commissure between the lateral and ventral vascular stems in the superior calyx. It is distinguished therefrom, besides the above-mentioned characters, by the different formation of the so-called closing valves on the margin of the umbrella. From the two species described by Sars*, *E. truncata* and *E. biloba*, as also from *E. Sarsii*, Gegenbaur †, it differs by the small size of the fluid-receptacle and the complicated structure of the umbrellar margin.

The polypites are very slender, with an elongated cnidarium and a light brown median stomachal section. *Epibulia monoica* attains a length of 28 millim.; in the largest specimen the inferior calyx was twice as long as the upper one. A few examples occurred in January and March.

9. *Epibulia aurantiaca*, var. *canariensis*.

I observed a species nearly allied to *E. aurantiaca*, and, like this, diœcious, twice in March. It showed the diverticula of the subumbrella less strongly developed on the inferior calyx and presented some differences in the development of the teeth projecting from the umbrellar margin. As, however, the differences are probably only unimportant, I regard the Canarian form for the present only as a variety of *E. aurantiaca*.

10. *Diphyes subtilis*, Chun.

D. subtilis makes the transition between the genera *Epibulia* and *Diphyes*. It has no hydrœcium and, like the true *Epibuliæ*, possesses wing-like edges on the inferior calyx, but has in common with the Diphyids the formation of sepa-

* 'Fauna littoralis Norvegiæ,' i. (1846), pp. 41–46, pl. 7.

† Nova Acta Ac. Cæs. Leop.-Car. xxvii. (1859) p. 372, pl. xxix. fig. 30.

rable *Eudoxiæ* with reserve-gonocalyces. As I showed in 1886*, *Ersæa elongata*, Will, represents the Eudoxia belonging to *D. subtilis*.

It appeared singly and not so frequently as in the Mediterranean during the whole winter.

11. *Diphyes bipartita*, Costa.

The common Diphyid of the Mediterranean (*Diphyes Sieboldii*, Köll., *D. gracilis*, Gegenb., *D. acuminata*, Leuck.) is abundant both in the depths and at the surface of the Atlantic Ocean, and appeared, with the Eudoxia pertaining to it (*Eudoxia campanula*, Leuck.), throughout the whole winter.

12. *Diphyes serrata*, sp. n.

Nectocalyces more slender than those of *D. bipartita*, with strong projecting teeth on the umbrellar margin. Ridges on the dome of the superior nectocalyx produced into wings. Eudoxiæ like *Eudoxia campanula*, with a very slender long bract.

Diphyes serrata appeared abundantly during the whole winter. Its Eudoxiæ (*Eudoxia serrata*, m.) are easily recognized by the slender bract, resembling an arrow-head. They attain a considerable size (as much as 8 millim.) and have sulphur-yellow cnidaria.

13. *Diphyopsis campanulifera*, Q. & G.

The large and beautiful *D. campanulifera* is the commonest Diphyid occurring at the Canaries and apparently throughout the Atlantic Ocean. It appeared regularly from the end of October onwards, and I observed it in great swarms in the larger currents during a passage from Teneriffe to Palma in March. It is possible that *Diphyes dispar*, Cham. & Eysenh.†, is identical with it; under this latter name it has also been thoroughly described by Huxley. However, a careful investigation furnished me with much information as to the change of the nectocalyces and the occurrence of a large vascular plate, consisting of numerous anastomoses, at the lower ventral section of the nectocalyces. *Its* Eudoxia-*groups become developed into the* Eudoxia Lessonii, *Huxley* ‡, *furnished with*

* Sitzungsb. Akad. Berl. xxxviii.

† Nova Acta Ac. Cæs. Leop.-Car. x. (1822), p. 365, pl. xxxii. fig. 4.

‡ 'The Oceanic Hydrozoa,' p. 57, pl. iii. fig. 6.

a sterile special nectocalyx, which may be identical with the Eudoxia described by Eschscholz * under the same name. I need hardly note that the abundant material at hand gave me the opportunity of tracing the development of the *Eudoxia*-groups on the stem through all phases up to their separation. *Eudoxia Lessonii*, like all the Eudoxiæ of the genus *Diphyes*, is diœcious. In the older Eudoxiæ I generally found a mature gonocalyx with a second smaller one and two bud-rudiments of a third and fourth calyx. The special necto-calyx, into which the calycal bud first formed on the stem is developed, persists and is not displaced by sterile reserve-calyces.

Häckel can only rely upon suppositions in regarding *Eudoxia* (*Cucullus*) *Lessonii* as derived from the *Diphyes appendiculata* insufficiently described by Eschscholtz.

Older specimens of *D. campanulifera* possessed a sulphur-yellow subumbrella on both calyces. The special necto-calyx of *Eudoxia Lessonii*, which is furnished with yellow spots, has usually a delicate emerald-green lustre.

Subfam. II. *Abylidæ*, Ag.

Besides the characters given by Agassiz and Häckel, it may be indicated as characteristic of the Abylidæ that their Eudoxiæ, in contrast to those of the Epibulidæ, are monœcious.

14. *Abyla trigona*, Q. & G.

From the middle of December onwards *Abyla trigona* occurred, at first in single specimens, but later on (at the end of February and in March) in great swarms. That their groups of appendages become developed into *Amphirrhoa alata*, Lesueur, which I regard as identical with *Eudoxia trigona*, Gegenb., was rightly supposed by Huxley, and proved by Gegenbaur (*loc. cit.* p. 347). I met with the *Amphirrhoa* as early as October.

15. *Bassia perforata* (*Bassia quadrilatera*?, Q. & G., *Abyla bassensis*, Huxl., *Abyla perforata*, Gegenb.).

The present species, which was undoubtedly discovered by Quoy and Gaimard, and afterwards figured by them as *Diphyes bassensis* †, is a very abundant form and appeared at

* 'System der Acalephen,' p. 126, pl. xii. fig. 2.

† 'Voyage de l'Astrolabe,' Zoophytes, pl. iv. fig. 18.

the Canaries throughout the whole winter. It descends into deep water, as I obtained a specimen in the closed net from 500 metres. Huxley correctly surmises that the *Eudoxia*-groups of *Bassia* become developed into *Sphenoides australis*, Huxl. This supposition I can confirm by direct observation.

16. *Abylopsis** *quincunx*, sp. n.

It is remarkable that hitherto all observers have confounded with each other the two most abundant species of *Abyla*, namely the Mediterranean *Abyla pentagona* and the Atlantic species, which is always much smaller. The Atlantic form, with its characteristic hydrœcium produced into the form of a neck, is easily distinguished from the *Abyla pentagona* of the Mediterranean, in which the small superior calyx is seated by a broad base upon the inferior one. Huxley has very recognizably described and figured the Atlantic species as *Abyla pentagona* (*loc. cit.* p. 40, pl. ii. fig. 2). As Quoy and Gaimard figure the Mediterranean form under the name of *Calpe pentagona*, I give the Atlantic one that of *Abylopsis quincunx*.

Their *Eudoxia*-groups are developed into *Aglaismoides Eschscholtzii*, Huxl., as I have been able to trace in detail. The latter differs in the form of the bract from the *Eudoxia cuboides* which belongs to *A. pentagona*.

17. *Ceratocymba spectabilis*, sp. n.

As *Ceratocymba* I describe the only Eudoxia, the derivation of which from a previously known *Abyla* I am unable to demonstrate. I regret the more that the polygastric colony to which it belongs did not occur, as it must certainly be a very remarkable form; for the splendid *Ceratocymba*, which is not less than 23 millim. long, represents the largest of all known Eudoxiæ. It consequently attains the length of a full-grown *Abyla trigona* or *Abylopsis pentagona*.

The large bract resembles a helmet with two laterally projecting triangular horns. The remarkably large oil-receptacle is curved like a note of interrogation (?), and is produced at its tip into two very long canals passing obliquely outwards into the angular processes of the bract. The dorsal surface of the oil-receptacle is coated with particularly large fluid-cells

* As the generic name *Calpe*, employed by Quoy and Gaimard, had already been made use of by Treitschke in 1825 for a butterfly, I propose to replace it by *Abylopsis*. In the conception of the genus I follow Huxley.

visible even to the naked eye. The polypite and tentacles show the ordinary structure; the long orange-coloured batteries are provided with a particularly strong elastic band twisted like a rope.

The gono-nectocalyces are always two in number, and, indeed, one is male and the other female in development, a condition which I have already noted as characteristic of the Eudoxiæ of the Abylidæ. The manubrium, which is occupied by the sexual products, is remarkably small in proportion to the enormously large calyces. The latter measure nearly 2 centim.; the length of the subumbrellar cavity in the larger calyx amounts to 13 millim. Their four edges are produced in a wing-like form and run out at the margin of the umbrella into tooth-like angles, one of which is developed to a considerable length. I could always observe two or three reserve-gonocalyces in different stages of development. Their size alternates quite regularly, so that, if the largest calyx of the Eudoxia is male, the somewhat smaller one which appears at the same time is female; upon this follows a male reserve-calyx, and then again a small bud, which, however, already shows the rudiments of the ova in the manubrium.

Ceratocymba spectabilis occurred rarely and singly from January to March. The bract behaves very remarkably under strong contact, inasmuch as upon irritation a whitish turbidity makes its appearance, first in the neighbourhood of the two horn-like canals of the oil-receptacle, and afterwards, commencing from the angles, also in the whole of the gelatinous mass. This is due to the appearance of extremely fine granules, which again disappear (in about half an hour) if the Eudoxia is left in repose. The peculiar turbidity reminds one of an analogous phenomenon in *Hippopodius*, only that there the milky coloration consequent upon irritation and afterwards disappearing is connected with the ectodermal cells of the nectocalyces. In a certain sense even the structureless jelly of the bract must be accessible to an irritation, as the gradual manifestation and equally gradual disappearance of a tolerably intense turbidity proves.

It is evident that a Eudoxia from the Straits of Gibraltar described by Quoy and Gaimard* as *Cymba sagittata* is allied to the *Ceratocymba* here described. At any rate the genus *Cymba* represents a Eudoxia and not a Monophyid, in which latter sense the generic name is adopted by Häckel. As, moreover, the name *Cymba* was employed for a mollusk as early as 1826, it must be withdrawn here.

* Ann. Sci. Nat. vol. x. (1827), p. 16, pl. ii. c. figs. 1–9.

The Abylidæ here cited furnish remarkable objects for the study of the finer histological characters. Besides the magnificently developed transversely striated subumbrellar musculature, the endoderm-cells of the calycular vessels, especially in those places where anastomosing vascular plates occur, furnish perfectly classical objects for the study of a direct nuclear division taking place without karyokinesis. The endoderm-cells are often filled with a whole brood of nuclei, produced by the constriction or by the breaking up of one large nucleus, sometimes curiously sausage-shaped or ramified. It has also already been mentioned that, in the species of *Abyla*, I have detected at the margin of the umbrella a nervous ring consisting of elongated, bipolar, fusiform cells.

Subfam. III. *Amphicaryonidæ*, Chun.

Nectocalyces with a rounded exumbrella, stem metamorphosed into a disk. The bud-groups are set free as diplophysiform Eudoxiæ.

Amphicaryon, g. n.

Nectocalyces of unequal size; oil-receptacle of the cap-shaped bract with two long lateral canals.

18. *Amphicaryon acaule*, sp. n.

Nectocalyces in young examples of nearly equal size; in older specimens the larger calyx completely encloses the smaller one by means of two lateral wings. The latter possesses an ascending and a descending fluid-canal, the former only an ascending stem reduced to a disk, on which the first groups bud forth ventrally, and the later ones also laterally. They are set free as diplophysiform Eudoxiæ without special nectocalyx, which I name *Diplodoxia acaulis*. The rounded cap-shaped bract possesses a deep ventral fissure. The roundish oil-receptacle is comparatively small, but the two canals descending obliquely from it are pretty long. The polypites are relatively thin-walled; before the separation of the Eudoxiæ they are generally seated, curved into a semicircular form, upon the disciform stem. The tentacles are of a delicate yellowish colour; in the small batteries five larger strongly refractive cnidarian capsules are remarkable on each side. The tactile filament is usually intensely orange-coloured. The gono-nectocalyces show on the ventral surface a groove bounded by wing-like processes.

Amphicaryon acaule appeared singly from December onwards to April: the Eudoxiæ belonging to it were observed as early as October. In older examples the smaller calyx was flattened out like a bowl and immersed in the larger one. The subumbrella of the smaller calyx is in all forms so small that it may easily be overlooked.

Amphicaryon becomes 15 millim. long, and, not only by the peculiar form of its calyces, but above all by the retrogression of its stem, represents one of the most noteworthy of the Canarian Siphonophora. It has, in common with the Diphyidæ already mentioned, the formation of Eudoxiæ, while by the rounded form of the calyces it makes the transition to the Prayidæ.

Subfam. IV. *Prayidæ*, Köll.

19. *Praya maxima*, Gegenb.

Occurred much more rarely than in the Mediterranean in perfectly sexually mature examples during February. In many groups two mature male or female gonocalyces were developed at the same time.

20. *Lilyopsis diphyes*, Vogt.

Observed only once, at the beginning of October.

Family III. **Stephanophyidæ**, Chun.

Calycophoridæ with four nectocalyces placed like a wreath in the same plane and with heteromorphous tentacles.

Stephanophyes, g. n.

Nectocalyces with the oil-receptacle repeatedly divided dichotomously. Stem monœcious. Appendicular groups constructed like those of the genus *Lilyopsis*, remaining sessile. In the internodes are seated heteromorphous tentacles, with small balaniform cnidaria without tactile filaments.

21. *Stephanophyes superba*, sp. n.

Nectocalyces similarly formed, resembling those of the genus *Lilyopsis*, with repeatedly dichotomously divided fluid-vessels, swollen into knots, and a large nectosac. Numerous reserve-nectocalyces present at the commencement of the

stem. Lateral subumbrellar vessels running in arabesque-like convolutions.

Gastric polyps transparent, with long peduncles and a long proventriculus. At the junction of peduncle and proventriculus originates the principal tentacle, with spirally coiled, transparent, large bluish cnidaria. The older ones are faintly coloured red; all are provided with long tactile filaments. At the base of the cnidaria a black pigment spot.

Special nectocalyces originate at the base of the stomachal peduncle close to the stem and remove subsequently proximally from the latter. Their axial vessel gives off a dorsal and a central branch; the lateral subumbrellar vessels have a twisted course. At the ventral surface the gelatinous mass is widely produced in a wing-like form.

The sexual buds are seated in bunches (six or seven in number) at the base of the stomachal peduncle. Male and female groups alternate on the same stem; frequently two or three male or female groups follow upon one another. Older male buds are pedunculate, with a small umbrella and an extraordinarily long reddish flesh-coloured manubrium; younger ones have the umbrella crinkled at the margin. Female buds with a small nectocalyx and globular manubrium, which harbours only three or four extraordinarily large and transparent ova.

Bracts resembling a sailor's hat ("sou'-wester"), with six fluid-canals swelled into knobs, lying over one another like roof-tiles.

In the internodes are seated the heteromorphous tentacles hitherto found only in Stephanophyes *among the whole group of the Calycophoridæ.* In the younger groups one tentacle, in older ones three or four, occur in each internode. In the latter case two or three tentacles are attached to a common peduncle. Each tentacle shows at the base a small, oval, mouthless feeler (as in the Physophoridæ), and is beset with numerous small, very short-stalked, acorn-shaped cnidaria without tactile filaments.

Of all Siphonophora with which I am acquainted *Stephanophyes superba* is the most delicate and at the same time one of the most magnificent. With perfect transparency it attains a length of 1½ foot. The graceful play of its heteromorphous tentacles, the energetic pumping movements of the large calyces and the numerous special nectocalyces, the bright red colouring of the knobbed fluid-vessels with their shining oil-drops, the delicate rosy or emerald-green shimmer of the gastric polyps, the perfect transparency of the large globular ova, and the delicate flesh-tint of the male manubria,

all combine to mark *Stephanophyes* as one of the most splendid objects among pelagic animals.

Unfortunately its extraordinary delicacy presents great difficulties to investigation. Within an hour or two of its capture it begins to melt away, and none of the modes of preservation employed with good results upon other Siphonophora sufficed even to preserve fragments tolerably well.

From January to March it occurred rarely and singly. In old specimens the stem appears to break up into fragments which are occasionally met with floating. *Stephanophyes* passes through a remarkable metamorphosis. The youngest specimens, perfectly transparent and therefore easily escaping even the practised eye, display throughout the characters of the genus *Lilyopsis*; they possess two nectocalyces with the fluid-canal only once dichotomously divided, and are completely destitute of the heteromorphous tentacles on the internodes of the older groups. These tentacles are subsequently formed between the younger groups, and at the same time a more abundant dichotomy of the fluid-canals makes its appearance even in the reserve-nectocalyces.

Thus *Stephanophyes* constitutes a typical bond of union between the Prayidæ and the Polyphyidæ, while, on the other hand, the occurrence of heteromorphous tentacles with small, astomatous, feeler-like polyps points towards the structural conditions of the Physophoridæ.

Family IV. **Polyphyidæ**, Chun.

22. *Hippopodius luteus*, Forsk., Q. & G.

Occurred pretty plentifully from the end of December onwards.

In conclusion, I give a summary of the Canarian Calycophoridæ which produce Eudoxiæ, adding the names of the authors who demonstrated the relation of the so-called monogastric colonies to the polygastric forms.

I. Monophyidæ.

1. Monophyes brevitruncata, *sp. n.*	Diplophysa codonella, *Chun*, 1888.	
2. —— irregularis, *Claus*	—— irregularis, *Claus*, 1874.	
3. Sphæronectes gracilis, *Claus* ..	Ersæa truncata, *Wil.* / Diplophysa inermis, *Gegenb.*	*Claus*, 1874.
4. Doramasia picta, *sp. n.*	Ersæa Bojani, *Esch.* / Eudoxia Bojani, *Huxl.*	*Chun*, 1888.
5. Muggiæa Kochii, *Chun*	Ersæa pyramidalis, *Will.* / Eudoxia Eschscholtzii, *Busch.*	*Chun*, 1882.
6. Halopyramis adamantina, *sp. n.*	Cuboides adamantinum, *Chun*, 1888.	

II. Diphyidæ.

7. Diphyes subtilis, *Chun*	Ersæa elongata, *Will, Chun,* 1886.	
8. —— bipartita, *Costa*	Eudoxia messanensis, *Gegenb.*	*Leuckart,* 1853.
	—— campanula, *Leuck.*	
9. —— serrata, *sp. n.*	—— serrata, *Chun,* 1888.	
10. Diphyopsis campanulifera, *Q. & G.*	—— Lessonii, *Esch., Huxl., Chun,* 1888.	
11. Abyla trigona, *Q. & G.*	Amphirrhoa alata, *Les.*	*Huxley,* 1858.
	Eudoxia trigona, *Gegenb.*	*Gegenbaur,* 1860.
12. Bassia perforata, *Q. & G.*	Sphenoides australis, *Huxl., Chun,* 1888 (surmised by Huxley, 1858).	
13. Abylopsis quincunx, *Chun*	Aglaismoides Eschscholtzii, *Huxl., Chun,* 1888.	
14. ——?	Ceratocymba spectabilis, *Chun.*	

III. Amphicaryonidæ.

15. Amphicaryon acaule, *sp. n.*	Diplodoxia acaulis, *Chun,* 1888.

Order II. PHYSOPHORIDÆ, Esch.

I have repeatedly endeavoured to show that the organism of the Physophoridæ displays manifold relations to that of the Calycophoridæ, which justify the conclusion that the two orders have a common origin. In this respect I would adduce in the first line the demonstration which I have furnished, that in the embryo of both orders a heteromorphous rudimentary nectocalyx is formed, which in the Calycophoridæ is thrown off (perhaps it persists in the Sphæronectidæ), whilst in the Physophoridæ it becomes converted into the pneumatophore. If I now mention further that in the more highly organized Calycophoridæ the nectocalyces occur of the same form in considerable numbers, that, further, the close concentration of the buds into Eudoxia-groups is given up, and that I am able to cite species in which the stem is transformed, as in many Physophoridæ, into a gemmiparous disk, we obtain a whole series of noteworthy relations which seem to indicate that the Physophoridæ took their origin, if not from Stephanophyidæ or Polyphyidæ, certainly from a root common to the two orders. To this may be added finally as an important argument that, by the discovery of the remarkable *Stephanophyes* with its heteromorphous tentacles, a condition is shadowed forth which has hitherto been regarded as an exclusive characteristic of the Physophoridæ.

In accordance with my previous statements I divide the Physophoridæ into the two suborders Haplophysæ and Tracheophysæ.

Suborder I. HAPLOPHYSÆ, Chun.

Physophoridæ with an unchambered pneumatophore which is partly lined by secondary ectoderm functioning as a gas-gland and which is destitute of tracheæ.

Tribe I. *PHYSONECTÆ*, Häck.

Family Agalmidæ, Brandt.

23. *Halistemma pictum*, Metschn.

The elegant Agalmid described by Metschnikoff as *Stephanomia picta*, and afterwards by Claus as *Halistemma tergestinum*, is evidently more widely distributed than has hitherto been supposed. It occurred very frequently from January to April, sometimes in enormously long specimens, which displayed as many as thirty-four nectocalyces. As the Mediterranean form was well known to me from previous investigations, I soon convinced myself that the Canarian species is perfectly identical with it. Although *Halistemma pictum* has been accurately described by Metschnikoff and Fuykas and monographically treated by Claus, certain circumstances which have escaped the above-mentioned naturalists seem to me to be not unimportant in connexion with the conditions of growth of the Physophorid stem.

Law of Growth of the Stem of Halistemma.—As is well known, there is at the base of the column of nectocalyces a zone of gemmation from which the youngest incipient groups of the Siphonophore-stem originate. The groups on the stem therefore increase in size in a distal direction; the groups situated at the end of the stem are at the same time also the oldest. In those Agalmidæ and Forskalidæ which are characterized by separated group-appendages ("dissolute Cormidien" of Häckel) the rule above cited, that the appendages of the stem regularly increase in age (usually also in size) in a distal direction, applies only to the gastric polyps with the tentacles belonging to them. Developmental history shows, particularly as regards *Halistemma pictum*, that, in point of fact, the gastric polyps seated at the end of the stem are the oldest, and that they gradually diminish in age in a proximal direction—that is, towards the nectostyle. It would, however, be a mistake to assume that the same condition prevails with respect to the other appendages of the stem, namely the bracts, palps, palpal filaments, and genital bunches. As most previous observers have already perceived, the latter are met with in

the internodes, *i. e.* in the interval between two polypites, in all stages of development, which originate irregularly dispersed upon the stem. Häckel himself says:—"Finally all order ceases and the whole stem appears beset with hundreds or thousands of different appendages (siphons, palpones, gonophores, bracts, &c.) irregularly grouped; so that it is impossible to discriminate the different correlated constituents of the dissolved cormidia."

I hope, however, to be able to demonstrate that in *Halistemma* (probably also in the other Agalmidæ and the Forskaliæ) a strict rule prevails in the production of the group-appendages. In *Halistemma*, as is well known, the internodial appendages of the stem (*i. e.* those situated between two polypites) are grouped in such a manner that a palp with its tactile filaments, a bract, and a male and a female gonophore concur to form a group. As I may mention in passing, the female gonophores developing near the palp constantly occupy a proximal, the male ones on the contrary a distal position on the stem. In the individual internodes the number of the groups constantly increases towards the end of the stem; thus, while in the proximal internodes we find only two or three groups, there are 12–15 in the distal internodes. The stem therefore grows internodially, and indeed in such a way *that in each individual internode the groups continually decrease in size in a proximal direction.* Hence, if we trace the groups of the stem in a distal direction, we find behind the polypite with its tentacles the buds of the youngest group, and then the other groups gradually increasing in size. The youngest group consists of a bud for the polypite and tentacles, and two buds situated close to it, one of which, as the female primordial bud, originates the female gonophores, and the other, as the male primordial bud, the male gonophores. Somewhat more distally comes the bud for the bract.

To show clearly the further conditions of growth in the internode, I indicate by A, B, C... the polypites with the tentacles belonging to them, and by *a*, *b*, *c*... the bud-groups situated in the internode between two polypites. If, then, A and *a* signify the oldest groups, and B and *b* &c. the successive younger ones, we should obtain for the last internode of the stem the following formula:—

$$B\,.\,h\,.\,g\,.\,f\,.\,e\,.\,d\,.\,c\,.\,b\,.\,a\,A.$$

At this stage, however, only the younger specimens of *Halistemma* remain. The number of groups in the internode, which in our special case we have assumed to be 8 (*a*–*h*),

increases continuously, *but at the same time new bud-groups appear between the oldest approximated groups of the internode.* In our case the oldest approximated groups are represented by a . A; consequently we obtain for a further developed internode the following formula (the newly-formed groups being indicated by $\alpha . \beta \ldots$) :—

$$B . i . h . g . f . e . d . c . b . a \alpha A.$$

The group α is in this case as far developed as the group i formed in regular sequence.

By further growth a secondary internode may be intercalated between a . A, which, in its growth, behaves exactly like the primary internode, in so far as in it also the groups are new-formed in a proximal direction. At the same time, however, new bud-groups again appear, in accordance with the law above mentioned, between the oldest approximated groups of the primary internode, *i. e.* between b and a. We should therefore obtain, for a later stage, the following formula :—

$$B . k . i . h . g . f . e . d . c . b \alpha' a \beta \alpha A.$$

The latest formed bud-groups of the same size are here k, α', and β.

These formulæ may easily be further developed, if we keep in our eye the law that new bud-groups always originate only between the oldest approximated groups of the primary internode, and that the intercalated secondary internodes, as well as the primary ones, form new groups in the proximal direction.

Only in one case I have also observed in the last internode of a very large *Halistemma* the rudiment of an intercalated tertiary internode (between α and A).

I may observe expressly that I have found the law of growth of the stem here developed to hold good without exception in all the specimens examined, and that the formulæ above given are taken from actual examples. When superficially examined, indeed, the last and longest internodes present a puzzling picture, and may give rise to the erroneous notion that the bud-groups have originated irregularly on the stem ; but so soon as the regular plan has been recognized, it is extraordinarily pleasing to trace it through all the internodes of the elongated stem of a quietly suspended *Halistemma*.

I must leave it to Häckel to say how such regularly ordered gemmation on the Physophorid stem is to be reconciled to his theory of the multiplication and dislocation of the Medusan organs on the Siphonophoran stock.

24. *Anthemodes canariensis*, Häck.

I observed a young specimen with six nectocalyces on the 21st of January.

25. *Crystallodes rigidum*, Häck.

The first specimen of *Crystallodes* occurred on January 12. From that date onwards this fine Physophorid appeared so regularly and so abundantly that it decidedly furnishes one of the most characteristic forms of the Canaries. Some specimens that I observed were in part considerably larger than the largest described by Häckel. Thus I not unfrequently captured animals of 75 millim. in length, with 24 complete nectocalyces and 9 individual groups. To complete Häckel's description, I may add that the larger examples presented 4–5 palps on each individual group, and that the male sexual racemes are placed proximally, the female ones distally A further remarkable circumstance is that the perfectly mature male and female gonophores possess a well-developed umbrella, and are able by means of this to move in the water; moreover, in the perfectly mature sexual medusæ the manubrium does not project from the nectosac. Among the rigid bracts only those which are directly inserted upon the appendicular groups are provided with a long vascular canal; the internodial bracts, on the contrary, are destitute of the canal. Sometimes I found old examples of *Crystallodes* in which the stem was of a sulphur-yellow colour.

As regards the post-embryonic development of *Crystallodes*, I would chiefly call attention to the peculiarly formed larval tentacles. Häckel is of opinion that the cnidaria of the primary tentacle are directly developed into the definitive cnidaria furnished with a terminal vesicle and two lateral filaments. I was also the more inclined to this view because the larval cnidaria not only show the lateral filaments and terminal vesicle already observed by Häckel, but also present a mantle-like involucrum, such as is actually characteristic of the definitive cnidaria. At any rate the cnidaria formed on the embryonal tentacles are considerably more complicated than those of any other Physophoridæ, with their naked reniform batteries, which remind us of the Calycophoridæ. Nevertheless they are not developed by spiral convolution of the urticating band into the definitive cnidaria, but they represent larval structures, followed in the later developed groups by heteromorphous structures. Thus I repeatedly observed full-grown old examples of *Crystallodes*, which still presented the well-

preserved larval tentacle upon the oldest gastric polype. Its cnidaria, as already mentioned, are furnished with a terminal vesicle, two terminal lateral filaments, and an involucrum. However, they scarcely attain half the size of the definitive cnidaria, are of a very delicate reddish flesh-colour, and are without the spiral convolution of the urticating band.

Family **Forskalidæ**, Häckel.

26. *Forskalia ophiura*, Leuck.

The common *Forskalia* of the Mediterranean was also extraordinarily abundant at the Canaries from January onwards, occasionally occurring in gigantic examples, the nectostyle of which measured 1 foot.

As its larval tentacles are hitherto unknown I remark that in young specimens I found the single larval tentacle seated upon the oldest gastric polyp, while all the other polyps possessed the definitive tentacles. The cnidaria of the former resemble the larval batteries of *Agalma* and *Halistemma*; at the extremity they are beset with the uncommonly long sensorial setæ, and characterized by two lateral intensely brownish-red tubercles, projecting like ocelli, upon which long vibratile cilia are inserted.

27. *Forskalia contorta*, Leuck.

To *Forskalia contorta* I refer several young specimens, still furnished with larval tentacles, which occurred singly from January onwards. The larval cnidaria resemble those of *F. ophiura*, except that the sensorial setæ are shorter, and the two pigmented tubercles are wanting.

28. *Forskalia cuneata*, sp. n.

Subumbrella of the nectocalyces furnished on each side with 4–6 streaks of intensely bright red pigment. Gastric polyps remarkably large, standing in a very distinctly marked spiral turned to the right. Hepatic streaks reddish brown. Cnidarian knobs bright red. Bracts wedge-shaped, the outer surface truncated at right angles and completely filling up the interspace between the different spiral turns. Vascular canal of the bracts bent at a right angle.

The handsome *Forskalia cuneata* does not become so large as the allied species (it attains a length of 70 millim.), but it is not less remarkable by its vivid pigmentation and its particularly large gastric polyps. From the pigmentation of the subumbrella, which is never wanting, and is observable in no

other species, even the young stages, which are able to swim very briskly, are easily recognizable. In most of them the larval tentacle, seated upon the oldest gastric polyp, was still demonstrable. The larval batteries are very like those of *F. contorta*; they are acorn-shaped, of a faint red colour, and furnished with numerous short sensorial setæ. The subsidiary tentacle is inserted somewhat beneath the top of the battery.

Family **Physophoræ**, Lesson (*Discolabidæ*, Häck.).

29. *Physophora magnifica*, Häckel.

Of the splendid *Physophora* discovered by Häckel at the Canaries a few examples occurred during February.

Family **Anthophysidæ**, Brandt (*Athorybidæ*, Huxley).

30. *Athorybia melo*, Esch., Q. & G.

To this species I refer some young specimens with only two tentacles and gastric polyps, which agree in the brownish pigmentation of the involucrum of the cnidaria (the terminal vesicle and lateral filaments are always present) and in the ridges of the bracts with the description given by Quoy & Gaimard. They occurred in February. To this species probably belong larval forms whose cnidaria on the single tentacle presented an involucrum and two lateral filaments, but no terminal vesicle. Moreover, the point of insertion of the subsidiary tentacle on the battery swells into a brown vesicular dilatation. The five bracts of these larvæ already resemble those of the full-grown *A. melo*; further, 5–6 palps may be recognized.

Tribe II. *PNEUMATOPHORIDÆ*, Chun.

Family **Physalidæ**, Brandt.

31. *Physalia caravella*, Esch.

I noticed the first *Physaliæ* at the end of January; from that date they occurred more and more abundantly, and after the violent storms in February and March were thrown in thousands upon the beach. Upon their minute structure I will report elsewhere.

Suborder II. TRACHEOPHYSÆ, Chun.

Physophoridæ with a chambered pneumatophore lined with chitin, which emits numerous tracheal tufts surrounding the polyps. At the periphery of the pneumatophore a mantle-

like limb is developed. Stem flattened, disciform. Gonophores set free as Medusæ (*Chrysomitra*).

Family **Disconanthæ**, Häck. (*Chondrophoræ*, Cham. & Eysenh.), *Velellidæ*, Esch.

The representatives of the subfamilies of the Disconanthæ, namely the Velellidæ and Porpitidæ, appear at the Canaries, as I could ascertain from the statements of the fishermen, only in the summer from July to September. During the whole seven months of my stay I observed neither young forms (Ratariæ) nor developed *Velellæ* and *Porpitæ*. Even after the violent storms of spring I could not detect *Velella* and *Porpita* either near Orotava or in the passage to Palma and Gran Canaria. During the winter and early summer they appear to be wanting in the eastern part of the Atlantic Ocean.

XXIV.—*Descriptions of new Species of African* Nymphalidæ. By W. F. Kirby, F.E.S.

The types of the following species are all in the collection of Mr. Henley Grose Smith, with the exception of that of *Euphœdra* (?) *Crowleyi*, a very curious insect, which is the property of Mr. Philip Crowley.

Euphœdra aureola.

Exp. $2\frac{3}{4}$ in.

Male.—Anterior wings velvety black, with a broad bluish line above the subcostal nervure, a moderately broad, oblique, orange-yellow band beyond the cell running from the subcostal nervure to the second median nervule, and a large patch of green scaling, coppery in the middle, on the inner margin, extending to three quarters of its length. The apical white patch is unusually narrow. Posterior wings bluish, with an indistinct coppery shade towards the costa beyond the cell; hind margin velvety black, with an indistinct broken submarginal line; inner margin dull brown or black, fringed with very long hairs. All the fringes black, with a long white spot at the apex of the anterior wings, and with four small white spots on the incisions on the anterior