THE

VOYAGE OF H.M.S. CHALLENGER.

ZOOLOGY.

REPORT on the PTEROPODA collected by H.M.S. Challenger during the Years 1873–76. By PAUL PELSENEER, D.Sc. (Brussels).

PART I.—The GYMNOSOMATA.

INTRODUCTION.

1. HISTORY OF THE GROUP.

IT is now more than two hundred years since a Gymnosomatous Pteropod was first described and figured;[1] but it was only at the beginning of this century that the organisation of these animals was investigated, and the group Pteropoda established.[2]

As to the subdivision Gymnosomata, its establishment is of a still later date. Péron and Lesueur, who considered the Pteropoda to form a much larger group than they really do,[3] divided these animals into two subgroups:—(1) those without shells; (2) those with shells[4]—and it has been found that this division, established on the very empirical character of the presence or the absence of a shell, is quite justified by the anatomical differences, as will be seen further on.

Nevertheless, the majority of zoologists continued for a long time to divide the Pteropoda into non-natural groups. Thus, Cuvier[5] distinguished those forms with

[1] *Clione limacina*, in 1676, by Martens, Spitzbergische oder grönlandische Reisebeschreibung, p. 169, pl. P. 6g. *f*.

[2] By Cuvier, in 1804 (Mémoire sur l'Hyale et le Pneumoderme; *Ann. Mus. Hist. Nat. Paris*, t. iv. p. 232), and not in 1788, as noticed by Brann (Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 884).

[3] They embraced, in fact, Opisthobranchia (*Phyllirhoë*, *Glaucus*), Heteropoda (*Carinaria*, *Firola*), and even Ctenophora (*Callianira*).

[4] Histoire de la famille des Mollusques Ptéropodes; *Ann. Mus. Hist. Nat. Paris*, t. xv. p. 57, 1810.

[5] Le Règne animal, ed. 1, 1817.

distinct heads from those without distinct heads, and, badly applying this character, placed some without shells and some with shells in the same subdivision. Oken[1] did the same, placing *Pneumonoderma* and *Clio* in one class, and *Clione* and *Cavolinia* in another class.

It was not until 1824 that de Blainville, relying on very judicious anatomical considerations, arrived at the same systematic result as Péron and Lesueur, and divided the Pteropoda (which he named Aporobranchia) into Gymnosomata and Thecosomata.[2] He rejected the strange forms that Péron and Lesueur had introduced into the Pteropod group, but he left *Phyllirhoe*,[3] which formed in his classification a third group, Psilosomata, of the same value as the two others.

Other groupings based on characters drawn from one organ alone, led to very bad results. Thus, Gray[4] divided the Pteropoda into Dactylobranchia and Pterobranchia, the genus *Cavolinia* alone forming the first division and all the other genera being united in the second.

Rang,[5] who followed the Cuvierian subdivisions, through insufficient study of characters placed some Pteropoda without shells and some with shells in the family with a distinct head, and tried to do the same in the case of the group without a distinct head.[6] This was, however, rather exaggerating the love of symmetry, although not so much as Oken,[7] who desired that each order should contain four families, each family four genera, &c.

Latreille,[8] on the other hand, divided the Pteropoda according to the size of their fins, into "Macroptérygiens" and "Microptérygiens." *Pneumonoderma* alone formed the second group, while all the other forms were included in the first.

Cuvier[9] and his school did not adopt the classification of de Blainville, but followed the divisions established in the first edition of Le Règne animal.

Since then, the non-natural arrangements have been gradually abandoned; and the division of the Pteropoda into two distinct groups, Thecosomata and Gymnosomata, is now generally adopted. There is, however, a slight misunderstanding amongst some zoologists as to the relative extent of these two subdivisions; but we shall see further on that this disagreement is really without foundation, and that the separation of the two groups is very clear.

When Cuvier established his division of Pteropoda, only two species (forming two

[1] Lehrbuch der Zoologie, Bd. I., 1815.
[2] *Dict. d. Sci. Nat.*, t. xxxii. p. 271.
[3] This animal remained here for a long time, until it was put in its right place, among the Nudibranchia.
[4] *London Medical Repository*, p. 236, 1821.
[5] Manuel de l'histoire naturelle des Mollusques, 1820.
[6] Description d'un genre nouveau de la classe des Ptéropodes, *Ann. d. Sci. Nat.*, ser. 1, t. v. p. 284, 1825.
[7] *Loc. cit.*
[8] Les familles naturelles du Règne animal, 1825.
[9] Le Règne animal, ed. 2.

genera) of Gymnosomata were known. But since then, the number of forms, both generic and specific, has increased in a very remarkable manner, chiefly owing to the results of several scientific expeditions.

During the first half of this century, it was, above all, French naturalists who, as a result of their travels, described new Gymnosomatous Pteropoda. It is sufficient to name Quoy and Gaimard, Rang, d'Orbigny, and Souleyet.

But, more recently, explorations of the great oceanic basins have been carried on in a more scientific and methodical manner and with much more perfect means of investigation. One may say that this new era was inaugurated by the Challenger Expedition, and several nations have already followed the example of England in this department. But, notwithstanding the great progress that these recent scientific expeditions have been the means of effecting in zoology, the Gymnosomatous Pteropoda have remained but little studied and a comparatively little known group.

The Gymnosomatous Pteropoda include but few species, they are difficult to gather, and very few naturalists have busied themselves with the task. The published descriptions of a great number of these species are very often incomplete and based on insufficient characters; and the figures which represent them are unfortunately nearly always imperfect.[1] The types from which these descriptions have been elaborated have now been lost, so that it is excessively difficult to distinguish between the series of forms hitherto named.

In these circumstances, it appeared useful to attempt to bring a little order and light into this chaos. Accordingly, while engaged with the description of the Gymnosomatous Pteropoda collected by H.M.S. Challenger (which description will form the essential part of this Report), I have made, at the request of Mr. John Murray, a critical examination of all the known genera and species of this interesting group of Mollusca.

Besides the animals collected by the Challenger Expedition, I have had the advantage of being able to study specimens from several museums and scientific expeditions, viz.:—

1. The Pteropoda belonging to the Museum of Brussels.

2. The valuable collection of Gymnosomatous Pteropoda in the Museum of Hamburg.

3. The Gymnosomatous Pteropoda of the U.S. National Museum at Washington (a collection of great interest).

4. The Pteropoda of the "Triton" expedition.

5. The Pteropoda collected by the Italian ship "Vettor Pisani," during its scientific voyage round the world (1882–85).

6. The Pteropoda collected by Mr. John Rattray, F.R.S.E., during the cruise of the S.S. "Buccaneer," off the west coast of tropical Africa (1885–86).

7. The Pteropoda for sale at the Zoological Station at Naples.

I take this opportunity to thank especially Professor Spencer F. Baird, and Mr. Wm. H. Dall, who obligingly sent to me the Gymnosomatous Pteropoda in the U.S.

[1] The zoologists who deserve the most of these reproaches are indisputably Quoy and Gaimard.

National Museum; Professor Pagenstecher and Dr. George Pfeffer, by whose kindness I was enabled to study those in the Hamburg Museum; and the Zoological Commission of the "Vettor Pisani," who sent to me for examination the Pteropods collected by this ship.

I have also to thank, for information and other assistance, Dr. John D. M'Donald, R.N., Dr. J. E. V. Boas of Copenhagen,[1] Dr. W. Giesbrecht of Naples, and Professor Ed. Perrier of Paris. In short, my best thanks are due to all those who, in any way, have assisted me.

I have described with much care all the species that I have been able to study, and I have figured them whenever there was not a sufficiently exact representation of them in existence.

But in spite of all the material employed for the elaboration of this Report, it is impossible to give here a complete monograph of all the living Gymnosomata. For, besides the forms which are now well known, there are many others which are insufficiently described by the naturalists who made them known, of which the types have been lost, and which have not again been found since their discovery. Thus, we have only a few indications of the existence of some species still nearly unknown. I have drawn attention to these forms, hoping that it may facilitate their recognition by future explorers.

After the description of the different species I shall examine:—

1. Their geographical distribution.
2. Their mutual phylogenetic relations.

2. The Gymnosomata and their Distinction from the Thecosomata.

The adult Gymnosomata are chiefly characterised as follows:—By the absence of a mantle-skirt, pallial cavity and shell; by the presence of a well-developed head, bearing two pairs of tentacles, of which the two posterior bear rudimentary eyes; by two fins of which the anterior edges are not joined together backwards, above the mouth; and by the anus being situated at the right side of the body.

Every Pteropod possessing these characters belongs to the Gymnosomatous group, and every Pteropod which does not possesses these characters is a Thecosomatous form, so clearly and well-marked is the separation between these two divisions. As I before said, the anatomical characters of the Pteropoda entirely agree with their division into Gymnosomata and Thecosomata. If these names are not strictly exact (because

[1] The text and the plates of this Report were already far advanced when Boas' work appeared (Spolia atlantica. Bidrag til Pteropodernes Morphologi og Systematik, *K. dansk. Vidensk. Selsk. Skrift.*, 1886). As Boas and I are agreed on many points relative to the Gymnosomata, it must be said that our results have been quite independently obtained. But I have taken advantage of Boas' special discoveries to render this monograph more complete.

the former possess a shell at the beginning of their larval life), the groups that they represent are quite natural ones.

The following table shows the principal differences between the adult Gymnosomata and Thecosomata (the two groups also present considerable differences in their embryonic development):—

Gymnosomata.	Thecosomata.
No mantle skirt nor shell.	A mantle skirt and a shell.
No pallial cavity.	A pallial cavity.
A well-developed head.	No distinct head.
Two pairs of tentacles.[1]	Only one pair of tentacles.
Fins not joining in front, above the mouth.	Fins joined at the anterior edge, above the mouth.
Stomach without horny plates.	Stomach provided with horny plates.
Anus on the right side.	Anus on the left side.
Cerebral ganglia connected together above the œsophagus.	Cerebral ganglia separated by a long commissure and situated laterally to the œsophagus.

Among the other differences which exist between the two groups, the following may be noticed.

1. The foot in the Gymnosomatous Pteropods is quite distinct from the fins; it is formed of a posterior lobe and two antero-lateral ones, joined in front, in the form of two longitudinal lips. Between these two lobes a small tubercle is generally found behind, formed by folds of the skin. The foot and fins in the Thecosomatous Pteropods form a single and continuous mass.

2. The penis of the Gymnosomata is latero-ventral and situated on the right side of the foot. The penis of the Thecosomata is anterior and cephalo-dorsal.

3. In the Gymnosomata there is an evaginable proboscis (the anterior protrusible portion of the digestive tract) of the acrembolic type,[2] generally bearing buccal appendages, which may be completely protruded. In the Thecosomata there is no proboscis at all.

4. Besides the jaw and the radula, the buccal cavity of the Gymnosomata contains hook-sacs,[3] a pair of evaginable sacs opening at each side of the radula. No Thecosomatous Pteropod is provided with such hook-sacs.

5. The jaw of the Gymnosomata, composed of a great number of horny plates or spines, forms only one piece, in which two halves are, indeed, visible, but these

[1] Paul Pelseneer, The Cephalic Appendages of the Gymnosomatous Pteropoda, *Quart. Journ. Micr. Sci.*, 1885, p. 505.

[2] Ray-Lankester, Mollusca, Encyclopædia Britannica, ed. 9, vol. xvi. p. 653.

[3] Cæcum buccale, van Beneden; spinose tentacular organs, Huxley; Hakensäcken, Gegenbaur; cheek pouches, buccal pouches, MacDonald; cylindres rétractiles, Fischer; hook-bearing processes of the mouth, Ray Lankester.

are always united in the median line. The jaw of the Thecosomata is always formed of two quite distinct pieces.

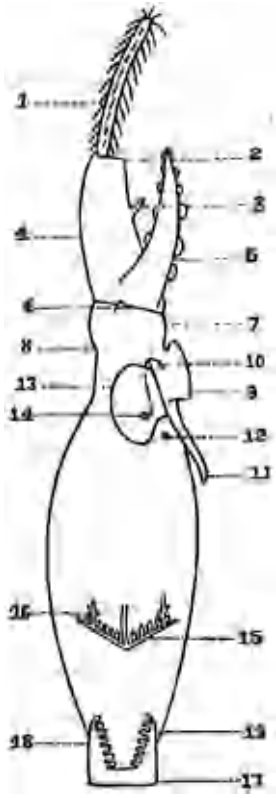

FIG. 1.—Diagram of a *Pneumonoderma*, seen from the right side, showing the different external parts of a Gymnosomatous Pteropod. 1, right hook-sac; 2, position of the jaw; 3, ventral papilla of the proboscis; 4, proboscis; 5, right acetabuliferous buccal appendage; 6, right buccal tentacle; 7, head; 8, position of the right nuchal tentacle; 9, right anterior lobe of the foot; 10, orifice of the penis; 11, posterior lobe of the foot; 12, anus; 13, right fin; 14, genital orifice and spermatic groove, hidden beneath the fin; 15, lateral gill; 16, lateral muscular crest of the lateral gill; 17, posterior gill (quadrangular crest); 18, radiating crest of the posterior gill; 18, fringes of the radiating branchial crest.

6. The radula of the Gymnosomata is provided with long, lateral teeth, with large basal pieces; the number of the teeth in a transverse row generally increases with age, until the adult state is reached, so that a knowledge of the radula of young specimens is of little use for specific identification. The radula of the Thecosomata has but one lateral tooth on each side, with a small basal piece.

In spite of the well-marked differences between the two groups, there are, however, some forms about the systematic position of which all zoologists do not agree, some placing them among the Gymnosomata, and others among the Thecosomata. *Halopsyche* (*Eurybia*), for instance, has been placed by many among the Thecosomata, because its organisation was not well known; but we shall see further on that it is indisputably a Gymnosomatous Pteropod. As for the Cymbuliidæ, even Fol[1] questions whether they have not more affinities with the Gymnosomatous than with the Thecosomatous Pteropoda. But they cannot be placed among the former, because they possess all the essential characters of the Thecosomata as given in the foregoing table, and do not exhibit any of those of the Gymnosomata. There is, therefore, nothing to justify Tiberi's opinion that *Tiedemannia* (*Gleba*), should be placed among the latter.[2]

3. The Habits of the Gymnosomata.

The Gymnosomatous Pteropoda do not form a numerous group of species, but they are found in all the seas of the world, and sometimes in great abundance. They are small animals, not more than an inch and a half long, and are carnivorous, often feeding on their Thecosomatous allies.

Naturalists are not agreed as to the position assumed by the Gymnosomata when

[1] Sur le développement des Ptéropodes, *Archives d. Zool. expér.*, ser. 1, t. iv. p. 173.
[2] Mollusques marins d'Italie, *Ann. Soc. Malacol. Belg.*, t. xiii. p. 77.

swimming. On this subject Soulevet [1] contradicts the statements of Péron,[2] Rang,[3] and d'Orbigny.[4] It appears, however, that they generally swim in a nearly vertical position with the head uppermost, or else slightly sloping, so that the ventral (pedal) side is turned upwards. They swim by moving the ends of the fins successively backwards and forwards.

The Gymnosomata, like the other Pteropoda, are nocturnal in their habits, ascending to the surface during the night and sinking to a lower level in the daytime, being driven down by the brightness of the light; and thus one can scarcely gather Pteropoda on the surface during the day. Mr Murray, however, informs me that he has frequently taken Gymnosomata at the surface in the Arctic seas during the daytime with a hand net.

It is impossible to distinguish, as d'Orbigny supposed,[5] twilight from nocturnal species. That writer thought that each species inhabits a definite zone of depth, since the different species come to the surface at different times, but it has been experimentally shown by Alexander Agassiz,[6] that no species of the pelagic fauna descends to more than 100 fathoms. It is then in this bathymetrical zone that the Pteropoda perform their daily oscillations, accompanied by some other pelagic animals, several of which serve as their prey.

The anatomical structure of the Gymnosomata will be described in the anatomical part of this Report.

4. The Gymnosomata of the Challenger Expedition.

The number of Gymnosomatous Pteropoda collected by the Challenger Expedition is comparatively not very extensive. This can be readily explained by the fact that these animals are not very numerous in species, and since they are pelagic and nocturnal in habit, they can only be captured by the tow-net during the night, when trawlings were not frequently made, or by sinking the nets to slight depths during the daytime, and also because many common surface forms were not always preserved.[7]

The number of the Challenger Gymnosomata is nevertheless greater than that of any other scientific expedition. The thirteen[8] stations at which they were captured yielded one new genus and specimens of all the other genera, except *Clione*, furnish-

[1] Voyage de la Bonite, Zoologie, t. ii. p. 270.

[2] Histoire de la famille des Mollusques Ptéropodes, *Ann. Mus. Hist. Nat. Paris*, t. xv. p. 69.

[3] Description d'un genre nouveau de la classe des Ptéropodes, *Ann. d. Sci. Nat.*, ser. 1, t. v. pp. 286, 287.

[4] Voyage dans l'Amérique méridionale, t. v. p. 198.

[5] *Loc. cit.*, p. 67.

[6] *Bull. Mus. Comp. Zool.*, vol. vi. p. 183.

[7] Narr. Chall. Exp., vol. i. p. 270, note by Dr John Murray.

[8] I do not include in this number the station (not specified) between Cape Verde and Bahia, at which the *Pneumonoderma* (*vitiaceum*, I think), recorded in the Narrative of the Cruise, vol. i. p. 218, was taken. This station is unknown to me, because I did not find, in the collection sent to me, specimens of *Pneumonoderma* from any station between these two localities.

ing altogether eleven different species (comprising nearly half of the known species), of which four are new and several others imperfectly known, or not yet figured. In one case a single station yielded three species.

Chierchia was therefore wrong, when he cited the Pteropoda as an example to show that several special collections made by the Italian ship "Vettor Pisani," are more complete than the corresponding series of the Challenger Expedition,[1] because during the cruise of the "Vettor Pisani" Gymnosomata were captured at only three stations, and these belong to only two genera and four species.

The Challenger specimens are divided as follows :—

Genera.	Species previously known.	New Species.
Dexiobranchæa, ...	2[2]	1
Spongiobranchæa, ...	1	—
Pneumoderma, ...	3	1
Clionopsis, ...	—	1
Notobranchæa, ...	—	1
Halopsyche, ...	1	—
6	7	4

In the following descriptive part of this Report, those species of Gymnosomata procured by the Challenger Expedition are marked with an asterisk.

[1] Collezioni per studi di scienze naturali fatte nel viaggio intorno al mondo della R. Corvetta Vettor Pisani, 1882–85, p. 116.

[2] The larvæ of a Gymnosomatous Pteropod, described by H. N. Moseley (On Stylochus pelagicus, &c., *Quart. Journ. Micr. Sci*, p. 32, pl. iii. fig. 14, 1877), belong to this genus, and very probably to a species previously known.

DESCRIPTION OF GENERA AND SPECIES.

PTEROPODA, Cuvier.

GYMNOSOMATA, de Blainville.

Deutocephala, Wagner, 1885.[1]
Pterota, Boas, 1886.[2]

THE GENERA AND FAMILIES OF GYMNOSOMATA.

Many genera of Gymnosomatous Pteropods have been described, but several of them cannot be retained.

I. Because they are synonyms :—

1. *Ægle*, Oken,[3] = *Pneumonoderma*, Cuvier.
2. *Cirrifer*, Pfeffer,[4] = *Pneumonoderma*, Cuvier.
3. *Clindita*, Quoy and Gaimard,[5] = *Clione*, Pallas.
4. *Eurybia*, Rang,[6] non Hübner = *Halopsyche*, Bronn.
5. *Pneumodermopsis*, Bronn,[7] = *Dexiobranchæa*, Boas.

II. Because they only represent the larval state of genera of which the adult is already known :—

1. *Trichocyclus*, Eschscholtz,[8] in which the larvæ of different genera have been placed.[9]
2. *Trizonius*, Busch,[10] = larva of *Pneumonoderma*.

[1] Die Wirbellosen des weissen Meeres, Bd. i. p. 119.
[2] Spolia Atlantica, p. 179.
[3] Lehrbuch der Zoologie, Bd. i. p. 328.
[4] Uebersicht der auf S. M. Schiff "Gazelle" und von Dr. Jagor gesammelt Pteropoden, *Monatsber. d. k. preuss. Akad. d. Wiss. Berlin*, p. 249, 1878.
[5] Description de cinq genres de Mollusques, *Ann. d. Sci. Nat.*, ser. 1, t. vi. p. 74, 1826.
[6] Description de deux genres nouveaux appartenant à la classe des Ptéropodes, *Ann. d. Sci. Nat.*, ser. 1, t. xii. p. 320, 1827.
[7] Die Klassen und Ordnungen des Thierreichs, Bd. iii. pp. 584, 645.
[8] Bericht uber die zoologische Ausbeute während der Reise von Cronstadt bis St. Peter und Paul, *Oken, Isis*, 1825. p. 735.
[9] *Trichocyclus dumerilii*, Esch. = larva of *Spongiobranchæa australis*, d'Orb. *Trichocyclus mediterranea*, Costa = larva of *Clionopsis krohnii*, Troschel.
[10] Beobachtungen über Anatomie und Entwicklung einiger wirbellosen Seethiere, p. 112.

III. Because they have been insufficiently characterised, never again gathered, and the type specimens have not been preserved; they are therefore too doubtful to be introduced into systematic nomenclature:—

1. *Pelagia*, Quoy and Gaimard.[1]
2. *Cymodocea*, d'Orbigny.[2]
3. *Homoderma*, van Beneden.[3]

Among the genera hitherto described I only admit six and the new genus *Notobranchæa* (these six genera are also those that were accepted by Boas,[4] before the description of *Notobranchæa*). They are the following:—

1. *Dexiobranchæa*, Boas.
2. *Spongiobranchæa*, d'Orbigny.
3. *Pneumonoderma*, Cuvier.
4. *Clionopsis*, Troschel.
5. *Clione*, Pallas.
6. *Halopsyche*, Bronn.

These six genera, and the new one *Notobranchæa*, are well known, well characterised and distinct. The following table gives their principal distinctive characters:—

Key to the Genera.

I. A specialised branchial apparatus.
  1. A lateral gill.
    A. No posterior gill, ... *Dexiobranchæa.*
    B. A posterior gill.
      a. A circular posterior gill, ... *Spongiobranchæa.*
      b. A tetraradiate posterior gill, ... *Pneumonoderma.*
  2. No lateral gill.
    A. No buccal appendages . . . . . *Clionopsis.*
    B. Buccal appendages, ... *Notobranchæa.*

II. No specialised branchial apparatus.
  1. Body lengthened, posteriorly pointed, ... *Clione.*
  2. Body ovoid, posteriorly rounded, ... *Halopsyche.*

How must we subdivide these seven genera of the Gymnosomatous group?

Fischer, who considers the Pteropoda to be a class of the same value as the Gastropoda (although the organisation of the Pteropoda shows, in the clearest manner, that they only form a subdivision of the Euthyneurous Gastropoda), distinguishes among the Gymnosomata two suborders:[5]—Scleroderma, containing only the genus *Halopsyche*, and Malacoderma, embracing all the other genera. But the character on which this subdivision is based is very insufficient, because the teguments of *Halopsyche* are not

[1] Voyage de découvertes de l'Astrolabe, Zoologie, t. ii. p. 192 = *Pterogelagia*, Bronn.
[2] Voyage dans l'Amérique méridionale, t. v. p. 133 = *Pterocymodocea*, Bronn.
[3] Exercices zootomiques, p. 54, pl. iii. figs. 4, 5.
[4] Vorlaufige Mittheilung über einige Gymnosomen Pteropoden, *Zool. Anzeiger*, p. 690, 1885.
[5] Manuel de Conchyliologie, p. 422.

more tough than those of some *Pneumonoderma*. Moreover, the Gymnosomata form a group of too low a status, and contain forms differing too little from one another to enable one to establish within it more important divisions than families.

Three of the seven genera I have admitted—*Pneumonoderma*, *Spongiobranchæa*, and *Dexiobranchæa*—show a very close resemblance to one another, and clearly differ from the other genera by the presence of acetabuliferous buccal appendages and of a right lateral gill; they constitute the family Pneumonodermatidæ.

Clione and *Halopsyche* are quite separated from the other genera by the complete want of branchial apparatus; they differ as much by the form of the body as by that of the fins, by the buccal appendages, &c., and respectively represent the families of the Clionidæ and Halopsychidæ.

Clionopsis, till now ranked near *Clione*, because its organisation was imperfectly known, cannot remain among the Clionidæ. In several characters (the presence of a tetraradiate posterior gill and of a dorsal spot) this genus resembles some Pneumonodermatidæ more than *Clione*; but other more important characters (the absence of a lateral gill and of acetabuliferous buccal appendages, the presence of a retractile proboscis of extraordinary length) exclude it from so natural and so well-characterised a group, which includes *Pneumonoderma*, *Spongiobranchæa*, and *Dexiobranchæa*. Therefore *Clionopsis* represents a special family—Clionopsidæ.

As to the new genus *Notobranchæa*, it must be excluded from all the above cited families: from the Clionidæ and Halopsychidæ, by the presence of a gill; from the Pneumonodermatidæ, by the want of the lateral gill and suckers; and from the Clionopsidæ, by the presence of buccal appendages and by the form of the gill and the foot.

A new family must therefore be established, Notobranchæidæ, for this new genus.

Hence, the Gymnosomata are divisible into five families, of which the first (Pneumonodermatidæ) includes three genera.

Family I. Pneumonodermatidæ.

1840. *Pneumodermida*, Gray (*pars*), Synopsis of the Contents of the British Museum, p. 86.
1842. *Pneumodermidæ*, d'Orbigny, Paléontologie française, terrains crétacés, t. ii. p. 4.
1846. *Pneumodermoidæ*, Agassiz, Nomenclator zoologicus, Index, p. 299.
1852. *Clios*, Souleyet (*pars*), Histoire naturelle des Mollusques Ptéropodes, p. 74.
1855. *Clionidea*, Gegenbaur (*pars*), Untersuchungen über Pteropoden und Heteropoden, p. 212.
1858. *Pneumodermonidæ*, H. and A. Adams (*pars*), The Genera of recent Mollusca, vol. i. p. 62.
1862. *Pneumodermidæ*, Bronn, Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 645.
1871. *Pneumodermatidæ*, Dall, Description of Sixty New Forms of Mollusca from the West Coast of North America, Amer. Journ. of Conchology, vol. vi. p. 139.
1881. *Clidæ*, Fischer (*pars*), Manuel de Conchyliologie, p. 243.

Characters.—Suckers on the ventral side of the protrusible anterior portion of the buccal cavity. A lateral gill on the right side. A jaw. Pigmented skin.

Such are the distinctive characters of this family, which only Bronn understood in the sense in which we now treat it, including the three genera *Dexiobranchæa*, *Spongiobranchæa* and *Pneumonoderma*.

Description.—The *body* of the Pneumonodermatidæ is more or less elongated, and rounded at its posterior extremity. The length of the cephalic region and the form of the lateral gill vary in the different genera.

The *foot* shows a posterior, generally long lobe, and two rather narrow antero-lateral lobes, united throughout their entire length to the cephalic region, between which posteriorly is a small tubercle.

The *fins*, tapering at their free end, are nearly triangular in shape, with bent margins; they are bluntly contracted at the posterior side of the base.

The *colour* in the individuals of this family is nearly uniform, being violet-brown. A dorsal glandular spot must be noticed as another character common to the three genera of Pneumonodermatidæ; this also exists in *Clionopsis*,[1] but it is here smaller and longer (see *Spongiobranchæa*, Pl. I. fig. 7).

The *suckers* of the buccal cavity are generally inserted on appendages; three in *Dexiobranchæa* (two symmetrical and lateral and one median, anterior during the evagination of the front part of the digestive tract), and two (lateral and symmetrical) in *Spongiobranchæa* and *Pneumonoderma*.

There is on the ventral wall of the buccal cavity in the two last genera, in front of the lateral appendages (during the evagination of the proboscis) a small median papilla. I found this papilla in *Spongiobranchæa australis* (fig. 2, p. 19), *Pneumonoderma violaceum*, *Pneumonoderma pacificum* (Pl. II. fig. 5), and *Pneumononoderma souleyeti* (Pl. II. fig. 6). Boas, who previously noticed this in some specimens of *Pneumonoderma*, regarded it as the rudiment of the median acetabuliferous appendage of *Dexiobranchæa*.[2]

The acetabuliferous appendages, which are inserted on the ventral wall of the buccal cavity, are flattened parallel to the body-wall, and show many different forms, being often short, broad and triangular, or else long, narrow, and with nearly parallel margins.

In *Spongiobranchæa* and *Pneumonoderma* the lateral appendages, which are typically developed, fold backwards when retracted, so that their base is then their most anterior part. They bear suckers only on the side which is turned against the wall of the buccal cavity during retraction. During the extension of the appendages, the two acetabuliferous surfaces are turned towards one another (since the appendages are inserted on the ventro-lateral sides of the cylinder formed by the exserted part of the digestive tract), in order to be applied together, on opposite sides of any prey which may pass in front of the mouth.

[1] Paul Pelseneer, Recherches sur le système nerveux des Ptéropodes, *Archives de Biologie*, t. vii. p. 100.

[2] Spolia atlantica, p. 151, note 1.

The body of every Gymnosomatous larva possesses three ciliated rings, of which the anterior is not continuous (see Pl. I. fig. 5) and is the first to disappear. Formerly, before the relation of these larvæ to the adult was known, they were considered and described as distinct genera.

These larvæ show many resemblances to one another, and when they are merely described without the complete development being traced out, or when the description omits the characters of the foot, buccal appendages and radula, which alone allow of their certain classification, it is very difficult to assert whether they belong to the Pneumonodermatidæ or not, or at all events to say to which genus of this family they do belong. It is not possible to determine specific distinctions from the radula alone, because the number of lateral teeth increases with age, until adult life.

We are therefore of course unable to assert with absolute certainty whether the *Trichocycli* are larvæ of the Pneumonodermatidæ or of another family. It is, however, probable that *Trichocyclus dumerili*, Esch.,[1] is the larva of *Spongiobranchæa australis*, on account of the length of its tentacles, which are much longer than those of *Pneumonoderma*. I shall show further on that *Trichocyclus mediterraneus*, Costa,[2] is the larva of *Clionopsis krohni*.

Trizonius cæcus, Busch.,[3] of Malaga, appears to belong to the present family, and to the genus *Pneumonoderma*; but it is very difficult to prove whether it really belongs to this genus, because the published description of it, as well as those of the two *Trichocycli*, are insufficient.

The Mediterranean Gymnosomata, moreover, are not yet all known. Larvæ formerly described by Gegenbaur,[4] do not appear to belong to any known genus inhabiting that sea, and ought to be placed in a new genus, *Thliptodon*, Boas,[5] the adults of which are still unknown. The larva that Professor H. N. Moseley discovered,[6] belongs to the genus *Dexiobranchæa*, as will be seen later on.

[1] *Oken, Isis*, p. 735, pl. v. fig. 4, 1825.

[2] Osservazioni su taluni Pteropodi del Mediterraneo, *Annuario del Museo zoologico della R. Universita di Napoli*, Anno v., p. 46, pl. i. fig. 3, 1865.

[3] Beobachtungen über Anatomie und Entwicklung, &c., p. 112, pl. viii. fig. 10.

[4] Untersuchungen über Pteropoden und Heteropoden, pp. 95–97, pl. v. figs. 14, 15.

[5] Spolia atlantica, p. 174.

[6] On Stylochus pelagicus, &c., *Quart. Journ. Micr. Sci.*, p. 32, pl. iii. fig. 14, 1877.

Dexiobranchæa,[1] Boas.

1855. *Pneumodermon* (*pars*), Gegenbaur, Untersuchungen über Pteropoden und Heteropoden, p. 74.
1862. *Pneumodermopsis*, Bronn, Die Klassen und Ordnungen des Thierreichs, Bd. iii. pp. 584, 648.
1885. *Dexiobranchæa*, Boas, Vorläufige Mittheilung über einige Gymnosomen Pteropoden, Zool. Anzeiger, No. 210, p. 688.

Body rather long, pointed posteriorly. Visceral mass not extending to the posterior end of the body.

Head moderately lengthened; anterior (labial or oral) tentacles strong.

Foot; posterior lobe pointed at its free extremity.

Lateral Gill; a simple, more or less long appendage, of a triangular shape, without longitudinal crests or fringes.

Proboscis moderately long. The radula in the adult has always a median tooth. The hook-sacs are but little developed, and consist of small deep depressions which contain short hooks.

Buccal Appendages.—There are morphologically three acetabuliferous appendages; one median, which becomes anterior during the evagination of the proboscis, and always bears five suckers, and two lateral appendages. The two latter, or the median appendage alone, or all three appendages, may be atrophied, and their suckers are then directly inserted on the ventral wall of the buccal cavity, forming groups corresponding to the atrophied appendages. The five suckers of the median appendage, or of the corresponding group, are always disposed in the following manner—a median distal sucker on the free extremity of the appendage, and two lateral ones on each side. The number of the suckers of the lateral appendage varies according to the species.

The skin is pigmented, and the two posterior ciliated rings generally remain a very long time.

Boas chiefly contributed to make this genus[2] well known; he was the first to describe with precision the acetabuliferous appendages, and of five species now known he discovered three. I think the name *Dexiobranchæa*, that he gave to this group, ought to be preserved, although Bronn had previously formed the genus *Pneumodermopsis* for the same type from one of its principal characters (viz., the absence of a posterior gill), because the latter genus was founded on the insufficient description, without a figure, which Gegenbaur gave of *Pneumodermon ciliatum*. But Boas was the first to make known the true characters of this genus, and he has figured specimens under the name of *Dexiobranchæa*, and it is therefore desirable to preserve this last name, rather than that of *Pneumodermopsis*, which accords with no good characters nor figures.

As I have said, this genus includes five species, that may be distinguished as follows:—

[1] From Δεξιός, on the right side, and Βραγχια, gill.

[2] Von Ihering regarded it as a larva (Vergleichende Anatomie des Nervensystems und Phylogenie der Mollusken p. 246).

Key to the Species.

I. The two distal lateral suckers of the median appendage larger than the two proximal ones.
  1. The lateral acetabuliferous appendages still distinct, . . *Dexiobranchæa ciliata.*
  2. The lateral acetabuliferous appendages atrophied, . . . *Dexiobranchæa minuta.*

II. The four lateral suckers of the median appendage of the same size.
  1. The median appendage atrophied, ... *Dexiobranchæa simplex.*
  2. The median appendage well developed.
    A. The suckers corresponding to the lateral appendages disposed in one row, ... *Dexiobranchæa pauciloma.*
    B. The suckers corresponding to the lateral appendages disposed in two rows, ... *Dexiobranchæa polycentyta.*

*1. *Dexiobranchæa ciliata* (Gegenbaur) (Pl. I. fig. 1).

1839. (?) *Pneumodermon mediterraneum*, von Beneden, Exercices zootomiques, pl. iii. fig. 3.
1855. *Pneumodermon ciliatum*, Gegenbaur, Untersuchungen über Pteropoden und Heteropoden, p. 74.
1862. *Pneumodermopsis ciliata*, Brown, Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 619.
1886. *Dexiobranchæa ciliata*, Boas, Spolia atlantica, K. dansk. Vidensk. Selsk. Skriv., 6 Række, Bd. iv. p. 159, pl. vii. fig. 104.
1886. *Dexiobranchæa impressa*, Boas, Spolia atlantica, p. 160.

Foot.—Posterior lobe very long and pointed.

Lateral Gill very long.

Buccal Appendages.—The lateral appendages are still present, but very short; they have the form of a horizontal projection on each side of the ventral wall of the buccal cavity, and each projection bears on its free edge from six to nine suckers of moderate size. The five suckers corresponding to the median appendage are as follows:—the median distal sucker is larger than those of the lateral appendages; of the four other suckers, the anterior (distal) pair is formed of two very large suckers (much larger than the last one), placed on long thin peduncles, and with a broad ledge having a pointed beak on the side opposite to the insertion of the peduncle.[1] The suckers of the posterior (proximal) pair are of about the same size as the suckers of the lateral appendages.

Radula.—Formula 7 : 1 : 7; the median tooth tricuspid.

Hook-sacs with from thirty to forty hooks.

Colour.—Greyish-violet.

Length.—Not larger than 1 cm.[2] The specimen figured is a little contracted at its posterior part.

[1] Boas, Spolia atlantica, pl. viii. fig. 113.

[2] The measurements given in this Report are always from the buccal aperture to the posterior extremity of the body, excluding therefore the evaginable parts of the mouth, namely, the proboscis, buccal appendages, and hook-sacs.

Challenger Specimen.—An old larva; April 26, 1876; St. Vincent, Cape Verde Islands, lat. 16° 49′ N., long. 25° 14′ W.

Habitat.—Færöe Channel, lat. 60° 15′ N., long. 7° 30′ W. ("Triton" Expedition, August 20, 1882; surface temperature about 54° F.), and neighbouring localities (Copenhagen Museum); west coast of North Africa, lat. 7° 1′ N., long. 15° 54′ W. (Mr. John Rattray, January 2, 1886; surface temperature 82°·9 F.); and lat. 16° 49′ N., long. 25° 14′ W. (Challenger Expedition); Messina.

*2. *Dexiobranchæa minuta*, n. sp. (Pl. I. fig. 2).

Foot.—Posterior lobe very long.

Lateral Gill rather long.

Cephalic Region long.

Buccal Appendages.—The suckers corresponding to the lateral appendages are arranged in two rows, about sixteen in number; the median appendage is very long and well developed; the median sucker and the two distal lateral ones are nearly of the same size as those of the lateral groups, and are inserted all three together on the distal extremity of the appendage, on short peduncles; the two proximal lateral suckers are very small and inserted near the base of the appendage, on very thin peduncles.

Radula and *Hook-sacs* not investigated in the single specimen collected.

Colour.—Scarcely any; a few small spots of brown pigment on the right side of the body.

Length, about 3 mm. The evaginated part of the penis resembles that of *Clione*.

Habitat.—Near Station 247, Japan to Honolulu; July 4, 1875; lat. 36° 42′ N., long. 179° 50′ W.

3. *Dexiobranchæa simplex*, Boas (Pl. I. fig. 3).

1886. *Dexiobranchæa simplex*, Boas, Spolia atlantica, K. dansk. Vidensk. Selsk. Skriv., 6 Række, Bd. iv. p. 160.

Foot.—Posterior lobe moderately long.

Lateral Gill rather short.

Buccal Appendages.—Suckers directly inserted on the wall of the buccal cavity, forming three groups corresponding to the three appendages. Each lateral group includes two small suckers, scarcely pedunculated. The terminal median sucker of the median group is of very large size (broad and high), and measures nearly 1 mm. in diameter;[1] it shows a distinct ledge and is placed on a short peduncle; the two lateral suckers of each side

[1] Boas, Spolia atlantica, pl. viii. fig. 114.

are very small and placed on long and thick peduncles, the anterior (distal) pair being inserted at the same height as the large median sucker.

Radula.—Formula 6 : 1 : 6 ; median tooth tricuspid.

Hook-sacs.—Depressions containing from forty to fifty hooks.

Colour.—Brownish.

Length, 4·5 mm. The two posterior ciliated rings remain until a late period.

Habitat.—South-East Pacific, off Caldera (Chili), about lat. 27° S. ; "Vettor Pisani" Expedition, February 18, 1883.

4. *Dexiobranchæa paucidens*, Boas.[1]

1886. *Dexiobranchæa paucidens*, Boas, Spolia atlantica, K. dansk. Vidensk. Selsk. Skriv., 6 Raekke, Bd. iv. p. 160, pl. vii. figs. 105, 106.

Foot.—Posterior lobe rather short.

Lateral Gill very short.

Buccal Appendages.—The suckers corresponding to the lateral appendages are inserted on the ventral wall of the buccal cavity, by very short peduncles, from eleven to thirteen in number; they are not arranged in two distinct groups, but are placed in a single row, forming a continuous semicircle. The median appendage is well developed ; its four lateral suckers are larger than those corresponding to the lateral appendages, and are set on long and thick peduncles ; the terminal sucker is larger than these four.

Radula.—Formula 2 : 1 : 2 ; the median tooth is bicuspid.

Hook-sacs.—Each rudiment of a hook-sac bears from four to six very short, thick, and slightly bent hooks.

Length, 5 mm.

Habitat.—Atlantic Ocean, on the route from Brazil to Europe (Copenhagen Museum).

*5. *Dexiobranchæa polycotyla*, Boas (Pl. I. figs. 4, 5).

1886. *Dexiobranchæa polycotyla*, Boas, Spolia atlantica, K. dansk. Vidensk. Selsk. Skriv., 6 Raekke, Bd. iv. p. 161.

Foot.—Posterior lobe long.

Lateral Gill long.

Buccal Appendages.—The suckers corresponding to the lateral appendages are arranged alternately in two rows, and form two distinct groups (right and left), each including from ten to twelve suckers with very short peduncles. Median appendage well developed, bearing a terminal sucker larger than those of the lateral groups ; the four lateral suckers of the median appendage are nearly of the same size as these last.

[1] I have not been able to examine this species ; the following characters are compiled from Boas' description and figures.

Radula.—Formula 3 : 1 : 3 ; the median tooth is tricuspid.

Hook-sacs.—Each with about ten rather long hooks.

Colour, brownish.

Length, 5 mm. The two posterior ciliated rings remain until a late period. The three rings were still visible in a specimen 3 mm. long.

Habitat.—The type-specimens, described by Boas, were gathered by the Italian ship "Vettor Pisani," in the South-East Pacific, off Caldera (Chili), about lat. 27° S., February 18, 1882.

In a part of the collection of this scientific expedition, which had not been seen by Boas, I have found larvæ of a species of Gymnosomatous Pteropod, caught off Panama about lat. 8° N., December 1883 (Pl. I. fig. 5), among which the oldest shows the peculiar acetabuliferous appendages of *Dexiobranchæa polycotyla*. Thus the geographical distribution of this species embraces the whole South-West Pacific, along almost the whole west coast of South America.

Challenger Specimens.—The Challenger specimens which belong to this species, are the very young larvæ of Gymnosomata described by H. N. Moseley,[1] from Station 297, November 11, 1875, Tahiti to Valparaiso, lat. 37° 29′ S., long. 83° 7′ W. These larvæ differ from those of *Pneumonoderma*, and resemble much that of *Dexiobranchæa ciliata*, described by Gegenbaur.[2] Besides, the abundance of *Dexiobranchæa* in this region enables me to place these larvæ with great certainty in this last genus.

As these specimens have not been preserved, and since the formula of their radula has not been recorded, it may seem difficult to determine specifically larvæ that are so young. Nevertheless, it is nearly certain that they belong to the present species, not only on account of its extensive geographical distribution, of its comparative abundance, and perhaps of the elongated form of the larva, but chiefly on account of the length of the posterior lobe of the foot.

Spongiobranchæa,[3] d'Orbigny.

1825. "*Cliodita*," Quoy and Gaimard (*pars*), Description de cinq genres de Mollusques, Ann. d. Sci. Nat., sér. 1, t. vi. p. 74.
1840. *Spongiobranchea*, d'Orbigny, Voyage dans l'Amérique méridionale, t. v. p. 130.
1842. *Spongiobranchia*, d'Orbigny, Paléontologie française, terrains crétacés, t. ii. p. 4.
1856. *Spongiobranchæa*, Woodward, A Manual of the Molluscs, p. 209.
1862. *Spongobranchia*, Bronn, Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 645.
1885. *Spongobranchus*, Wagner, Die Wirbellosen des weissen Meeres, Bd. i. p. 120.

Body ovate, rather long, round posteriorly ; visceral mass extending to the posterior extremity of the body ; skin pigmented.

[1] On Stylochus pelagicus, &c., *Quart. Journ. Micr. Sci.*, 1877, p. 32, pl. iii. fig. 14.
[2] Untersuchungen über Pteropoden und Heteropoden, pl. iv. fig. 11.
[3] From σπογγος, sponge, and βραγχια, gill.

Foot.—Posterior lobe lengthened, tapering greatly, and pointed at its posterior end.

Head rather long; labial tentacles long.

Gills.—(1) Lateral gill little developed and very short, forming a simple prominence on the right side of the body; (2) posterior or caudal gill as a simple membranous ring, without exterior radii and fringes or folds at its base.

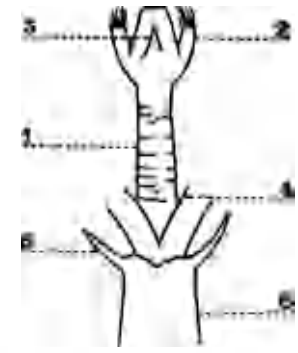

Fig. 2.—The proboscis of *Spongiobranchæa*, expanded; ventral aspect. Magnified about 6 diameters. 1, proboscis; 2, hook-sacs; 3, ventral papilla; 4, acetabuliferous appendages; 5, labial tentacles; 6, head.

Acetabuliferous Appendages.—Two symmetrical appendages inserted on the ventral wall of the front portion of the buccal cavity, or protrusible part of the digestive tract; each appendage bears, on the side which is median during the extension, suckers arranged in a single row, and of which the size increases from the base of the appendage to its distal extremity.

The protrusible front portion of the digestive tract consists of a rather long proboscis (fig. 2, 1), on the ventral side of which, as in *Pneumonoderma*, is a papilla (fig. 2, 3) anterior (during the evagination of the proboscis) to the acetabuliferous appendages.

Hook-sacs rather short, like those of *Clione*, and also containing teeth of different length, slightly bent.

Radula always with a median tooth in the adult.

Jaw rather small, with slender spines.

Since d'Orbigny (1840), whose species *australis* is alone a true *Spongiobranchæa*,[1] this genus has never been studied till lately by Boas and by me. Souleyet,[2] Gegenbaur,[3] Fischer,[4] &c., have considered it as a *Pneumonoderma* badly described, and Krohn[5] as an immature *Pneumonoderma*. It is, however, a very good, distinct, and well-characterised genus, as may be seen from the foregoing description and from the figures.

* *Spongiobranchæa australis*, d'Orbigny (Pl. I. figs. 6, 7).

1825. "*Cliodita caduceus*," Quoy and Gaimard, Description de cinq genres de Mollusques, Ann. d. Sci. Nat., sér. 1, t. vi. p. 74, pl. ii. fig. 2.

1840. *Spongiobranchæa australis*, d'Orbigny, Voyage dans l'Amérique méridionale, t. v. p. 131, pl. xix. figs. 1–7.

Acetabuliferous Appendages bearing on their median side from eight to ten suckers, with short peduncles. The three or four more proximal are very small, the largest (distal) are inserted on the ventral margin of the appendages, as in *Pneumonoderma mediterraneum*.

Radula.—Formula 8 : 1 : 8.

[1] *Spongiobranchæa elongata*, d'Orb. = *Clione longicaudata*, Soul.

[2] Voyage de la Bonite, Zoologie, t. ii. p. 272.

[3] Untersuchungen über Pteropoden und Heteropoden, p. 172.

[4] Manuel de Conchyliologie, p. 424.

[5] Beitrage zur Entwickelungsgeschichte der Pteropoden und Heteropoden, p. 17.

Hook-sacs bearing about twenty long hooks, placed in the bottom of the sac, and several shorter on the lateral walls, of which the extremities come to the same height as those of the bottom hooks when the sac is evaginated.

The other characters are the same as for the genus. The specimens of this species always show a constriction in the posterior half of the body, behind the dorsal spot, and at the height of the lateral gill.

Length.—Maximum, 22 mm.

Colour.—Grey-brown; a thin longitudinal white line, in the middle of the back, extending backwards to the above constriction.

Challenger Specimens.—Station 158, March 7, 1874; Termination Land to Melbourne; lat. 50° 1′ S., long. 129° 4′ E.

Station 314a, January 22, 1876; Sandy Point to Falkland Islands; lat. 51° 24′ S., long. 61° 46′ W.

Between Stations 332 and 333, March 11, 1876; Rio de la Plata to Tristan da Cunha; lat. 36° 22′ S., long. 26° 1′ W.

Habitat.—Antarctic Seas, within the isothermal line of 50° F. for August (it often does not even pass beyond the isotherm of 40°); from long. 60° W. to long. 123° E., and probably all around the Antarctic Pole. The extreme observed latitudes are lat. 36° 22′ S. (Challenger Expedition, March 11, 1876), and lat. 54° 30′ S. (d'Orbigny). The localities, "New Britannia, Marquesas," in the Hamburg Museum, are certainly erroneous.

Observations.—It is evident from one of the original drawings of Pteropoda by Dr. Hooker (sent to me with the Challenger Pteropoda) that the English Antarctic Expeditin (1840), had obtained *Spongiobranchæa australis*. But this drawing does not bear any indication of locality. D'Orbigny only knew a single very small specimen of this species (7 to 8 mm. long); and it is thus easy to understand why he only saw six suckers on each buccal appendage. He says nothing about the lateral gill; but he ought to have recognised it, as it may be seen in his figure.[1] It is extraordinary that he says: anus "à gauche,"[2] the anus being on the right side as in all the Gymnosomata.

I have already[3] expressed the opinion that *Trichocyclus dumerili*, Esch.,[4] is the larva of *Spongiobranchæa*. I support this interpretation on the length of the labial tentacles of this larva.[5] Johannes Müller had already said[6] that, for this reason, *Trichocyclus* appeared to him to be more the larva of *Clione* than of *Pneumonoderma*;

[1] Voyage dans l'Amérique méridionale, t. v., pl. ix. fig. 2.

[2] *Loc. cit.*, p. 131.

[3] Description d'un nouveau genre de Ptéropode Gymnosome, *Bull. Sci. Départ. Nord*, 1886, p. 218.

[4] Bericht über die zoologische Ausbeute während der Reise von Cronstadt bis St. Peter und Paul; *Oken, Isis*, 1825, p. 735, pl. v. fig. 4.

[5] I may here notice that Eschscholtz's figure is not exact, because it shows the first ciliated ring anterior to these tentacles.

[6] Ueber verschiedene Formen von Seethieren, *Archiv f. Anat. u. Physiol.*, 1854, p. 70.

but the larvæ of *Clione*, as well as the adults of this genus, have always the posterior extremity tapering and pointed, whereas that of *Trichocyclus* is round, as in *Spongiobranchæa*. The locality where *Trichocyclus dumerili* was obtained ("Südsee"),[1] also agrees well with my interpretation.

I have identified *Cliodita caduceus*[2] with *Spongiobranchæa australis*; because, in spite of the imperfect figure given by Quoy and Gaimard, one can there recognise the posterior gill of *Spongiobranchæa*, and the same constriction in the posterior half of the body as in the specimens of *Spongiobranchæa australis*. The locality of *Cliodita caduceus* ("entre l'île de France et le Cap de Bonne Espérance") also agrees with this opinion.

Pneumonoderma,[3] Cuvier.

1804. *Pneumoderme*, Cuvier, Mémoire concernant l'animal de l'Hyale, &c., Ann. Mus. Hist. Nat. Paris, t. iv. p. 232.
1810. *Pneumoderma*, Péron and Lesueur, Histoire de la famille des Mollusques Ptéropodes, &c., Ann. Mus. Hist. Nat. Paris, t. xv. p. 65.
1815. *Pneumodermus*, Oken, Lehrbuch der Zoologie, Bd. i. p. 326.
1815. *Ægle*, Oken, Lehrbuch der Zoologie, Bd. i. p. 326.
1819. *Pneumoderme*, Lamarck, Histoire naturelle des animaux sans vertèbres, t. vi. p. 293.
1846. *Pneumonoderma*, Agassiz, Nomenclator Zoologicus, Index, p. 299.
1855. *Pneumonodermum*, Herrmannsen, Indicis generum Malacozoorum primordia, vol. i. p. 309.

Body ovate, rather long, a little shrunk behind, and rounded at its posterior extremity; visceral mass extending to that extremity. Skin pigmented, more coloured on the right than on the left side (especially at the head).

Head very long, or else united to the body by a long neck (this lengthening is a consequence of the great length of the hook-sacs). Labial tentacles short, and wide at their bases.

Foot.—Posterior lobe long, always rounded at its free extremity; anterior lobes attached to the head in their entire length; between them there is a small plicated tubercle, as in the Clionopsidæ.

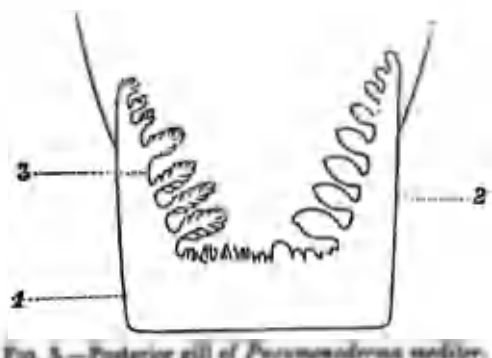

FIG. 5.—Posterior gill of *Pneumonoderma mediterraneum*, ventral aspect; magnified 10 diameters. 1, quadrangular crest; 2, radiating crests; 3, fringes of the radiating crests.

The Lateral Gill placed on the right side, is composed of (1) three longitudinal, parallel crests, thin and transparent, placed on the body wall; (2) a free part, posterior to these crests, of a triangular shape, more or less elongate, of which the summit points backwards; the two free edges of this triangle bear crests which continue the lateral somatic ones (*see* fig. 1, p. 6). The median somatic crest continues on the triangular lobe (where it is very projecting) up to its summit. The two crests on the free sides

[1] *Loc. cit.*, *Oken, Isis*, 1828, p. 738.
[2] Description de cinq genres de Mollusques, *Ann. d. Sci. Nat.*, ser. 1, t. vi. p. 74, pl. ii. fig. 2.
[3] From πνευμων, lung, and δερμα, skin.

of the triangular lobe bear fringes at their bases; these fringes generally are continued on the lateral somatic crests. The median crest of the gill never bears fringes.

The Posterior Gill is formed of a quadrangular projecting crest, thin, membranous and transparent, which surrounds the posterior end of the body. There arises from each corner of this principal crest, a longitudinal one directed forwards (the two crests arising on the right side, that is, on the side of the lateral gill, are always shorter than the two crests of the left side). The four radiating crests and the two anterior and posterior sides of the quadrangular one have fringes or foldings at their bases.

The posterior gill of *Pneumonoderma* is an adaptive one (whereas the lateral gill morphologically corresponds with that of the Tectibranchiate Opisthobranchs, such as *Aplysia*, for example); it is but a modification of a part of the cutaneous envelope, which must assist the lateral gill in its breathing function. The formation of crests, the development of fringes at the base of these, and the subdivision of these fringes, are successive adaptations, favourable to the aeration of the blood by increasing the surface in contact with the water.

It is difficult to understand how such a good observer as Gegenbaur,[1] followed in this respect by Bronn,[2] thinking to correct Cuvier, van Beneden, and Souleyet, has stated that the posterior gill of *Pneumonoderma* only shows three radiating crests. Is his observation based on monstrous or rather on specimens deformed from bad preservation?

Buccal Appendages.—Two symmetrical appendages, latero-ventrally inserted on the proboscis (Pl. II. fig. 5) and having the form of flattened ribbons, more or less wide and long. They bear pedunculated suckers,[3] on one side only, the median one during the extension of the appendages.

Proboscis shorter than in *Spongiobranchæa*, and showing, in all (?) the species,[4] the same median abdominal papilla as in *Spongiobranchæa australis*, placed in front of the acetabuliferous appendages when the proboscis is protruded.

Radula, never with a median tooth in the adult (this tooth exists in the larvæ); the number of the lateral teeth never varies much in the different species from four to six.

Hook-sacs cylindrical and very long; they contain a great many slightly bent hooks, scattered over the whole wall of the sac, the longest at the extremity and the shortest at the base (during the evagination of the sac).

The gills of this genus have nearly always been insufficiently described (as in the defective descriptions of Gegenbaur and Bronn), and still more often badly figured. In

[1] Untersuchungen über Pteropoden, &c., p. 85.

[2] Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 607.

[3] The structure of these suckers was studied by Niemiec (Recherches morphologiques sur les ventouses dans le règne animal, *Revue Zool. Suisse*, t. ii., 1885), and by me (The Cephalic Appendages of the Pteropoda. *Quart. Journ. Micr. Sci.*, 1888).

[4] I found this papilla on *Pneumonoderma violaceum*, *Pneumonoderma parisiense* (Pl. II. fig. 5) and *Pneumonoderma meleagrinum* (Pl. II. fig. 6).

regard to the posterior gill, de Blainville[1] gives it as only formed of three sides (the right side of the quadrangular crest wanting). Several writers have figured fringes on the four sides of this crest; in this respect the figure of Rang[2] is much more exact, but the one given by d'Orbigny,[3] and republished by so many modern authors,[4] is quite erroneous, and makes this gill resemble fins. As for the lateral gill, it is generally forgotten or figured in a shapeless manner. Lastly, in regard to the structure of these gills, there is no figure, not even those of Souleyet,[5] which are by far the best and most exact, that shows the true conformation of the fringes.

These fringes are differently formed in the different species. Those of *Pneumonoderma souleyeti* are very little developed, and only form simple undulations at the base of the crests. Those of *Pneumonoderma pacificum* form well-marked and regular undulations, those of one side alternating with those of the other, and resembling the fringes of the gill of *Clionopsis grandis*. In *Pneumonoderma boasi* there are a few fringes more distinct, shrunk at their base, but markedly separate. Lastly, in the group including *Pneumonoderma violaceum*, *Pneumonoderma peroni*, and *Pneumonoderma mediterraneum*, the fringes of the gills show their greatest specialisation; they are numerous, nearly contiguous, and subdivided into parallel ramifications, very close to one another, directed from the base of the fringe to its distal extremity (fig. 3, 3). The conformation of the gills is very useful for the distinction of the species.

Huxley,[6] and several others after him, as Woodward[7] and Fischer,[8] have said that *Pneumonoderma* possesses a "small anomalous shell." I have examined a great many specimens of *Pneumonoderma* of all sizes, and even old larvæ, and I can assert that like all the other Gymnosomata, *Pneumonoderma* is absolutely devoid of mantle skin and shell. It is quite probable on the other hand, whatever Lankester may say,[9] that the larvæ of *Pneumonoderma* bear a larval shell in the beginning of their development, as in *Clione*.[10]

The discrimination of the species of *Pneumonoderma* is certainly the most laborious part of the systematic treatment of the Gymnosomata. A considerable number of species have been described, but for the most part the descriptions are imperfect and insufficient, and the type specimens have been lost.

A comparative and synthetical study of all the specific forms of this genus has not yet been made, and with the materials now available, it might not even yet give

[1] Manuel de Malacologie et de Conchyliologie, pl. xliii. figs. 4, 4b.
[2] Histoire Naturelle des Mollusques Ptéropodes, pl. ix. fig. 5.
[3] Voyage dans l'Amérique méridionale, t. v., pl. ix. fig. 11.
[4] Bronn's Thierreich, Claus' Text-book, Lankester's Mollusca, in Encyclopædia Britannica.
[5] Voyage de la Bonite, Zoologie, pl. xv. figs. 40–42.
[6] On the Morphology of the Cephalous Mollusca, *Phil. Trans.*, 1853, p. 40.
[7] A Manual of the Mollusca, p. 208.
[8] Manuel de Conchyliologie, p. 423.
[9] Mollusca; Encyclopædia Britannica, ed. 9, vol. xvi. p. 608.
[10] Fol, Sur le développement des Ptéropodes, *Archives d. Zool. expér.*, sér. 1, t. iv., pl. x. figs. 6, 7.

definitive results. The first, and a very commendable, attempt to bring light into this chaos, was made by Boas,[1] and in the following systematic account of the genus *Pneumonoderma* I have availed myself of the results he has obtained; this account is thus more perfect, although it cannot be considered as conclusive.

I have found in the literature of the Pteropoda eleven different specific names attributed to *Pneumonoderma*.

Among these eleven names there is one that belongs to a *Dexiobranchæa*—namely, *Pneumodermon ciliatum*, Gegenbaur, and among the ten others, there are—

First, names which are synonyms, as will be shown further on :—

1. *Pneumodermon audebardi*, Rang,[2] = *Pneumonoderma violaceum*, d'Orbigny.
2. *Ægle cucullata*, Oken,[3] = *Pneumonoderma peroni*, Lamarck.
3. *Pneumodermis atlanticum*, Oken,[4] = *Pneumonoderma violaceum*, d'Orbigny.
4. *Pneumodermon macrocotylum*, Boas,[5] = *Pneumonoderma mediterraneum*, van Beneden.

Secondly, several names applied to species of which the characterisation is quite insufficient, and of which the type specimens have been lost. One is therefore obliged to eliminate them from the actual systematic nomenclature of *Pneumonoderma* :—

1. *Pneumodermon pellucidum*, Quoy and Gaimard.[6]
2. *Pneumodermon ruber*, Quoy and Gaimard.[7]

I shall, however, refer again to these two species.

The obscurity which surrounds the nomenclature of the genus *Pneumonoderma* results from the difficulty of finding distinctive characters between the different species, so that the descriptions which have been given of some forms might have been applied to others, which are nevertheless distinct. It may therefore be said that the real cause of this confusion is the fact that the zoologists who have undertaken the systematic classification of the Mollusca possess but little knowledge of the organisation of the animals that they describe, and therefore cannot appreciate which organs maintain constant characters throughout the whole genus, and which have characters that vary from one species to another. To convince oneself of this truth, one must compare the descriptions of Quoy and Gaimard, of Rang, and even of d'Orbigny and Dall, with those of Boas, and he will then understand the accuracy of this observation.

The first well-known species of the present genus was *Pneumonoderma peroni*, Lamarck, from the Indian Ocean.

[1] Spolia atlantica, pp. 152–154.
[2] Histoire naturelle des Mollusques Ptéropodes, pl. x. fig. 17.
[3] Lehrbuch der Zoologie, Ed. i. p. 327 (*vers. typ.*, 273).
[4] *Loc. cit.*, p. 327.
[5] Spolia atlantica, p. 152.
[6] Voyage de découvertes de l'Astrolabe, Zoologie, t. ii. p. 390, pl. xxviii. fig. 29.
[7] *Loc. cit.*, t. ii. p. 390, pl. xxviii. figs. 18–24.

Up to the time of d'Orbigny (1840), the *Pneumonoderma* of the North Atlantic (*Pneumonoderma violaceum*), was described under the same name; and under this name also, Souleyet[1] reunites some different *Pneumonoderma*, of which not one was the true *Pneumonoderma peroni*.

It is true that in 1815 Oken[2] had distinguished the two forms (*Pneumonoderma peroni* and *Pneumonoderma violaceum*), and had respectively named them *Ægle cucullata* and *Pneumodermis atlantica*; but the diagnoses he gave of them are so brief and incorrect that these names cannot be retained, and must be regarded as synonyms.

The two other names to retain with *Pneumonoderma peroni* and *Pneumonoderma violaceum*, are *Pneumonoderma mediterraneum*, van Beneden, and *Pneumonoderma pacificum*, Dall.

Thus, among the ten different specific names above mentioned, there are only four which can be considered as definitive in the actual nomenclature. Besides these four species I shall describe two new ones, *Pneumonoderma souleyeti* and *Pneumonoderma boasi*, of which the former was collected by the Challenger Expedition.

As I have already said, the different species of *Pneumonoderma* are very difficult to distinguish from one another. The distinctive character proposed by Boas is founded on the number and form of the suckers of the buccal appendages; but this character is not sufficient for all the species. By adding to it the character drawn from the conformation of the gills, one can much more easily distinguish the six species above mentioned.

By the conformation of the posterior gill, these six forms are divided into two groups, each including three species :—

I. In the first group the radiating crests of the posterior gill are one-fifth of the length of the body, and bear numerous fringes (from seven to twelve), which are long and subdivided. The species of this group generally have the free part of the lateral gill rather short; one of them does not possess fringes on the lateral somatic crest of this gill.

II. In the second group, the radiating crests of the posterior gill are short (one-tenth of the length of the body), and bear a few fringes (about three), little projecting, and simple. Two species of this group (*Pneumonoderma pacificum* and *Pneumonoderma souleyeti*) have the free part of the lateral gill long, and the fringes of the posterior gill little developed.

The following table, combining the characters taken from the gills with those of the acetabuliferous appendages, allows of the easy discrimination of the six species of *Pneumonoderma* described in this Report.

[1] Voyage de la Bonite, Zoologie, pl. xiv. figs. 7–16.
[2] Lehrbuch der Zoologie, Bd. i. p. 327.

Key to the Species.

I. Radiating crests of the posterior gill long, with subdivided and numerous fringes.
  1. Each acetabuliferous appendage bearing seven large suckers inserted on the margins of the appendage, . . *Pneumonoderma mediterraneum.*
  2. Each acetabuliferous appendage bearing numerous small suckers on their whole median face.
    A. Each appendage with about forty suckers, . . *Pneumonoderma violaceum.*
    B. Each appendage with about one hundred suckers, . *Pneumonoderma peronii.*

II. Radiating crests of the posterior gill short, with simple and not numerous fringes.
  1. Fringes well marked, strongly separated, and shrunk at their base, ... *Pneumonoderma boasi.*
  2. Fringes slightly developed and forming merely simple, continuous and slightly projecting undulations.
    A. Triangular, rather short acetabuliferous appendages, each bearing about fifty suckers, . . . *Pneumonoderma pacificum.*
    B. Very long acetabuliferous appendages with nearly parallel margins, each bearing about seventy-five suckers, ... *Pneumonoderma souleyeti.*

1. *Pneumonoderma mediterraneum*, van Beneden (Pl. I. fig. 8; Pl. II. fig. 1).

1838. *Pneumoderman mediterraneum*, van Beneden, Note sur une nouvelle espèce de Pneumoderme, Mém. Acad. Sci. Bruxelles, t. xi. p. 13, pl. iii. figs. 1–2.
1852. *Pneumoderman peronii*, Souleyet (*pars*), Voyage de la Bonite, Zoologie, t. ii. p. 274, pl. xiv. figs. 13, 14, 16.
1855. *Pneumoderman mediterraneum*, Gegenbaur, Untersuchungen über Pteropoden und Heteropoden, p. 213.
1859. *Spongiobranchea australis*, Chenu (*pars*), Manuel de Conchyliologie, t. i. p. 116, fig. 509.
1873. *Pneumoderman peronii*, Costa, Pteropodi della Fauna di Napoli, p. 22, pl. v. figs. 1–3.
1886. *Pneumoderman macrocalyum*, Boas, Spolia atlantica, K. danesk. Videnesk. Selsk., Skriv., 6 Raekke, Bd. iv. p. 152.
1886. *Pneumoderman audebardi*, Lenard, Prodrome de Malacologie française, Mollusques marins, p. 19.

Body rather long.

Foot.—Posterior lobe very long (no other known *Pneumonoderma* has it so long).

Lateral Gill rather short, with fringes on the lateral somatic crests.

Posterior Gill.—The four radiating crests are long, and possess on each side of their base about seven ramified fringes; such fringes are also to be found on the anterior and posterior sides of the quadrangular crest.

Acetabuliferous Appendages rather long and not very wide at their base; each bearing generally seven (sometimes six) suckers inserted on the median side of the appendage, the four largest on the abdominal margin, and the three smallest at the distal extremity and on the dorsal margin; the latter are sometimes very small. The shape of the

suckers is nearly that of a flat porringer with a rather narrow edge; the largest are about one line in diameter.

Radula.—Formula 6 : 0 : 6.

Hook-sacs very long.

Colour.—Violet brown, more or less dark (Costa[1] describes this species as red coloured).

Length.—The adult specimens measure 17 mm.

Habitat.—Mediterranean Sea (Naples, Messina, Nice); according to Boas,[2] this species is also to be found in the Atlantic Ocean, and in the China Sea.

Observations.—Contrary to the opinion of Boas, I consider the species with seven suckers, obtained frequently at Naples (and which he designates *Pneumodermon macrocotylum*), as identical with the species from Nice, formerly described by van Beneden as *Pneumonoderma mediterraneum*; I therefore think that the latter name must be retained for it.

Boas identifies his *Pneumodermon macrocotylum* with "*Pneumodermon mediterraneum*," Gegenbaur, which he consequently distinguishes from van Beneden's species. But Gegenbaur[3] says:—"Acetabula five or six"; and van Beneden's figures[4] also show the same number of suckers (five or six).

The suckers in van Beneden's figures really appear smaller than those of a well-preserved *Pneumonoderma* from Naples; but in very contracted specimens (as those of van Beneden), the shape of the suckers is altered and they seem smaller.

I have already said that the Mediterranean Gymnosomata are not yet well known. Gegenbaur observed a "*Pneumodermon violaceum*" "more common at Messina, during autumn, than *Pneumodermon mediterraneum*," and bearing from ten to fourteen suckers on each buccal appendage. This form, of course, differs from *Pneumonoderma violaceum*, d'Orbigny, and has not since been seen in the adult state. Boas[5] has found some larvæ from Messina bearing ten or eleven suckers on each appendage, and these undoubtedly belong to the species *Pneumonoderma violaceum* of Gegenbaur.

Up to the present time adult *Pneumonodermata* have only been found in the Mediterranean, at Naples, Messina and Nice. But they must also live in other parts of this sea, since larvæ have been found at Malaga (*Trizonius cæcus*), by Busch,[6] and in the Adriatic sea, at Trieste, by Johannes Müller.[7]

[1] Pteropodi della fauna di Napoli, p. 22.
[2] Spolia atlantica, p. 153.
[3] Untersuchungen über Pteropoden und Heteropoden, p. 213.
[4] *Loc. cit.*, p. 213.
[5] Spolia atlantica, p. 151.
[6] Beobachtungen über Anatomie und Entwicklung einiger wirbellosen Seethiere, p. 115.
[7] Ueber verschiedene Formen von Seethiere, *Archiv f. Anat. u. Physiol.*, p. 80, 1854.

*2. *Pneumonoderma violaceum*, d'Orbigny (Pl. I. fig. 9).

1815. *Pneumodermis atlantica*, Oken, Lehrbuch der Zoologie, Bd. i. p. 327.
1832. *Pneumoderman peronii*, Quoy and Gaimard, Voyage de découvertes de l'Astrolabe, Zoologie, t. ii. p. 388, pl. xxviii. figs. 1–6.
1840. *Pneumodermon violaceum*, d'Orbigny, Voyage dans l'Amérique méridionale, t. v., pl. ix. figs. 10–15.
1850. *Pneumodermon cucullatum*, Gray, Catalogue of the Mollusca in the Collection of the British Museum, p. 39.
1852. *Pneumodermon peronii*, Souleyet (*pars*), Voyage de la Bonite, Zoologie, t. ii. p. 274, pl. xiv. figs. 12, 15.
1852. *Pneumodermon audebardi*, Rang, Histoire naturelle des Mollusques Ptéropodes, pl. x. fig. 13.
1859. *Spongiobranchea australis*, Chenu (*pars*), Manuel de Conchyliologie, t. i. p. 116, fig. 508.
1879. *Currifer pavadoma*, Pfeffer, Uebersicht der auf S. M. Schiff "Gazelle" und von Dr. Jagor gesammelten Pteropoden, Monatsber. d. k. preuss. Akad. d. Wiss. Berlin, p. 249, fig. 20.

Body and head resembling those of *Pneumonoderma mediterraneum*.

Foot.—Posterior lobe not so long as in the foregoing species.

Lateral Gill short; lateral somatic crests without fringes.

Posterior Gill with long radiating crests, each of which bears about seven ramified fringes on each side of the base.

Acetabuliferous Appendages triangular in shape, of moderate length, and rather large at their base. Each appendage bears about forty suckers covering their whole median face; these suckers are smaller than those of *Pneumonoderma mediterraneum*, but have nearly the same shape.

Colour.—Brownish; the pigment being chiefly distributed on the right side. I have seen specimens in the Hamburg Museum which are nearly colourless, or albinos, and have but very little pigment on the right side of the head.

Length.—About 13 mm. Souleyet[1] gives the length of the Atlantic *Pneumonoderma* that he studied (and which belongs to the present species), as 25 mm.; but this is certainly with the proboscis and hook sacs everted.

Challenger Specimens.—Near Station 354, May 7, 1876; Atlantic, off the Azores; lat. 34° 22′ N., long. 34° 28′ W.

In the Narrative of the Cruise (vol. i. p. 219), there is also mentioned a "*Pneumodermon*" (without indication of species) collected between Cape Verde and Bahia, Stations 93 to 128, July 27 to September 14, 1875.[2] I did not, however, find, in the collections sent to me, any specimens of *Pneumonoderma* from any station between the

[1] Voyage de la Bonite, Zoologie, t. ii. p. 274.

[2] In this trip there were only four trawlings (Stations 101, 104, 106 and 107, from St. Vincent to St. Paul's Rocks), between lat. 6° 46′ N. and lat. 1° 22′ N., and from long. 14° 20′ W. to long. 26° 26′ W.; this zone quite agrees with the area of distribution of *Pneumonoderma violaceum*.

two above cited. But since all the stations between these latter are north of lat. 15° S., the specimens noticed undoubtedly belong to *Pneumonoderma violaceum*.

Habitat.—This species lives only in the Atlantic Ocean, and especially in that part adjoining the African coast, and is distributed between lat. 45° N. and lat. 15° S., the extreme western localities (long. 45° W.) are in the northern hemisphere, the most eastern (long. 6° W.) in the southern hemisphere.

Observations.—Boas,[1] with some doubt, ascribes to the present species specimens from the Indian Ocean, but they are certainly distinct, because each of their buccal appendages only bears from twenty-five to thirty suckers.

In this species Boas[2] also includes specimens from the south-east Pacific (off Caldera, Chili), but they are the types of a new species, *Pneumonoderma boasi*, described further on.

*3. *Pneumonoderma peroni*, Lamarck (Pl. II. fig. 2).

1815. *Ægle cucullata*, Oken, Lehrbuch der Zoologie, Bd. i. p. 327.
1819. *Pneumoderman peronii*, Lamarck, Histoire naturelle des Animaux sans Vertèbres, t. vi. p. 294.

Body.—Head and foot as in the foregoing species.

Lateral Gill short, with fringed lateral somatic crests.

Posterior Gill with long radiating crests, each of which bears, on each side of the base, as many as twelve contiguous fringes, very much developed and subdivided.

Acetabuliferous Appendages triangular, with a large base, bearing about a hundred suckers a little smaller than those of *Pneumonoderma violaceum*, more convex and inserted on very extensible peduncles.

Radula.—In the largest specimens I was able to examine (about 15 mm.), the formula was 4 : 0 : 4.

Colour.—Bluish-grey; pigment divided into numerous little spots, visible under a magnifying glass.

Length.—A little greater than that of *Pneumonoderma violaceum*; the adult specimens measure 15 mm.

Challenger Specimens.—Station 222, March 16, 1875; off the Admiralty Islands; lat. 2° 15′ N., long. 146° 16′ E.

Habitat.—Indian Ocean, from the equator to lat. 40° S., and the seas of the Malay Archipelago; this species also lives in the south Atlantic Ocean, but only south of the Tropic of Capricorn, while *Pneumonoderma violaceum* is only to be found north of this tropic and has its southern limit at lat. 15° S.; *Pneumonoderma peroni*, on the contrary, is only to be found from lat. 25° S. to lat. 37° S., and between long. 0° and 34° W.

[1] Spolia atlantica, p. 154, Nos. 42 and 43.

[2] Spolia atlantica, p. 154.

4. *Pneumonoderma boasi*, n. sp. (Pl. II. fig. 3).

1886. *Pneumodermon violaceum*, Boas (*pars*), Spolia atlantica, K. dansk. Vidensk. Selsk. Skriv., 6 Raekke, Bd. iv. p. 154.

Body, *head*, and *foot* as in the two foregoing species.

Lateral Gill short, with fringes not subdivided, and fringed lateral somatic crests.

Posterior Gill with short radiating crests, of which the fringes are not subdivided, but distinct, markedly separated, projecting and narrow at their base; they number three on each side of the radiating crests.

Acetabuliferous Appendages bearing about forty small suckers, of the same shape as those of *Pneumonoderma mediterraneum*.

Hook-sacs rather short.

Colour.—Brownish; pigment existing as small spots visible to the naked eye.

Length, 7 mm. (in a contracted state).

Habitat.—South-East Pacific, off Caldera (Chili), about lat. 27° S.; "Vettor Pisani" Expedition, February 18, 1883.

Observation.—A young specimen, about 4 mm. long, still showed well-marked traces of the second ciliated ring of the larva; the fringes on the branchial crests were not yet formed.

*5. *Pneumonoderma pacificum*, Dall (Pl. II. figs. 4, 5).

1871. *Pneumodermon pacificum*, Dall, Descriptions of Sixty New Forms of Molluscs from the West Coast of North America, Amer. Journ. Conch., vol. vii. p. 139.

Body.—Head and foot like those of the other species of the genus.

Lateral Gill long, with fringed lateral somatic crests.

Posterior Gill with short radiating crests, of which the fringes are simple well-marked foldings on each side of the crests, those of one side alternating with those of the other. These fringes are close to one another, and the radiating crests being short, they are not numerous.

Acetabuliferous Appendages triangular, bearing about fifty small suckers of the same shape as those of *Pneumonoderma mediterraneum*.

Radula.—Formula 4 : 0 : 4, in specimens 1 cm. long.

Hook-sacs long.

Colour.—Purplish-brown; pigment chiefly abundant on the right side, and distributed in small spots, visible with a magnifying glass.

Length.—Dall[1] gives 1 inch as the maximum size of this species; the specimens from the Challenger Expedition are about 1 cm. long.

Challenger Specimens.—Station 240, June 21, 1875; Yokohama to Honolulu; lat. 35° 20′ N., long. 153° 39′ E.

[1] *Amer. Journ. Conch.*, vol. vii. p. 140.

Station 254, July 17, 1875; Yokohama to Honolulu; lat. 35° 13′ N., long. 154° 43′ W.

Habitat.—The type-specimens of this species were obtained by Dall in lat. 37° 8′ N., long. 136° 10′ W. The following localities have also been furnished to me by Mr. W. H. Dall:—Off Santa Barbara Islands (California), about lat. 33° 30′ N., long. 118° 45′ W.; off Sitka (Alaska), and near the Kodiak Island, about lat. 58° N., long. 135° W.

Including the two Challenger localities, this species is therefore distributed throughout the whole north-east Pacific Ocean, and along the west coast of North America, from lat. 58° N. to lat. 33° N., and between long. 160° E. and long. 118° E.

Observation.—This species has not hitherto been figured, but as it was found among the Challenger Pteropoda, I have been able to give good figures of it in this Report.

The description of Dall was not only not accompanied by figures, but like the descriptions of Quoy and Gaimard, and of Rang, it did not indicate any character which might specifically distinguish it. Happily, Mr. Dall had the kindness to send to me some specimens of this species, and after comparison I recognised that the specimens of *Pneumonoderma* from Stations 240 and 254 were identical with them. Having thus identified these specimens with certainty, I have been able to give a description sufficient to distinguish *Pneumonoderma pacificum* from the other species of the same genus, by means of characters drawn from the acetabuliferous appendages (*e.g.*, their form and the form and number of the suckers), from the gills, radula, &c.

*6. *Pneumonoderma souleyeti*, n. sp. (Pl. II. fig. 6).

Body rather short, swollen in its anterior half; neck of moderate length.

Foot as in the foregoing species.

Lateral Gill long.

Posterior Gill with very wide quadrangular crest and very short radiating ones; undulations of the base of the crests hardly developed and indeed almost absent.

Acetabuliferous Appendages as long as the body, with a narrow base, and nearly parallel margins, bearing about seventy-five small suckers of the same shape as those of *Pneumonoderma mediterraneum*, and the size of which regularly decreases from the base to the extremity of the appendage.

Colour.—The single specimen collected by the Challenger Expedition is but little coloured; it shows brown pigment chiefly on the right side.

Length, 4 mm.

Challenger Specimen.—Station 254, July 17, 1875; Yokohama to Honolulu; lat. 35° 13′ N., long. 154° 43′ W.

Observation.—The appearance of this small *Pneumonoderma*, when its fins are a little contracted, is very peculiar, and resembles very much that of some Cephalopods, as, for example, *Cranchia scabra*, Leach.

I have dedicated this species to Souleyet, whose remarkable works will always remain the basis of our knowledge of the Pteropoda. After the death of this courageous worker, his exceedingly able works on the anatomy of the Mollusca were nearly forgotten in France, especially among the zoologists of Paris, where, however, the comparative anatomy of Molluscs is held in esteem, and it is English, German, and Danish zoologists (Huxley,[1] Bronn,[2] and Boas[3]), that have given to Souleyet the position to which in my opinion he is entitled. And since in that group of Pteropoda that Souleyet studied so much and contributed so much to make known there is not one species bearing his name, I have thought that the best way of showing my respect for his memory, was to give his name to that new species which has the most remarkable appearance.

As remarked previously, the other specific names of *Pneumonoderma* are synonyms of other already known species, with the exception of two names of Quoy and Gaimard, already referred to, "*Pneumodermon pellucidum*"[4] and "*Pneumodermon ruber*."[5]

Boas thinks[6] that the first may be a *Clionopsis*, because it possesses a foot like that in this genus. But according to the figure of Quoy and Gaimard, it has a well-developed lateral gill like that in *Pneumonoderma*; and *Clionopsis* does not possess such a gill. This is therefore a point which throws doubt upon the exactness of the drawing of the above mentioned writers, and which will at present prevent any decision in regard to the systematic position of this species.

As to the "*Pneumodermon ruber*" of the same writers, it certainly includes different forms.

First, a species (*loc. cit.*, pl. xxvii. figs. 19, 20) which also possesses a foot as in *Clionopsis* and a lateral gill as in *Pneumonoderma*, and in regard to which one must make the same remark as regarding "*Pneumodermon pellucidum*."

Second, a species (*loc. cit.*, pl. xxvii. figs. 21–24) which possesses a foot and gill as in *Pneumonoderma*, but which is so badly described and figured that there is no character to distinguish it from the other species of this genus, or sufficient to identify it with one of these species.

Nothing can therefore be decided, either in regard to "*Pneumodermon ruber*" or "*Pneumodermon pellucidum*," until the forms which Quoy and Gaimard described under these names are again obtained.

[1] On the Morphology of the Cephalous Mollusca, *Phil. Trans.*, 1853, p. 52.
[2] Die Klassen und Ordnungen des Thierreichs, Bd. iii. pp. 685, 873.
[3] Spolia atlantica, pp. 9, 10.
[4] Voyage de découvertes de l'Astrolabe, Zoologie, t. ii. p. 390, pl. xxvii. fig. 25.
[5] Better *rubrum*. *Loc. cit.*, t. ii. p. 388, pl. xxvii. figs. 19–24.
[6] Spolia atlantica, p. 171.

Family II. Clionopsidæ.

1855. *Clioidea*, Gegenbaur (*pars*), Untersuchungen über Pteropoden und Heteropoden, p. 212.
1859. *Pneumodermonidæ*, H. and A. Adams (*pars*), The Genera of Recent Mollusca, vol. ii. p. 613.
1869. *Clionida*, Bronn, Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 645.
1873. *Clionopsidei*, Costa, Pteropodi della Fauna di Napoli, p. 24.

Characters.—Proboscis very long. Buccal appendages absent. A jaw. A quadriradiate posterior gill. No lateral gill. Skin not pigmented.

Description.—*Body* voluminous, rather transparent, barrel-shaped, a little contracted at both extremities; posterior extremity rounded; visceral mass extending to this extremity, forming an axial mass. Skin without pigment, showing generally a great many small spots due to fatty glands; dorsal spot rounder than in *Pneumonoderma*.

Head small, neck rather short; labial tentacles thick, but short and shrunk at their extremity.

Foot lying far forward, and without posterior lobe; anterior lobes like those of *Pneumonoderma*, connected in all their length; between these two lobes, on the posterior part of the foot, there is a plicated tubercle. Fins small in proportion to the body.

Posterior Gill.—Membranous posterior crest rather short, forming a hexagon elongated in the dorso-ventral diameter, and the four ventral and dorsal angles of which each give rise to a small membranous crest which is turned forwards. These crests (the hexagonal and the four radiating ones) show different degrees of specialisation in the different species, and may bear at their base fringes or foldings like those of *Pneumonoderma* and *Spongiobranchæa*.

Proboscis or evaginable anterior portion of the digestive tract (penis, Troschel) excessively long; it is about three times the length of the body, while in *Spongiobranchæa* (which of all the other Gymnosomata possesses the longest proboscis), it is not a third of this length. When the proboscis of *Clionopsis* is invaginated, the horny parts, the radula, jaw, and hook sacs are placed very far from the buccal aperture.

Radula always with median tooth (tricuspid) in the adult.

Hook-sacs (whose true signification Krohn was the first to make known [1]) very short, possessing strong hooks, rather numerous, short, of nearly uniform length, slightly bent and mostly arranged in a bunch.

[1] Beiträge zür Entwickelungsgeschichte der Pteropoden und Heteropoden, p. 40.

Clionopsis,[1] Troschel.

1854. *Cliopsis*, Troschel, Beiträge zur Kenntniss der Pteropoden, Archiv f. Naturgesch., Jahrg. xx. p. 222.
1855. *Clio*, Gegenbaur (*pars*), Untersuchungen über Pteropoden und Heteropoden, p. 212.
1862. *Clionopsis*, Brunn, Die Klassen und Ordnungen des Thierreichs, Ed. iii. p. 645.

Characters and *Description* as for the family Clionopsidæ.

The animals of this genus have been wrongly placed next to *Clione* by nearly all zoologists. Since the organisation of *Clionopsis* has become better known (Boas and I have independently worked at the subject, but Boas' researches have priority to my own), it is evident that in some respects this genus comes nearer to *Pneumonoderma*; but it possesses some peculiar characters in which it differs as much from the Pneumonodermatidæ as from the Clionidæ. It must therefore be placed in another family, the Clionopsidæ, already established by Costa.

The three species of this genus may be distinguished as follows :—

Key to the Species.

I. Animal of large size; the posterior gill possessing four very distinct radiating crests.
  1. Radiating crests of the posterior gill without fringes, ... *Clionopsis krohni*.
  2. Radiating crests with fringes, ... *Clionopsis grandis*.
II. Animal of small size, with the radiating crests on the posterior gill nearly obsolete, *Clionopsis modesta*.

1. *Clionopsis krohni*, Troschel (Pl. II. fig. 9; Pl. III. fig. 1).

1854. *Cliopsis krohnii*, Troschel, Beiträge zur Kenntniss der Pteropoden, Archiv f. Naturgesch., Jahrg. xx. p. 222, pl. x. figs. 2–4.
1855. *Clio mediterranea*, Gegenbaur, Untersuchungen über Pteropoden und Heteropoden, p. 212, pl. iv. fig. 14.
1869. *Trichocyclus mediterraneus* (larva), Costa, Osservazioni su taluni Pteropodi del Mediterraneo, Annuario del Mus. Zool. d. R. Univ. di Napoli, Anno v. p. 46, pl. i. fig. 3.
1879. *Clionopsis krohnii*, Costa, Pteropodi della Fauna del Regno di Napoli, p. 26, pl. v. figs. 7–9.

Body long and thick.

Head small; nuchal tentacles much projecting (this is the Gymnosomatous Pteropod on which these appendages are the most developed).

Foot.—Anterior lobes with posterior right angle, so that their posterior extremity is neither free nor very projecting; the folded tubercle on the posterior end of the foot is not divided by a median longitudinal wrinkle. Fins rounded at their distal extremity.

[1] From *Clione*, a Gymnosomatous Pteropod, and ὄψις, appearance.

Posterior Gill a simple hexagonal crest, from the four ventral and dorsal angles of which there arise four short crests, without foldings or fringes, directed forwards. (In one specimen I only found three radiating crests, two dorsal and one ventral; perhaps the two ventral crests were fused together, or the left one was absent.) This gill was unknown to Troschel, who founded his genus *Cliopsis* on young specimens not more than 8·5 mm. long,[1] in which the place of the gill was still hidden by the posterior ciliated ring;[2] but it was figured by Costa in 1873.[3]

Proboscis very long; in the figured specimen (Pl. III. fig. 1), it is not yet quite everted, since the radula, jaw, and hook-sacs do not appear at its extremity.

Radula.—The formula is 6 : 1 : 6; the formula 4 : 1 : 4 given by Troschel[4] is that of young specimens; and even for them it is probably inexact, because Macdonald has found that larvæ measuring but 3 mm. (Pl. II. fig. 9) already possessed five lateral teeth on each side, the most distal being exceedingly small.

Hook-sacs.—Each containing about sixty hooks.

Colour.—The animal is colourless, rather transparent, with numerous small brown spots (in the specimens preserved in alcohol) visible to the naked eye, and due to cutaneous fatty glands.

Length.—Up to 24 mm.

Habitat.—Central parts of the Mediterranean Sea; Naples, Messina, and south of Sicily, 20 miles east of Malta, lat. 36° 1′ N., long. 15° 5′ E., where Macdonald found larvæ.

Observations.—I have already said that the genus *Trichocyclus* is not a good one, and that the forms described under this name are larvæ of different genera of Gymnosomata. All the Gymnosomata indeed, in the second part of their embryonic development, exist as naked larvæ, with three ciliated rings.

I may state that *Trichocyclus mediterraneus*, Costa,[5] is the larva of *Clionopsis krohni*; a fact that I was able to ascertain by original drawings, much more perfect than Costa's figure, which Dr. J. D. Macdonald kindly sent to me. One of these drawings (Pl. II. fig. 9) represents a larva, 3 mm. long, with the two posterior ciliated rings still attached, and one may say that its foot is similarly formed to that of the adult *Clionopsis krohni*, and that there is no longer a posterior lobe. The axial visceral nucleus is another proof which shows that this larva belongs to the genus *Clionopsis*, as do also the radula (of which the formula is then 5 : 1 : 5), and the form of

[1] *Archiv f. Naturgesch.*, Jahrg. xx. pl. x. fig. 1.

[2] Von Ihering therefore thought that *Cliopsis* was the "Jungstadium" of *Clione*, instead of a good genus (Vergleichende Anatomie des Nervensystems und Phylogenie der Mollusken, pp. 245, 246).

[3] Pteropodi della Fauna di Napoli, pl. v. fig. 6.

[4] Beitrage zur Kenntniss der Pteropoden, *Archiv f. Naturgesch.*, Jahrg. xx. p. 231.

[5] *Annuario del Mus. Zool. d. R. Univ. d. Napoli*, t. iii. p. 46, pl. i. fig. 3.

the hook-sacs, which are very short and contain numerous hooks disposed in the form of a bunch.

This larva was gathered by Macdonald, in lat. 36° 1′ N., and long. 15° 5′ E.

2. *Clionopsis grandis*, Boas (Pl. II. figs. 7, 8).

1885. *Pneumodermon peronii*, Verrill, Third Catalogue of the Mollusca recently added to the Fauna of the New England Coast, Trans. Conn. Acad. Arts and Sci., vol. vi. p. 431.

1886. *Clionopsis grandis*, Boas, Spolia atlantica, K. dansk. Vidensk. Selsk. Skriv., 6 Raekke, Bd. iv. p. 170.

Body a little more truncated at its posterior extremity than in the foregoing species. Nuchal tentacles less developed.

Foot.—The lateral lobes are a little larger and have the posterior extremity terminating in an acute angle, so that a small part of this extremity is free; the folded tubercle, situated behind and between these two lobes, is divided into two by a longitudinal median wrinkle.

Fins short and wide, rounded at their free extremity.

Posterior Gill.—Hexagonal crest of the same shape as in *Clionopsis krohni*; radiating crests longer. All these crests both radiating and hexagonal, and the latter on its six sides, lateral, ventral and dorsal, bear fringes on each side at the base, those of one side alternating with those of the other, whilst in *Pneumonoderma* fringes are developed only on the dorsal and ventral sides of the quadrangular crest and on the radial crests; these fringes are simple rounded foldings, short, not contracted at the base or subdivided, and resembling those of *Pneumonoderma pacificum*.

Radula.—The formula is 5 : 1 : 5 in the adult.

Hook-sacs with about the same number of hooks as in *Clionopsis krohni*.

Colour.—The animal is colourless; the small brown spots are not so large as in the foregoing species, and are chiefly numerous on the posterior part of the body and inside the hexagonal crest of the gill.

Length.—The specimen I have studied (from the North Atlantic) measured 22 mm.; but one specimen observed by Boas (from the China Sea), reached a length of 30 cm.

Habitat.—Australasian locality—China Sea (Copenhagen Museum). North Atlantic localities—(1) Twenty miles south-east of Cape Hatteras, lat. 35° 0′ N., long. 75° 0′ W. (U.S. National Museum and Brussels Museum); (2) lat. 39° 37′ N., long. 71° 18′ W., collected by the steamer "Albatross" of the U.S. Fish Commission, August 1883 (Verrill, as "*Pneumodermon peronii*").

I have not seen the type specimens of Boas in the Copenhagen Museum. The above description and the figures are taken from a specimen from the North Atlantic, sent to the Brussels Museum by the U.S. National Museum, under the name of "*Pneumodermon*, n. sp. (?)"

I did not find any specific differences between the characters of this specimen and those enumerated in Boas' description. If the comparison of living specimens from the two localities confirms the identity of the two forms, as I believe it will, it will prove that this species possesses an extensive geographical distribution.

* 3. *Clionopsis modesta*, n. sp. (Pl. III. fig. 2).

Body a little more oval and less truncated at the extremities than in the two foregoing species. Head small; labial tentacles rather short.

Foot rather large, with lateral lobes terminating behind in an acute angle; folded tubercle rather long.

Fins contracted towards their distal extremity.

Posterior Gill with scarcely distinct crests, and without foldings or fringes; radiating crests nearly obsolete.

Radula and *Hook-sacs* not investigated in the single specimen collected.

Colour.—Very pale rose, and without the small spots which are seen in the foregoing species; rectum visible as a dark brown line.

Length, 3 mm. Notwithstanding the small size of this species it is not a larva, but an adult specimen, the three ciliated rings having disappeared.

Challenger Specimen.—Station 254, July 17, 1875; Yokohama to Honolulu; lat. 35° 13′ N., long. 154° 43′ W.

In regard to the "two species of *Pneumodermon*" of Quoy and Gaimard, which Boas thinks may possibly belong to *Clionopsis*, see p. 32.

Pelagia alba of the same zoologists[1] (from Amboina; length, 23 mm.) seems also to have some resemblance to *Clionopsis*, in the general form of the body and the absence of a lateral gill. The absence of a posterior gill in Quoy and Gaimard's figure is explained by the slight development of this organ in most species of *Clionopsis*, and the absence of the foot by the fact, that when its two anterior lobes are removed, the foot, which possesses no posterior lobe, becomes almost indistinct. The enlargement of the cephalic region in the above mentioned figure, quite agrees with the supposition that the two anterior lobes of the foot were removed from one another in the figured specimen.

Family III. NOTOBRANCHÆIDÆ.

1886. *Notobranchaida*, Pelseneer, Description d'un nouveau genre de Ptéropode Gymnosome, Bull. Sci. départ. Nord, p. 224.

Characters.—Buccal appendages conical. Lateral gill absent. Posterior gill; three radiating crests (the dorsal one fringed) meeting posteriorly. Pigmented skin.

[1] Voyage de découvertes de l'Astrolabe, Zoologie, t. ii. p. 392, pl. xxviii. figs. 7–9.

Description.—Body ovate, contracted and pointed at the posterior extremity. Visceral mass not extending to this extremity. No dorsal spot as in the two foregoing families. Head short and swollen; neck short.

Foot.—Posterior lobe long, pointed at its free extremity; anterior lobes long, free for a great part of their length; between them, on the foot, a small tubercle.

Fins large, broad and rounded at their free extremity.

Posterior Gill.—Three longitudinal membranous crests which meet together at the posterior extremity of the body, and spread over about the posterior third of the body; of these crests, one is median and dorsal, the two others lateral (right and left) and symmetrical, the ventral side being naked. The dorsal crest alone is fringed, the fringes of the right side alternating with those of the left side; the two lateral crests are simple, without fringes or foldings. There is no lateral gill.

Buccal Appendages.—One pair of thick, short (perhaps shortened by shrinking in the alcoholic specimens), symmetrical cones, inserted on the lateral sides of the wall of the buccal cavity, flattened on their median side, and with a smooth surface.

Radula, *Jaw*, and *Hook-sacs* unknown. I had only a single specimen for examination from the Challenger collection (type of *Notobranchæa inopinata*), and one specimen in the Brussels Museum (type of *Notobranchæa macdonaldi*); thus I was not able to extract the horny buccal organs of these specimens without damaging them. But from the shortness of the neck it may be inferred that the hook-sacs are also rather short; and from the general resemblance of *Notobranchæa* to *Clione*, I think it probable that the radula of the adult, in this family, always possesses a median tooth, and that the jaw is perhaps absent.

As these horny pieces are important, from a systematic point of view, for the comparison of genera and species, they ought to be examined in the first specimen which is gathered in the future.

Notobranchæa,[1] Pelseneer.

1825. *Clio*, Rang (*pars*), Description d'un nouveau genre de la classe des Ptéropodes et de deux espèces nouvelles du genre Clio, Ann. d. Sci. Nat., ser. 1, t. v. p. 286.

1883. *Clio*, Macdonald (*pars*), On the Zoological Characters of the living Clio caudata, Trans. Roy. Soc. Edin., vol. xxiii. p. 186.

1886. *Notobranchæa*, Pelseneer, Description d'un nouveau genre de Ptéropode Gymnosome, Bull. Sci. départ. Nord, p. 224.

Characters and *Description* as for the family Notobranchæidæ.

I made this genus known in June 1886, founding it on a Gymnosomatous Pteropod from the North Atlantic, which was sent to the Brussels Museum by the U.S. National Museum.

I have previously said that many specimens of Pteropods were prepared for micro-

[1] From νῶτος, back, and βράγχια, gill.

scopical examination (stained and mounted in Canada balsam) by R. von Willemoes Suhm, without any previous examination. It was in this collection of preparations, which was sent to me along with the alcoholic specimens of Pteropods, that I found the following specimens of Gymnosomata from four Stations:—

Station 170, ...	*Halopsyche gaudichaudi.*
Station 240, ...	*Pneumonoderma pacificum.*
Between Stations 332 and 333, March 11, 1876,	*Spongiobranchæa australis.*
Near Station 354, May 7, 1876, . .	*Pneumonoderma violaceum.*

A little after the publication of my Description d'un nouveau genre de Ptéropode Gymnosome, and when the text of this Report was already far advanced, I re-examined this series of preparations to make certain that no Gymnosomatous Pteropod had escaped me. It was then that I found a specimen of a naked Pteropod from the North Atlantic, which was in such a state, from the colouring and the compression between the slide and cover-glass, that I did not recognise it on the first examination.

When this specimen was freed from the balsam, by dissolving the latter in chloroform, I was able to study it more easily, and found that it belonged to the new genus I had just established.

As the form that I described in June 1886 was only obtained in 1883, and the Challenger specimen from the Pacific was caught on June 24, 1875, the priority of the discovery of the genus *Notobranchæa* belongs to the Challenger Expedition, and to it also would have belonged the nominal priority, if the single specimen from Station 242 had not unfortunately been stained and compressed on the glass slide instead of being preserved in alcohol.

The two known species of the present genus are distinguished as follows:—

I. Dorsal crest of the gill with large and long fringes; anterior lobes of the foot free for two-thirds of their length, ...	*Notobranchæa macdonaldi.*
II. Dorsal crest of the gill with short and small fringes; anterior lobes of the foot free for half their length, ...	*Notobranchæa inopinata.*

1. *Notobranchæa macdonaldi*, Pelseneer (Pl. III. figs. 3, 4).

1884. *Clione longicaudatus*, Verrill, Second Catalogue of the Mollusca recently added to the Fauna of the New England Coast, Trans. Connect. Acad. Arts and Sci., vol. vi. p. 216.

1886. *Notobranchæa macdonaldi*, Pelseneer, Description d'un nouveau genre de Ptéropode Gymnosome, Bull. Sci. départ. Nord, p. 225.

Head round, neck contracted.

Foot with anterior and posterior lobes long and pointed at their free extremity; anterior lobes free for the two posterior thirds of their length; between these two lobes

there is, on the foot, a small tubercle, at the same place as in the Pneumonodermatidæ and Clionopsidæ.

Posterior Gill with dorsal crest bearing on each side from eight to ten fringes, those of one side alternating with those of the other.

Buccal Appendages.—Two thick symmetrical cones, occupying the whole width of the buccal cavity.

Length.—About 1 cm. (the specimen, contracted in its posterior part, measures 8 mm. in the contracted state).

Colour.—Brownish-grey.

Habitat.—North Atlantic, lat. 38° 10′ N., long. 74° 15′ W.; off Carolina (U.S. National Museum and Brussels Museum); lat. 39° 22′ N., long. 68° 34′ W., October 3, 1883, steamer "Albatross," of the U.S. Fish Commission (Verrill, as *Clione longicaudatus*).

Observation.—The specimens collected by Professor Verrill are certainly identical with the one sent to the Brussels Museum, because the latter was also identified by Professor Verrill as *Clione longicaudatus*, and because they were collected near the same place.

The larvæ noticed by Professor Verrill under the name of *Trichocyclus dumeriillii* (*sic*) are certainly not identical with the *Trichocyclus dumerilii* of Eschscholtz. Verrill's identification is due to the fact that all the Gymnosomatous larvæ with ciliated rings resemble each other very much. Although I have not seen these "*Trichocycli*," it seems to me that they are in reality the larvæ of *Notobranchæa macdonaldi*, because they were collected on the same day and at the same place as that species.

*2. *Notobranchæa inopinata*, n. sp. (Pl. III. figs. 5, 6).

Body and general aspect as in the foregoing species.

Neck a little less constricted.

Foot.—The anterior and posterior lobes are shorter than in *Notobranchæa macdonaldi*; the two anterior ones are less narrow and free only in their posterior half.

Posterior Gill.—The dorsal crest bears small fringes, somewhat spreading.

Buccal Appendages.—So far as I have been able to make out the single specimen I have studied, they are like those of the foregoing species.

Length, 4 mm.

Colour.—It cannot be estimated, the specimen having been stained with carmine by von Willemoes Suhm.

The state of the specimen does not allow of a more complete description being given.

Challenger Specimen.—Station 242, June 24, 1875; east of Japan; lat. 35° 29′ N., long. 179° 50′ W.

To the genus *Notobranchæa*, I refer *Clio capensis*, Rang,[1] from the Cape of Good Hope, which was considered by Gray,[2] d'Orbigny,[3] and Boas,[4] as a *Pneumonoderma*. The foot of "*Clio capensis*" shows the same disposition indeed as that of *Notobranchæa macdonaldi*; the neck and the head are also short, and finally, one can distinguish[5] the three crests of the posterior gill. But the figures given by Rang are not accurate in regard to the foot and still less so in regard to the gill; besides, the buccal appendages are not at all known. It is therefore impossible to identify the two forms.

On the other hand, Macdonald[6] has noticed, as "trigonal tailed *Clio*," a little Gymnosomatous Pteropod in which he has observed the same conformation of gill as in *Notobranchæa*. But the foot is not described, and there should be two (?) pairs of buccal cones, like those of *Cliona*.

Macdonald wrote me that he had obtained this Pteropod off Sydney Harbour. It follows then that the genus *Notobranchæa* is distributed in both the northern and southern hemispheres, in the Atlantic as well as in the Pacific Ocean.

Family IV. CLIONIDÆ.

1840. *Clionida*, Gray, Synopsis of the Contents of the British Museum, p. 86.
1842. *Pneumodermidæ*, d'Orbigny (*pars*), Paléontologie française, terrains crétacés, t. ii. p. 4.
1846. *Clionoida*, Agassiz (*pars*), Nomenclator Zoologicus, Index, p. 90.
1850. *Clioneidæ*, Gray, Catalogue of the Mollusca in the Collection of the British Museum, pt. ii., Pteropoda, p. 35.
1852. *Clios*, Souleyet (*pars*), Histoire naturelle des Mollusques Ptéropodes, p. 74.
1855. *Cliaidea*, Gegenbaur (*pars*), Untersuchungen über Pteropoden und Heteropoden, p. 212.
1856. *Cliida*, Woodward (*pars*), A Manual of the Mollusca, p. 208.

Characters.—Two or three pairs of conical buccal appendages. Jaw absent. Gill absent. Skin not pigmented.

Description.—*Body* long, contracted behind and pointed at its posterior extremity, visceral mass not extending to that extremity, and in the adult occupying only the anterior half of the body. Skin generally not pigmented; no dorsal spot. Head round and short; long labial tentacles; neck short.

[1] Description d'un nouveau genre de la classe des Ptéropodes et de deux espèces nouvelles du genre Clio, *Ann. d. Sci. Nat.*, sér. 1, t. v. p. 286, pl. vii. figs. 3, 4.
[2] Catalogue of the Mollusca in the Collection of the British Museum, pt. ii., Pteropoda, p. 40.
[3] Voyage dans l'Amérique méridionale, t. v. p. 190.
[4] Spolia atlantica, p. 167.
[5] Rang, *loc. cit.*, pl. vii. figs. 3, 4.
[6] On the Zoological Characters of the living Clio caudata, *Trans. Roy. Soc. Edin.*, vol. xxxiii. p. 180, pl. ix. fig. 3, 3.

Foot.—Anterior lobes large, broad in front, narrow and pointed behind, attached in nearly their whole length; posterior lobe short and pointed.

Gills.—Quite absent.

Proboscis short.

Buccal Appendages.—Two or three pairs of retractile, glandular and sensory cones, symmetrically inserted on the two sides of the buccal cavity.

Jaws.—Absent.

Radula always possessing in the adult a rather broad median tooth, without long projecting spines, and rather resembling that of *Halopsyche* than of any other Gymnosomatous Pteropod.

Hook-sacs of moderate size, with hooks of various lengths, so that when the sac is evaginated the extremities of all the hooks reach to about the same level.

The species of this family are generally described by zoologists under the name of *Clio*. But this name was established by Browne in 1756,[1] and preserved by Linné for a Thecosomatous Pteropod which most naturalists now name *Cleodora pyramidata*.

As the description of the genus *Cleodora* by Péron and Lesueur was only published in 1810,[2] the name *Clio*, on account of its priority, must be preserved instead of *Cleodora*, which is more generally used. O. F. Müller was therefore wrong when in 1776[3] he applied the generic name *Clio* to a naked Pteropod, for this name was originally used for a Thecosomatous form, and those zoologists who have followed him to this day are equally in error.

The Gymnosomatous Pteropods that are generally described under the name of *Clio* must be placed in the genus *Clione* which Pallas established as far back as 1774[4] for the type species, *Clione limacina* (his *Clione borealis*).

For the various Gymnosomata which certainly belong to the genus *Clione*, it was proposed to form new generic sections. Thus for some species whose buccal appendages were not described, Quoy and Gaimard in 1825 established[5] the genus *Cliodita*, based upon inexact differential characters. But these naturalists recognised later that this group could not stand and they abandoned their genus altogether.[6] It is therefore rather surprising to find that some more recent writers nevertheless preserve this genus.[7]

On the other hand, several zoologists, without giving new generic names, have shown

[1] The Civil and Natural History of Jamaica, p. 388.

[2] Histoire de la famille des Mollusques Ptéropodes, *Ann. Mus. Hist. Nat. Paris*, t. xv. p. 60.

[3] Faunæ Danicæ prodromus, p. 226.

[4] Spicilegia zoologica, fasc. x. p. 28.

[5] Description de cinq genres de Mollusques, *Ann. d. Sci. Nat.*, sér. 1, t. vi. p. 74.

[6] Voyage de découvertes de l'Astrolabe, Zoologie, t. ii. p. 371, 1832.

[7] Gray, Catalogue of the Mollusca in the Collection of the British Museum, pt. ii., Pteropoda, p. 37; H. and A. Adams, The Genera of Recent Mollusca, vol. i. p. 62; Bronn, Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 845; Fischer, Manuel de Conchyliologie, p. 424.

the necessity of forming new genera for some Gymnosomatous forms which I consider undoubtedly to belong to the genus *Clione*.

Gegenbaur, indeed, unfortunately confounding the tentacles and buccal appendages under the same name, divided *Clione* into two groups[1]:—(1) those with more than two "tentacles"—"*Clio borealis*" and "*Clio australis*"; (2) those with two tentacles—"*Clio capensis*, *Clio longicaudata*, *Clio limacella*, *Clio flavescens*, and *Clio mediterranea*"; and he says that if he had treated the question from the systematic point of view, he should have created a new genus for these last species.

But there are two species among these which do not belong to the family Clionidæ, namely, *Clio capensis*, Rang (= *Notobranchæa* sp.), and *Clio mediterranea*, Gegenbaur (= *Clionopsis krohni*, Troschel). "*Clio*" *longicaudata*, Souleyet, besides its true tentacles, which number two pairs as in *Clione limacina* (= *Clio borealis*), possesses two pairs of buccal cones of the same nature as the three pairs in the latter species. *Clio limacella*, Rang (which has never been described, but only figured), is a species very closely allied to *Clione longicaudata*, if not identical with it, and it very probably also possesses two pairs of buccal cones. Finally, respecting "*Clio*" *flavescens*, Gegenbaur, we shall see further on that our knowledge of its larva shows that it also possesses two pairs of buccal cones, as in *Clione longicaudata*. Thus, these latter species do not differ from the type of the genus *Clione*, except by having two pairs of buccal cones instead of three; and I think that this difference is not at all a generic one.

Macdonald also thought that one might generically separate the forms with three pairs of buccal cones from those which only possess two.[2] In his group with two pairs of buccal appendages, Macdonald includes two forms; one very close to *Clione longicaudata*, the other with a posterior gill, which thus does not belong to the family Clionidæ, and which must be removed from the *Clione* with two pairs of buccal appendages as well as from those which possess three pairs, and will be placed in the genus *Notobranchæa*.

It is quite as inadmissible for me to generically separate forms of Gymnosomata so nearly resembling one another, because they have two or three pairs of buccal cones, as to place in the same genus a Gymnosomatous Pteropod with a gill (*Notobranchæa*) and another without a gill (*Clione*). All the Gymnosomata with an elongated body, without a gill and with buccal cones (two or three pairs), must be placed in a single genus *Clione*.

Lastly, Fol, on account of the species he has called "*Clio*" *aurantiaca*, also thought that he should establish a new genus.[3] As we shall show further on, "*Clio*" *aurantiaca* must be considered as the old larva of a previously known species of the genus *Clione*.

[1] Untersuchungen über *Pteropoden und Heteropoden*, p. 212.

[2] On the Zoological Characters of the living Clio caudata, *Trans. Roy. Soc. Edin.*, vol. xxiii. p. 187.

[3] Sur le développement des Ptéropodes, *Archives d. Zool. expér.*, sér. 1, t. iv. p. 179.

Clione,[1] Pallas.

1774. *Clione*, Pallas, Spicilegia zoologica, fasc. x. p. 28.
1776. *Clio*, O. F. Müller (*non* Browne), Faunæ danicæ prodromus, p. 226.
1825. *Cliodita*, Quoy and Gaimard (*pars*), Description de cinq genres de Mollusques, Ann. d. Sci. Nat., sér. I, t. v. p. 74.
1840. *Spongiobranchæa*, d'Orbigny (*pars*), Voyage dans l'Amérique méridionale, t. v. p. 132.

Characters and Description.—As in the family Clionidæ, great confusion has existed for a long time in regard to the cephalic appendages of *Clione*. In a paper on these organs[2] I have shown that there may be distinguished :—

(1) The buccal appendages or cephaloconi, inserted on the wall of the buccal cavity.

(2) The true tentacles, situated on the external wall of the head, and numbering two pairs. First, the anterior, labial or oral pair, and second, the posterior, nuchal or cervical pair.

A great number of Gymnosomatous Pteropods are described under the name *Clione* (or *Clio*) ; but a considerable proportion of these forms are so little known, so imperfectly and insufficiently described and figured, that it is impossible since the type specimens have been lost to give a diagnosis of them, and to admit them into the nomenclature.

I have found in the literature (after eliminating, of course, the Thecosomata bearing the name *Clio*, which are more often called *Cleodora*) nineteen different names of *Clione* (or *Clio*).

Among these nineteen names there are :—

1. One given to a Mollusc of another group—

(1) *Clio amati*, Delle Chiaje[3] = *Gastropteron meckeli*, Kosse.

2. Names given to forms belonging to other genera of Gymnosomata—

(2) *Clio capensis*, Rang = *Notobranchæa* sp.
(3) *Cliodita caduceus*, Rang = *Spongiobranchæa australis*, d'Orbigny.
(4) *Clio mediterranea*, Gegenbaur = *Clionopsis krohni*, Troschel.

3. Names which are synonyms of other specific names of the genus *Clione*, as we shall see further on—

(5) *Clio aurantiaca*, Fol = *Clione flavescens*, Gegenbaur.
(6) *Clione borealis*, Pallas = *Clione limacina*, Phipps.
(7) *Clio caudata*, Gray (*non* Macdonald) = *Clione longicaudata*, Souleyet.
(8) *Clione dalli*, Krause = *Clione limacina*, Phipps.

[1] From Clio, a mythological name.
[2] The Cephalic Appendages of the Gymnosomatous Pteropoda, *Quart. Journ. Micr. Sci.*, 1885, p. 493.
[3] Memorie sulla storia e notomia degli animali senza vertebre del Regno di Napoli, t. i. p. 59.

(9) *Clione elegantissima*, Dall = *Clione limacina*, Phipps.

(10) *Clio miquelonensis*, Rang = *Clione limacina*, Phipps.

(11) *Clione papilionacea*, auctorum = *Clione limacina*, Phipps.

(12) *Clio retusa*, O. F. Müller (*non* L.) = *Clione limacina*, Phipps.

4. Names applied to species not well enough known and described to be distinguished from one another—

(13) *Clio australis*, Bruguière.

(14) *Cliodita fusiformis*, Rang.

(15) *Clio limacella*, Rang (without description).

(16) *Clio pyramidata*, Rang.

I shall speak afterwards of these last four species.

There are, then, only three forms well enough known and characterised to be distinguished from one another, as in the following table :—

I. With three pairs of buccal cones, ... *Clione limacina*.

II. With two pairs of buccal cones.

1. Animal small, of a brownish colour, with the posterior lobe of the foot very short, *Clione longicaudata*.

2. Animal of moderate size, of a yellowish colour, with the posterior lobe of the foot rather long, ... *Clione flavescens*.

Of these three species only one is very abundant in the Arctic Seas, and the two others are very localised, and thus the Challenger, which did not go to the Arctic Seas, did not bring back specimens of the genus *Clione*. It is the only genus of Gymnosomata that was not collected during the cruise.

1. *Clione limacina* (Phipps).

1773. *Clio limacina*, Phipps, A Voyage towards the North Pole, p. 195.

1774. *Clione borealis*, Pallas, Spicilegia zoologica, fasc. x. p. 28, pl. i. figs. 18, 19.

1776. *Clio retusa*, O. F. Müller, Faunæ danicæ prodromus, p. 226.

1825. *Clio miquelonensis*, Rang, Description d'un nouveau genre de la classe des Ptéropodes et de deux nouvelles espèces du genre Clio, Ann. d. Sci. Nat., sér. 1, t. v. p. 285, pl. viii. fig. 2.

1871. *Clione elegantissima*, Dall, Description of Sixty New Forms of Mollusca from the West Coast of North America, Amer. Journ. of Conchology, t. vi. p. 139.

1885. *Clione dalli*, Krause, Ein Beitrag zur Kenntniss der Mollusken Fauna des Beringe Meeres, Archiv f. Naturgesch., Jahrg. L. p. 299, pl. xviii. fig. 19*a*.

... *Clione papilionacea*, auctorum.

Body long, tapering to a point behind. Head round and swollen; neck short. Skin not pigmented over all its surface, but of a bright red colour at the posterior extremity and on the head and buccal cones[1] of the living animal (the alcoholic specimens are of an orange colour).

Foot.—Large anterior lobes, broad in front, pointed behind, attached in nearly their

[1] See the figure of Eschricht, Anatomische Untersuchungen über die Clione borealis, pl. i. figs. 1–4.

whole length; posterior lobe short, pointed behind and nearly concealed when the anterior lobes fall back against one another. In some specimens from Behring Strait, the posterior lobe is so short that it is only distinguished by a small undulation from the anterior lobes. Fins nearly triangular in shape, pointed at their free extremity.

Penis very long, bifid towards its base, and formed of a short lateral branch and a long posterior one.

Buccal Appendages.—Three pairs of contractile cones, symmetrically inserted on the wall of the anterior part of the digestive tract, so that they occupy the whole circumference of this part. At the median base of these cones the digestive tract is contracted into a pad, so that it forms a pair of false "lips."[1] The dorsal pair of cones are the longest and the ventral the shortest. When they are expanded, these organs are very long; their surface is covered with granulations visible with a magnifying glass. (These appendages contain special nervous terminations and glandular follicles.[2]) Behind the false lips is the short evaginable portion of the digestive tract or proboscis.

Radula.—Its formula varies with the size of the specimen. Therefore Krause gives 6 : 1 : 6 or 7 : 1 : 7,[3] Sars 8 : 1 : 8,[4] Loven 12 : 1 : 12,[5] and Boas 14 : 1 : 14,[6] &c. It is easy to find all these formulæ and the intermediate ones when examining specimens of various lengths. In specimens of large size which I have examined, I have found the same formulæ as Loven and Boas, or the intermediate one (13 : 1 : 13).

Hook-sacs of moderate length, with hooks of various sizes, regularly decreasing from the bottom of the sac to the edge, slightly bent (the larger less than the small) and assuming a fan-like arrangement when the sac is evaginated.

Colour.—Transparent; in the living animal the extremities are coloured bright red; the visceral mass (liver) is brownish-violet.

Length.—The largest specimens measure 35 to 40 mm.

Habitat.—*Clione limacina* is found in all the seas around the North Pole; Kara Sea; Nova Zembla; Waigatz Straits; White Sea; Spitzbergen; Norwegian coast—Finmark and Lofoten Islands to Karmoe Island (lat. 59° N.); Kattegat, Bohuslän; Island of Mull; west of Hebrides (lat. 59° N., long. 10° W.); Jan Mayen Island; Iceland; Coasts of Greenland; Baffin Bay; Davis Strait; Hudson Strait; Labrador; Newfoundland; Arctic Ocean, Alaska, Cape Lisburne; Behring Strait and Sea; Aleutian Islands (Akutan Pass); North Pacific, lat. 81° 30′ N., long. 161° 26′ W.).

The most northern point where *Clione limacina* was observed is lat. 81° 40′ N. (Ross); the southern limit of its geographical distribution nearly corresponds to the isothermal

[1] Pelseneer, The Cephalic Appendages of the Gymnosomatous Pteropoda, *loc. cit.*, pl. xxxv. fig. 4, *d*.

[2] See my paper on this subject, *loc. cit.*, pp. 495–500.

[3] Ein Beitrag zur Kenntniss der Mollusken Fauna des Beringa Meeres, *Archiv f. Naturgesch.*, Jahrg. II. p. 299.

[4] Bidrag til Kundskaben om Norges arktiske Fauna, I., Mollusca Regionis Arcticæ Norvegiæ, pl. xvi. fig. 21, *f*.

[5] Om tungans bevapning hos Mollusker, *Öfversigt k. Vetensk. Akad. Handl.*, 1847, p. 188, pl. iii.

[6] Spolia atlantica, p. 162.

line of 60° F. (for August) or with the isocryme of 44° F. When the temperature sinks very low *Clione limacina* may reach more to the south; thus, from April 7th to the beginning of May 1868, it was observed at Portland, Maine, U.S.A. (lat. 43° 30′ N.)[1] and in 1833 at New York (lat. about 41° N., the latitude of Madrid and Naples).

Notwithstanding that these two localities are comparatively southern from a geographical point of view (isothermally New York corresponds with Scotland), they are less remarkable than the European locality of Falmouth, Cornwall (about lat. 50° 9′ N.),[2] for, isothermally, Falmouth nearly corresponds with the localities in lat. 35° N. on the east coast of North America.

Observation.—The larvæ of this species had not been described until quite recently, and having been able to examine a great many larvæ of all sizes, I prepared drawings of young *Clione*; but since Boas has lately figured it,[3] I do not think it necessary to introduce these into the plates of this Report.

The naked larvæ of *Clione limacina*, in the first stage of their development, are certainly testaceous like that of *Clione flavescens*, Gegenbaur (*Clio aurantiaca*, Fol).[4] They differ from the adult by the length of the posterior lobe of the foot (which is often longer than figured by Boas), and by the fact that the visceral mass extends more posteriorly in the body. The fins of the very small larvæ are but little developed.

The ciliated rings often remain to a very late stage, but in a rather variable manner; the anterior ring has nearly always disappeared from specimens measuring from 2 to 3 mm., and the second ring from specimens of 5 or 6 mm., but old larvæ of 15 mm. occasionally retain the three ciliated rings. Traces of the posterior ring are often found on specimens of rather large size.

The hook-sacs of the larvæ with ciliated rings are identical with those of adults, while the radula differs by the small number of lateral teeth.

Clione limacina is the only Gymnosomatous Pteropod of which the copulation has been observed. Copulating specimens, preserved in alcohol, are disposed as follows: the two animals are in contact ventrally, in symmetrical positions, with their axes parallel; the union is reciprocal, the two penes crossing each other, the short branch being placed at the genital orifice of the other animal, and the long branch turned behind and applied by its extremity to the ventral side of the other branch.

With *Clione limacina* I identify *Clione elegantissima*, Dall. This form was found by Dall in the North-West Pacific; the collected specimens measured about 7 mm. One of these specimens which Dall kindly sent to me does not differ at all from *Clione limacina*

[1] Gould, Report on the Invertebrata of Massachusetts, p. 507.

[2] There is in the collection of the Museum d'Histoire Naturelle of Paris a specimen from Falmouth, presented by Leach.

[3] Spolia atlantica, pl. vii. fig. 103. In the same plate (fig. 101) there is a good figure of the adult. Therefore a new figure of the adult *Clione limacina* in the plates of this Report is quite unnecessary.

[4] Sur le développement des Ptéropodes, *Archives d. Zool. expér.*, sér. 1, t. iv. pl. x. figs. 6, 7.

of the same length; the hook-sacs, the radula, the buccal cones, the foot, &c., are quite similar. In the living animal a red line exists on the fins, which, however, is not now visible in the alcoholic specimens; but in other respects *Clione elegantissima* is exactly the same as the young of *Clione limacina*.

With respect to *Clione dalli*, Krause, this author says that it only differs from *Clione elegantissima* by having two ciliated rings. The collected specimens measured from 5 to 6 mm., and had the radula similar to that in specimens of *Clione limacina* of the same size. They are thus really the young of this species.

2. *Clione longicaudata* (Souleyet).

1840. *Spongiobranchea elongata*, d'Orbigny, Voyage dans l'Amérique méridionale, t. v. p. 132, pl. ix. figs. 8, 9.

1850. *Clione caudata*, Gray, Catalogue of the Mollusca in the Collection of the British Museum, pt. ii., Pteropoda, p. 37.

1852. *Clio longicaudatus*, Souleyet, Voyage de la Bonite, Zoologie, t. ii. p. 286, pl. xiv. figs. 17–21.

Body very long, with posterior part very pointed.

Foot.—Antero-lateral lobes large, wide in front, pointed posteriorly; posterior lobe probably very short;[1] Souleyet says[2] that the foot of *Clio longicaudatus* is like that of *Pneumonoderma*, without the posterior lobe. But the anterior lobes being very large, they probably hid the posterior lobe, as often happens in *Clione limacina*. Besides, we have seen that, in this last species, there are some specimens with the posterior lobe of the foot very small; but however minute it may be, this lobe is always distinct, and exists in all the *Clione* (*Clione limacina*, *Clione flavescens*) and in all the other Gymnosomata, except *Clionopsis*. It is therefore very improbable (as Ihering[3] following Souleyet's figure states) that *Clione longicaudata* has no posterior lobe to the foot.

Proboscis rather short.

Buccal Appendages.—Two pairs of cones, like those of *Clione limacina*.

Colour.—Dark brown.

Length.—Does not measure 10 mm. (Souleyet).

Habitat.—Atlantic Ocean, lat. 10° N., long. 21° W.; "*Spongiobranchea elongata*," which I identify with the present species, was gathered in lat. 4° N., long. 25° W.

Observation.—"*Spongiobranchea elongata*," d'Orbigny, is in reality not a *Spongiobranchæa*; in the shape of the body, head, and foot, it quite resembles *Clione longicaudata*. The habitats of the two forms make their identity still more certain, the localities where they were gathered being very close to one another.

[1] The type-specimen of Souleyet, in the Museum of Paris, being quite destroyed, and d'Orbigny's specimens not having been preserved, it was impossible to definitively decide on this point until new specimens had been obtained.

[2] Voyage de la Bonite, Zoologie, t. ii. p. 286.

[3] Vergleichende Anatomie des Nervensystem und Phylogenie der Mollusken, p. 248.

3. *Clione flavescens*, Gegenbaur.

1855. *Clio flavescens*, Gegenbaur, Untersuchungen über Pteropoden und Heteropoden, p. 73, pl. iv. fig. 15, A, B.

1875. *Clio aurantiaca* (larva), Fol, Sur le développement des Ptéropodes, Archives d. Zool. expér., sér. 1, t. iv. p. 178, pl. x. fig. 10.

Body of moderate length, and terminating behind in a point (quadrangular, according to Gegenbaur). The visceral mass only extends to the middle of the body.

Head rather wide (in Gegenbaur's figure the nuchal tentacles are distinguishable).

Foot.—Anterior lobes rather wide, pointed behind; posterior lobe rather long and pointed.

Fins wide at the base, but like those of *Clione limacina*.

Buccal Appendages.—They have not been described, and Professor Gegenbaur wrote me that the type specimen of this species no longer exists. But from the larva, it is known that *Clione flavescens* possesses two pairs of cephaloconi, as in the foregoing species.

Radula.—Unknown in the adult; in the larva, there are 2 : 1 : 2 teeth (Fol)[1]; (in the adult the radula probably possesses twice or three times as many lateral teeth). The median teeth resemble those of *Clione limacina*, except that they possess a small median denticle.

Hook-sacs rather short in the larva.

Colour.—The skin is transparent with a yellowish reflection; the visceral mass has a yellow tint.

Length.—About 22 mm.

Habitat.—Messina (Sicily). The first "Preisverzeichniss" of the zoological station[2] mentions "*Clio flavescens*" from the Gulf of Naples, but the form there obtained was *Clionopsis krohni*. *Clione flavescens* has only been found at Messina, once in the adult, and twice in the larval state.[3]

It is a true *Clione*, as much by the shape of the body and foot as by the absence of gills. Bronn was therefore wrong in saying that only *Clionopsis* was found in the Mediterranean Sea.[4]

Observation.—I consider "*Clio aurantiaca*," which Fol thought "probably adult," as the young of *Clione flavescens*.

Notwithstanding that it has been seen to lay eggs, "*Clio aurantiaca*" is not an adult. It hardly reaches 2 mm. in length, and has still all the three ciliated rings; besides its radula has a larval formula.

[1] Sur le développement des Ptéropodes, *Archives d. Zool. exper.*, sér. 1, t. iv. p. 178.

[2] *Mitth. aus d. zool. Stat. zu Neapel*, Bd. 1.

[3] Besides Fol, J. Muller, Ueber verschiedene formen von Seethieren, *Archiv f. Anat. u. Physiol.*, p. 70, 1864.

[4] Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 630.

The following considerations clearly prove that this form is the young state of *Clione flavescens*:—

1. The presence of but one true *Clione* in the Mediterranean has been so far ascertained, viz., *Clione flavescens*. On the other hand, only one larva of a true *Clione*, "*Clio aurantiaca*," is known to exist in the Mediterranean. This form is indeed a true *Clione*, a fact made evident by the shape of the foot, as well as by that of the buccal appendages. As to the larvæ of *Clione* described by Johannes Müller,[1] they are identical with "*Clio aurantiaca*," as may be seen from the buccal appendages and the radula.

2. *Clione flavescens* has never been collected except at Messina. At Messina also, and there alone, the larva called "*Clio aurantiaca*" has been twice caught.

3. *Clione flavescens* is yellow; this also is the colour of "*Clio aurantiaca*."

I therefore think there can be no doubt at all as to the identity of these two forms, and hence one may safely conclude that *Clione flavescens* possesses two pairs of buccal cones or cephalocони, as exist in *Clio aurantiaca*.

I cannot figure this species nor the foregoing one, because the only known specimens do not now exist. They and *Dexiobranchæa paucidens* are the only species that I have not myself seen.

Among the species of the genus *Clione* which are imperfectly known, there are two which in their general aspect rather closely resemble *Clione longicaudata*; they are:—

1. "*Clindita fusiformis*," Quoy and Gaimard,[2] collected between the Cape of Good Hope and Mauritius.

2. "*Clio limacella*," Rang,[3] without description or recorded habitat; only known from figures.

A *Clione* from the South-West Pacific, of which Dr. Macdonald gave me an original drawing, very much resembles "*Clio*" *limacella*, and is of the same length (6 mm.); they are both adults, because they no longer show any trace of ciliated rings.

Lastly, "*Clio*" *caudata*, Macdonald,[4] which this writer identifies with *Clione longicaudata*,[5] also resembles very much "*Clio*" *limacella*. "*Clio caudata*," Macdonald, which was collected off Sydney Harbour, possesses a radula of which the formula is 6 : 1 : 6, and bears two pairs of buccal cones.

Probably "*Clio*" *fusiformis* and "*Clio*" *limacella* are also provided with two pairs of buccal appendages, and belong to the group of *Clione longicaudata*.

Our knowledge of these species shows that the genus *Clione* is distributed south of

[1] *Archiv f. Anat. u. Physiol.*, p. 70, 1854.

[2] *Description de cinq genres de Mollusques*, *Ann. d. Sci. Nat.*, sér. 1, t. vi. p. 74, pl. ii. figs. 3, 4.

[3] Histoire naturelle des Mollusques Ptéropodes, pl. x. figs. 10–12.

[4] On the Zoological Characters of the living Clio caudata, *Trans. Roy. Soc. Edin.*, vol. xxiii. p. 185, pl. ix. fig. 3, *t.*

[5] I cannot confirm this identification, because Macdonald gives no description of this form, and especially no indication of the conformation of the foot.

the equator, but is rather localised and not very abundant, for no one has ever collected numerous specimens of the different species just mentioned.

In regard to two other species, "*Clio*" *pyramidalis*, Quoy and Gaimard,[1] and "*Clio*" *australis*, Bruguière,[2] they are very imperfectly known.

The first was taken in the harbour of Amboina, and measured 10 mm. in length; it is represented as of so strange a shape, that the accuracy of the figure of Quoy and Gaimard is a little doubtful.

The second species is known only from an obscure description and more obscure figure by Bruguière, who says that it was abundant on the south coast of Madagascar. Since the time of Bruguière, some naturalists have made collections of the Mollusca of that island, but no one has again found this species. I hope, however, that further researches will be made, for it would be very interesting indeed to obtain this Pteropod, because it would be the largest of all (according to Bruguière, it measures 2 inches in length), and it is said to have also three pairs of buccal cones, as in *Clione limacina*.

The other species described under the name of *Clione* or *Clio* (after deducting the Thecosomata which bear the latter name, and which most zoologists still call *Cleodora*), are, as we have already seen, synonymous with other forms previously known.

Ross[3] recorded, under the name *Clio borealis*, a Gymnosomatous Pteropod obtained between lat. 60° and 64° S., along with "*Argonauta arctica*" (the latter is really a *Limacina*, and was found by the Challenger).[4] According to Souleyet,[5] the naturalists of the "Astrolabe" also found, during the last voyage, a *Clione* "among the ice of the South Pole," which must certainly be the same species as the "*Clio borealis*" of Ross. Unfortunately, in the zoological account of this voyage, there is no Pteropod mentioned, and I do not know what became of the specimens of *Clione* noticed by Souleyet.

However, if one may be allowed to make a hypothesis respecting these examples, it seems to me rather probable that they are only *Spongiobranchæa australis*, a species which is widely distributed throughout the cold Antarctic Seas, where it was previously observed from long. 60° W. to long. 123° E.; towards the equator it scarcely passes beyond the isothermal line of 50° F. (for August), and it has up to the present time been collected as far as lat. 51° S. It is therefore a species belonging to the cold regions, and I think it will be found to exist all around the South Pole, as *Clione limacina* does around the North Pole.

Bronn[6] mentions an Australian *Clione*, according to Lamartinière. But the species described by this last writer is a *Clio* (Thecosomatous Pteropod) known to zoologists under the name of *Clio* (or *Cleodora*) *pyramidata*.

[1] Voyage de découvertes de l'Astrolabe, Zoologie, t. ii. p. 371, pl. xxvii. fig. 37.
[2] Encyclopédie méthodique, Vers, t. i. p. 507, pl. lxxv. figs. 1, 2.
[3] A Voyage of Discovery and Research in the Southern and Antarctic Regions, vol. i. p. 169, 1847.
[4] Station 153, lat. 65° 42′ S., long. 78° 40′ E.
[5] Histoire naturelle des Mollusques Ptéropodes, p. 80.
[6] Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 582.

Family V. Halopsychidæ.

1850. *Cymbuliadæ*, Gray (*pars*), Catalogue of the Mollusca in the Collection of the British Museum, pt. ii., Pteropoda, p. 24.
1856. *Hyaleidæ*, Woodward (*pars*), A Manual of the Mollusca, p. 204.
1859. *Eurybiidæ*, Chenu, Manuel de Conchyliologie, t. i. p. 115.

Characters.—One pair of long flattened buccal appendages, not retractile into the front part of the digestive tract. Proboscis absent. Gill absent. A bifid jaw. Unpigmented skin.

Description.—*Body* ovate, of medium length, wide and thick, rounded behind. Visceral mass extending to the posterior part of the body. The integuments are hard, but do not form a shell at all. The head and fins of the contracted specimens may be retracted into the body-wall, as in *Pneumonoderma*; in that state, a dorsal extension of the integuments of the body covers and protects the head.

Head very small relatively to the body.

Foot.—Anterior lobes free and rounded behind; posterior lobe of moderate length, contracted posteriorly. The separation of the posterior lobe of the foot from the fins is more difficult to make out than in the other Gymnosomata, although the disposition is the same, and the figures of Souleyet[1] and Huxley[2] are inexact on that point.

Fins.—They differ from those of all other Gymnosomata. In the latter, they are always abruptly contracted at the base, and their greatest width is placed immediately behind this contracted part; but the fins of the Halopsychidæ on the contrary are very long, and gradually narrow from the extremity towards the base, so that the greatest width is at the distal end. This extremity is nearly truncated and slightly sinuous in the middle.

Proboscis and *Hook-sacs* absent.

Jaw.—The two halves extend dorsally, on each side of the buccal orifice, forming a long double or triple row of small toothed horny plates.

Radula always with a median tooth, without denticles; resembling that of *Clione*.

Cephalic Appendages.—They have been described under various names, and generally in an inexact and incomplete manner, by the zoologists who have studied the organisation of *Halopsyche*.

In this genus, as well as in all the Gymnosomata (with the exception of *Clionopsis*), there are:—

1. *Tentacles properly so called.*—As in all the other genera of Gymnosomatous Pteropods, they number two pairs; (1) the anterior, oral or labial tentacles, placed more dorsally than in the other Gymnosomata; they were called by most of the writers, "the median branch inserted at the base of the tentacles;" (2) the posterior, nuchal or cervical tentacles, which have not yet been seen by any naturalist, except Huxley, who calls them "rudiments of eyes upon the outer side of the base of the tentacles,"[3] whereas

[1] Voyage de la Bonite, Zoologie, pl. xv. fig. 1. [2] On the Morphology of the Cephalous Mollusca, pl. iv. fig. 3.
[3] On the Morphology of the Cephalous Mollusca, *Phil. Trans.*, p. 41, pl. iv. fig. 3, *t*, 1853.

these nuchal tentacles are quite separated from the so-called "tentacles." They are terminated by a small swelling, and although rather short, they are more projecting than in all other Gymnosomata, except *Clionopsis krohni*; they are more laterally inserted than in the other genera but are innervated in the same manner.[1] These tentacles are shown in Pl. III. figs. 7, 8.

2. *Buccal Appendages.*—They number one pair, are very long (nearly as long as the fins), flattened and extensible, and are inserted one on each side of the buccal orifice (3, fig. 4). They are the so-called tentacles of the majority of zoologists, less the "medial branch of their basis," which is, as we have seen, the true anterior tentacles (2, fig. 4). Souleyet calls them gills.[2] Ihering[3] is the only one who considered them as corresponding to the buccal appendages of *Clione*, &c.; but he did not recognise the tentacles properly so-called.

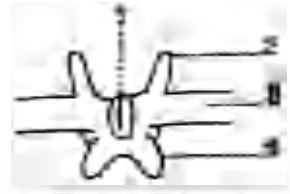

Fig. 4.—Head of *Halopsyche gracilis*, front view; magnified about 10 diameters. 1, buccal orifice; 2, anterior tentacle; 3, buccal appendage; 4, anterior lobe of the foot.

Regarding the union by their bases of the anterior tentacles and buccal appendages, I explain it as follows. The genus *Halopsyche* is the only one among the Gymnosomata which does not possess the so-called cephalic hood, which covers the buccal appendages when these are retracted within the buccal cavity. The buccal orifice of *Halopsyche*, therefore corresponds to the "false lips" of *Clione*; the buccal appendages indeed are inserted on its sides, like the cephaloconi in *Clione*. The anterior tentacle not being therefore inserted on a cephalic hood in this genus, has been confounded, so far as the base is concerned, with the buccal appendage, because both have a common retractor muscle.

The structure of the buccal appendages of *Halopsyche* is not known, and I had no specimens sufficiently good for histological investigation.

Halopsyche,[4] Bronn.

1825. *Pysche*, Rang (not Linné), Description d'un nouveau genre de la classe des Ptéropodes, Ann. d. Sci. Nat., sér. 1, t. v. p. 284.
1827. *Euribia*, Rang (not Hübner, 1806), Description de deux genres nouveaux appartenant à la classe des Ptéropodes, Ann. d. Sci. Nat., sér. 1, t. xii. p. 328.
1856. *Eurybia*, Woodward, A Manual of the Mollusca, p. 206.
1862. *Halopsyche*, Bronn, Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 645.
1862. *Thecosomata*, Bronn, Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 645.

Characters and *Description* the same as for the family Halopsychidæ. Rang established the genus *Pysche* in 1825 for a Pteropod without a shell that he called

[1] Pelseneer, Recherches sur le système nerveux des Ptéropodes, *Archives de Biologie*, t. vii. p. 110.
[2] Voyage de la Bonite, Zoologie, t. ii. p. 247.
[3] Vergleichende Anatomie des Nervensystems und Phylogenie der Mollusken, p. 240.
[4] From ἅλς, sea, and ψυχή, a mythological name.

Pysche globulosa, and which he considered to be one without a distinct head. But since the name *Pysche* had already been applied by Linné to a genus of butterflies, it had to be eliminated from the nomenclature of the Pteropods, and Bronn, therefore, substituted the name *Halopsyche*, which has been adopted by Verrill,[1] Lankester[2] and Boas.[3]

In 1827 Rang formed another new genus, *Eurybia*, for a Pteropod that he thought to be testaceous (a supposition since proved to be incorrect); but here again the name *Eurybia* had been already used by Hübner (1806), and it could not be retained for a Pteropod, and Bronn therefore changed it to *Thecosomata*.

But, on the other hand, Souleyet[4] showed that the two genera "*Psyche*" and "*Eurybia*" of Rang are not distinct, and the name *Halopsyche* must therefore be retained for the whole group.

Rang,[5] Cuvier,[6] Gray,[7] Owen,[8] Woodward,[9] Adams,[10] Bronn[11] and Lankester,[12] have all considered these animals as Thecosomatous Pteropods; Macdonald[13] and Boas[14] alone maintaining that they are Gymnosomata. This last opinion is the true one.

Halopsyche indeed does not possess any character of the Thecosomata; on the contrary, it shows all the characters common to the Gymnosomata; it possesses neither mantle skirt, shell, nor pallial cavity; it has a distinct head, bearing two pairs of tentacles (the posterior with rudiments of eyes); the foot and fins are separated; there are buccal appendages and a jaw of which the two halves are united in the median line; there are no stomachal horny plates; the anus is on the right side (and not on the left, as stated by Huxley[15]); the cerebral ganglia are united above the œsophagus; and finally, the larvæ resemble those of all the Gymnosomata (Pl. III. fig. 9).

Halopsyche therefore has no relation to the Thecosomata. If its radula seem to resemble that of the Thecosomata in the number of the teeth, it differs from it by the conformation of the teeth, as may be seen below.

Halopsyche can no longer be regarded, as some zoologists believe, as a transitional

[1] Notice of Recent Additions to the Marine Invertebrata of the North-East Coast of America, *Proc. U.S. Nat. Mus.*, vol. iii. p. 393.

[2] Mollusca, Encyclopædia Britannica, ed. 8, vol. xvi. p. 666.

[3] Spolia atlantica, p. 171.

[4] Voyage de la Bonite, Zoologie, t. ii. p. 252.

[5] Description de deux genres nouveaux appartenant à la classe des Ptéropodes, *Ann. d. Sci. Nat.*, sér. 1, t. xii. p. 328.

[6] Le Règne animal.

[7] Catalogue of the Mollusca in the Collection of the British Museum, pt. ii., Pteropoda, p. 87.

[8] Mollusca, Encyclopædia Britannica, ed. 8, vol. xv. p. 361.

[9] A Manual of the Mollusca.

[10] The Genera of Recent Mollusca, vol. i. p. 66, 67.

[11] Die Klassen und Ordnungen des Thierreichs, Bd. iii. pp. 646.

[12] Mollusca, Encyclopædia Britannica, ed. 9, vol. xvi. p. 636.

[13] On the Anatomy of Eurybia gaudichaudi, *Trans. Linn. Soc. Lond.*, vol. xxii. p. 248.

[14] Spolia atlantica, p. 171.

[15] On the Morphology of the Cephalous Mollusca, *Phil. Trans.*, p. 41, 1853.

type, with common characters of the two groups Thecosomata and Gymnosomata, because these groups are very distinctly separated from one another.

**Halopsyche gaudichaudi*, Souleyet (Pl. III. figs. 7–9).

1852. *Eurihia gaudichaudii*, Souleyet, Voyage de la Bonite, Zoologie, t. ii. p. 253, pl. xiv. figs. 1–6.

1883. *Thecurybia norfolkensis*, Lankester, Molluscs, Encyclopædia Britannica, ed. 9, vol. xvi. p. 666, fig. 83.

1886. *Halopsyche gaudichaudii*, Boas, Spolia atlantica, p. 173, pl. viii. fig. 119.

Body ovate, nearly globose, barrel-shaped, rounded at the posterior extremity.

Head small and rather short.

Fins long, wide and truncated at their extremity, of which the margin is slightly sinuous.

Radula.—Formula 1 : 1 : 1; the median tooth entirely differs from that of the Thecosomata, and on the contrary much resembles that of *Clione*; the lateral teeth are long and narrow and have a wide basal part, as in all the Gymnosomata.

Colour.—Nearly absent; the body-wall is translucent and slightly yellowish.

Length, 4 mm.; very large specimens reach 6 or 7 mm. (Souleyet).

Challenger Specimens.—West Pacific locality—Station 170, July 14, 1874; off the Kermadec Islands; lat. 29° 55′ S., long. 178° 14′ W.

Australasian locality—Station 201, October 26, 1874; off Mindanao, Philippine Islands; lat. 7° 3′ N., lat. 121° 48′ E. (numerous specimens).

Habitat.—West Pacific Ocean, to long. 174° E., between lat. 40° N. (Kiel Museum), and lat. 29° S (Challenger Expedition, Station 170); generally in large shoals.

Observation.—According to Macdonald[1] this species possesses the curious peculiarity of being ovoviviparous. The larvæ are proportionally longer than the adults; they are posteriorly a little pointed and thus possess the general form of the larvæ of the Gymnosomata (Pl. III. fig. 9). The two posterior ciliated rings remain visible until a late period.

Cymbulia norfolkensis, Quoy and Gaimard,[2] must be related to the present genus; it seems very close to *Halopsyche gaudichaudi*, from which it only differs (according to the figures of Quoy and Gaimard) by having small tubercles on the wall of the body. *Cymbulia norfolkensis* was caught near the Norfolk Islands, and measures about 5 mm. in length, but it is not well enough known to definitively decide its systematic position.

In regard to *Eurihia hemispherica*, Rang[3] and *Psyche globulosa*, Rang,[4] both from

[1] On the Anatomy of Eurybia gaudichaudi, *Trans. Linn. Soc. Lond.*, vol. xxii. p. 246, pl. xliii. fig. 6.

[2] Voyage de découvertes de l'Astrolabe, Zoologie, t. ii. p. 376, pl. xxvii. figs. 31, 32.

[3] Description de deux genres nouveaux appartenant à la classe des Ptéropodes, *Ann. d. Sci. Nat.*, sér. 1, t. xii. p. 329, pl. xiv*. figs. 9–11. The specimens called *Eurihia hemispherica* in the British Museum are not Pteropods.

[4] Description d'un nouveau genre de la classe des Ptéropodes, *Ann. d. Sci. Nat.*, sér. 1, t. v. p. 284, pl. vii. fig. 1.

the Atlantic Ocean (the latter from Newfoundland), it is very difficult thoroughly to appreciate them, so summary are the descriptions and figures of Rang; but they appear to resemble one another very closely.

Verrill says[1] that he found the "*Halopsyche*" *globulosa*, Rang, on the shores of Newfoundland and Nova Scotia. I have several times asked him for a specimen for examination, but have never obtained one.

Souleyet[2] thinks that *Argivora parva*, Lesueur,[3] from La Martinique, also resembles *Halopsyche*; but the information available in regard to this species is very fragmentary, and its affinities cannot at present be decided. It is described, indeed, as a naked *Cymbulia*; it may, therefore, be a *Tiedemannia* (*Gleba*), that is, a Thecosomatous Pteropod.

In conclusion, I must notice the genus *Thliptodon*, Boas, that I mentioned when speaking of the larvæ of the Pneumonodermatidæ. This genus is known only from its larva, and thus its systematic position remains uncertain among the various families of Gymnosomata.

These larvæ have a larger head than any other known larva of Gymnosomatous forms. Its radula has a formula of 4 : 1 : 4; the median tooth is very short and without denticles; on the contrary the lateral teeth are very long, narrow, and slightly bent at their free extremity. The jaw, the hook-sacs, and the buccal appendages have never been seen; perhaps some of them are wanting. The largest larvæ have a foot, the posterior lobe of which is well developed. The third or posterior ciliated ring has the form of a star with three radii; it may, therefore, be asked if the posterior gill of the adult is not perhaps like that of *Notobranchæa*.

Two larvæ observed by Krohn[4] (one of them at Funchal, Madeira), possess a radula which resembles that of the above larvæ, formerly described by Gegenbaur[5] (and which Boas called *Thliptodon gegenbauri*).

With respect to the genus *Cymodocea* (*Cymodocea diaphana*, d'Orbigny),[6] it is a form that is quite indeterminable from d'Orbigny's description; it was, moreover, founded upon a mutilated specimen.

It is very doubtful whether the organism called *Homoderma*[7] was a Pteropod at all; it has no fins, and its mouth is lateral not axial.

[1] Notice of Recent Additions to the Marine Invertebrata of the North-East Coast of America, *Proc. U.S. Nat. Mus.*, vol. iii. p. 303.

[2] Histoire naturelle des Mollusques Ptéropodes, pp. 71, 72.

[3] De Blainville, Manuel de Malacologie, p. 655.

[4] Beitrage zur Entwickelungsgeschichte der Pteropoden und Heteropoden, pp. 11, 14, pl. i. figs. 6, 11.

[5] Untersuchungen über Pteropoden und Heteropoden, pl. v. figs. 14–17.

[6] Voyage dans l'Amérique méridionale, t. v. p. 133, pl. ix. figs. 16, 17.

[7] Van Beneden, Exercices zootomiques, p. 54, pl. iii. figs. 4, 5.

SUMMARY OF THE KNOWN SPECIES OF GYMNOSOMATA.

It will be seen from the foregoing descriptive monograph, that we now know fairly well, and in the adult state, twenty-one species of Gymnosomatous Pteropoda, which are divided as follows :—

Genera.	Species.
Dexiobranchæa, ...	5
Spongiobranchæa, ...	1
Pneumonoderma, ...	6
Clionopsis, ...	3
Notobranchæa, ...	2
Clione, ...	3
Halopsyche, ...	1
7	21

Of these twenty-one species, eleven were collected by the Challenger Expedition; these eleven species belong to six of the seven known genera, the genus *Clione* being alone wanting (for the arrangement of the species in the different genera, see the table in the Introduction, p. 8). One of these genera is new (*Notobranchæa*), as are also more than a third of the species collected (four out of eleven).

The eleven Challenger species were obtained at thirteen different Stations, as shown in the following list; all being collected, like all the living Pteropoda, in surface gatherings.

GEOGRAPHICAL DISTRIBUTION.

STATION LIST OF THE GYMNOSOMATOUS PTEROPODA OF THE CHALLENGER EXPEDITION.

STATION 158. March 7, 1874; south of Australia; lat. 50° 1′ S., long. 123° 4′ E.; surface temperature, 45° F.

Spongiobranchæa australis. Also at Station 314A; and on March 11, 1876

STATION 170. July 14, 1874; off the Kermadec Islands; lat. 29° 55′ S., long. 178° 14′ W.; surface temperature, 65° F.

Halopsyche gaudichaudi. Also at Station 201.

STATION 201. October 26, 1874; Philippine Islands; lat. 7° 3′ N., long. 121° 48′ E.; surface temperature, 83° F.

Halopsyche gaudichaudi. Also at Station 170.

STATION 222. March 16, 1875; north of New Guinea; lat. 2° 15′ N., long. 146° 16′ E.; surface temperature, 82°·8 F.

Pneumonoderma peroni.

STATION 240. June 21, 1875; North Pacific, east of Japan; lat. 35° 20′ N., long. 153° 39′ E.; surface temperature, 64°·8 F.

Pneumonoderma pacificum. Also at Station 254.

STATION 242. June 24, 1875; North Pacific, east of Japan; lat. 35° 29′ N., long. 161° 52′ E.; surface temperature, 68°·5 F.

Notobranchæa inopinata.

Between Stations 247 and 248. July 4, 1875; North Pacific; lat. 36° 42′ N., long. 179° 50′ W.; surface temperature, 73°·2 F.

Dexiobranchæa minuta.

STATION 254. July 17, 1875; North Pacific, north of the Sandwich Islands; lat. 35° 13′ N., long. 154° 43′ W.; surface temperature, 72° F.

Pneumonoderma pacificum. Also at Station 240.
Pneumonoderma souleyeti.
Clionopsis modesta.

STATION 297. November 11, 1875; off the western coast of South America; lat. 37° 29′ S., long. 83° 7′ W.; surface temperature, 57° F.

Dexiobranchæa polycotyla (larvæ).

STATION 314A. January 22, 1876; between Cape Virgins and the Falkland Islands; lat. 51° 24′ S., long. 61° 46′ W.; surface temperature, 49° F.

Spongiobranchæa australis. Also at Station 158; and on March 11, 1876.

Between Stations 332 and 333. March 11, 1876; west of Tristan da Cunha; lat. 36° 22′ S., long. 26° 1′ W.; surface temperature, 64°·7 F.

Spongiobranchæa australis. Also Stations 158 and 314A.

April 26, 1876; St. Vincent, Cape Verde Islands; lat. 16° 49′ N. long., 27° 14′ W.; surface temperature, at noon 73°·2 F., at midnight 72°·2 F.

Dexiobranchæa ciliata.

Near Station 354. May 7, 1876; Atlantic, south of the Azores; lat. 34° 22′ N., long. 34° 29′ W.; surface temperature, 67°·8 F.

Pneumonoderma violaceum.

GENERAL CONCLUSIONS.

A. THE PELAGIC PROVINCES.

The geographical distribution of littoral marine organisms has been the subject of many researches, and we possess considerable knowledge of their arrangement and groupings into distinct great natural faunas. But it is very different with regard to pelagic animals, our knowledge of their geographical distribution being much more fragmentary.

In order to satisfactorily determine the natural pelagic provinces into which oceans

and seas are divided, the study of all, or nearly all pelagic animals, ought to be combined, because by limiting investigation to one single group of organisms, one is erroneously led to multiply the geographical subdivisions. But since up to the present time there are but few groups of pelagic animals (Crustacea, Polyzoa, &c.), the geographical distribution of which has been investigated, all attempts at synthesis in this way would as yet be premature, and would give merely provisional results.

The distribution of the Pteropoda will add to our knowledge on this subject, and I shall here give the conclusions at which I have arrived after studying the geographical distribution of the Gymnosomatous Pteropoda.

The importance of currents in influencing the geographical distribution of pelagic organisms is much greater than in the case of littoral animals; and it seems to me that each great surface area of water coinciding with an important current or system of currents, forms a distinct pelagic province.

Relying chiefly upon the distribution of the Pteropoda, I think I may at least divide the surface of the ocean into the ten following provinces, many of them resembling those established by Mr. George Busk in his Report on the Polyzoa, and which have been followed in several other Reports.

I. *Arctic Province.*—This province corresponds to the region generally accepted by zoologists under this name. It extends north of both the Old and the New Continents, and between them, as the Behring Sea, the Arctic current, and the current of Hudson's Bay (or the Labrador current). Thus, this province extends all around the North Pole, within the limit of the floating ice, or, more exactly, of the isotherm of 60° F. for August.

II. *North Atlantic Province.*—This division comprises all the Atlantic Ocean, south of the foregoing province, to the equator; it includes the Gulf of Guinea and also a small part of the Central Atlantic, south of the equator. This province thus embraces the whole area traversed by the following system of currents; the Gulf Stream, Rennel's current, North African and Guinea current, and the main equatorial current, besides the whole Mediterranean Sea; that is to say, this province is nearly equivalent to the following littoral regions of the malacologists:—Celtic, Lusitanian, West African, Carribean and Atlantic. It corresponds to Dana's north temperate and torrid zones of the Atlantic, without the subtorrid region of the South Atlantic.

The part of the Atlantic Ocean which is traversed by the Brazil current perhaps constitutes a special province; but I cannot be certain about this, not having received any Pteropoda from this region.

III. *South-West African Province.*—This division includes the parts of the South Atlantic traversed by the South Atlantic current. On account of the origin of this current this province has some relations with the following one.

IV. *Indian Ocean Province.*—This province comprises the whole Indian Ocean,

from the east coast of Africa to Australia, and extending to about lat. 36° S. This province was not visited by H.M.S. Challenger, and requires to be explored.

V. *Australasian Province.*—This division nearly corresponds to the Indian province of Keferstein,[1] that is, including the seas of the Malay Archipelago, the China Sea, the seas of the Philippines, of Celebes, of New Guinea, and of the north of Australia.

VI. *West Pacific Province.*—This province includes the part of the Pacific Ocean which is traversed by the equatorial currents—north equatorial drift current, equatorial counter current, south equatorial drift current. It extends no further than from lat. 40° N. to lat. 30° S., and rather corresponds with the Polynesian province of Keferstein.[2]

VII. *East Australian Province.*—This division occupies that part of the ocean between Australia and New Zealand.

VIII. *North Pacific Province.*—This division extends, south of the Behring Sea, from one continent to the other, and comprises all that part of the North Pacific Ocean which is traversed by the North Pacific drift current. It extends to the south as far as the foregoing province, and towards the American coast its southern limit is near lat. 30° S. This province is thus limited by the Aleutian and Californian regions of the malacologists.

Until the voyage of H.M.S. Challenger this province was scarcely explored at all, and its exploration, therefore, gave remarkable results. All the four new species of Gymnosomata were obtained in it.

IX. *South-East Pacific Province.*—This province lies along the American continent, and occupies all that part of the Southern Pacific Ocean which is traversed by Humboldt's current, that is to say, from lat. 37° S. to the Bay of Panama.

X. *Antarctic Province.*—This province surrounds the South Pole, and comprises the region corresponding to the Arctic province, namely, nearly the whole part of the sea included within the isothermal line of 50° F., for August, and traversed by the Cape Horn current, the southern connecting current, the South Australian current, and the Antarctic drift; it is nearly the same as the Magellanic littoral region of the malacologists.

This province has been hitherto but little explored. As to the Pteropoda, its short exploration by H.M.S. Challenger procured, with other well-known species, three species of Thecosomata, which had never been observed since their first discovery, namely, *Limacina antarctica*, Woodward (Station 153), *Limacina* (or *Spirialis*) *australis*, Souleyet (Stations 146, 153), and a new species of *Clio* (or *Cleodora*) (Station 156), which had probably been previously collected by the naturalists of the "Astrolabe" during her last voyage to the South Pole,[3] but which was not described.

[1] Bronn, Die Klassen und Ordnungen des Thierreichs, Bd. iii. p. 1136.

[2] *Loc. cit.*, p. 1136.

[3] Souleyet, Histoire naturelle des Mollusques Ptéropodes, p. 48.

B. Geographical Distribution of the Genera.

1. The genus *Dexiobranchæa* is found in the Atlantic (north of the equator) in the Mediterranean Sea, and in the North and South-East Pacific Ocean.

Among the five known species, two inhabit the North Atlantic province, near the west coast of the Old Continent; two inhabit the South-East Pacific province, on the west coast of the New Continent; the fifth species lives in the North Pacific.

2. The genus *Spongiobranchæa* inhabits the whole Antarctic province, all round the South Pole, where its single species seems quite to correspond to *Clione limacina* of the Arctic province. Like this last species, indeed, *Spongiobranchæa australis* never passes the limit of floating ice, and its area of distribution is enclosed within the isotherm of 50° F. for August.

3. The genus *Pneumonoderma*, which most abounds in species, is also the genus which has the widest area of distribution. It was observed in the whole Atlantic Ocean between lat. 45° N. and lat. 38° S., in the Mediterranean Sea, in the Indian Ocean, and in the Pacific Ocean from lat. 58° N. to lat. 42° S.

In the Atlantic Ocean, *Pneumonoderma violaceum* is hardly found south of the equator; *Pneumonoderma peroni*, in the Atlantic, is never found north of the tropic of Capricorn; it also lives in the Indian Ocean and Australasian provinces, always south of the equator.

In the Pacific Ocean, *Pneumonoderma pacificum* and *Pneumonoderma souleyeti* are localised in the North Hemisphere, and *Pneumonoderma boasi* in the South Hemisphere.

Some species, as *Pneumonoderma peroni* and *Pneumonoderma mediterraneum*, seem to be very widely dispersed (the former in the South Hemisphere, the latter in the Northern). This genus, however, requires fresh study when new and more abundant material has been accumulated.

4. The genus *Clionopsis* is only distributed in the North Hemisphere—North-West Atlantic Ocean, Mediterranean Sea, China Sea and North Pacific Ocean.

5. The genus *Notobranchæa* was observed in both hemispheres, both in the Atlantic and Pacific Oceans.

6. The genus *Clione* (with the exception of the badly known species that Bruguière found at Madagascar) is distributed throughout the whole Arctic province (the area of dispersion of *Clione limacina* exactly corresponds with this province), the North Atlantic Ocean, the Mediterranean Sea and the South-West Pacific Ocean.

7. The genus *Halopsyche* has been observed in the whole of the West Pacific Ocean, north and south of the equator.

The following table summarises the description given above of the geographical distribution of the genera of Gymnosomatous Pteropoda (this table only gives the

minimum areas of distribution, because all doubtful indications have been removed from it) :—

	Arctic.	North Atlantic.	South-West African.	Indian Ocean.	Austra-lasian.	West Pacific.	East Austra-lian.	North Pacific.	South-East Pacific.	Ant-arctic
Deniobranchæa, ...		+						+	+	
Spongiobranchæa, . . .										+
Pneumonoderma, . . .		+	+	+	+				+	
Clionopsis, ...		+						+		
Notobranchæa, . . .		+	+ [1]				+ [2]			
Clione, ...	+	+					+ [3]			
Halopsyche, ...					+	+				

With respect to the species of Gymnosomata, the following list shows how they are distributed in the different provinces.

C. The Species of Gymnosomata arranged in Provinces.

I. Arctic Province.

Clione limacina.

II. North Atlantic Province.

Deniobranchæa paucidens.

* [4] *Deniobranchæa ciliata.*

Pneumonoderma mediterraneum, also V.

* *Pneumonoderma violaceum.*

Clionopsis krohni.

Clionopsis grandis, also V.

Notobranchæa macdonaldi.

Clione longicaudata.

Clione flavescens.

III. South-West African Province.

Pneumonoderma peroni, also IV. and V.

[1] *Clio cuspidata*, Rang.

[2] The "trigonal tailed *Clio*" of Macdonald ; see pp. 41, 43.

[3] The "*Clio caudata*" of Macdonald.

[4] Species marked with an asterisk have been collected in the province by the Challenger Expedition.

IV. Indian Ocean Province.

Pneumonoderma peroni, also III. and V

V. Australasian Province.

Pneumonoderma mediterraneum,' also II

**Pneumonoderma peroni*, also III. and IV.

Clionopsis grandis, also II.

**Halopsyche gaudichaudi*, also VI.

VI. West Pacific Province.

**Halopsyche gaudichaudi*. also V.

VIII. North Pacific Province.

**Dexiobranchæa minuta*.

**Pneumonoderma souleyeti*.

**Pneumonoderma pacificum*.

**Clionopsis modesta*.

**Notobranchæa inopinata*.

IX. South-East Pacific Province.

Dexiobranchæa simplex.

Dexiobranchæa polycotyla.

Pneumonoderma hoasi.

X. Antarctic Province.

**Spongiobranchæa australis*.

" *Pneumoderma macrocotylum*," Rang.

PHYLOGENETIC RELATIONS OF THE GENERA OF GYMNOSOMATOUS PTEROPODA.

In the anatomical part of this Report, I shall show the close affinities that these Mollusca possess to the Tectibranchiate Opisthobranchs.

The zoologists who have carefully studied the organisation of the Thecosomata and Gymnosomata have always recognised the great differences that separate the two groups; and many have thought that they have not had a common origin. Boas, however, was the first who clearly stated this opinion,[1] against which no solid argument can be opposed.

Here I have only to consider the origin of the Gymnosomata. According to my opinion, their origin ought to be found in the group Aplysiidæ, Opisthobranchia which already show a remarkable adaptation to swimming habits. In the anatomical part of this Report I shall show the great and numerous resemblances which exist between the organisation of the Gymnosomata and that of the Aplysiidæ.

With regard to the relations of the different genera of Gymnosomatous Pteropoda among themselves, we find rather primitive genera which have retained much of their resemblance to the primitive stock, and others which are highly specialised. Between these two extremes, there are a whole series of forms, by means of which the evolution of the group could almost be traced, and which are not difficult to arrange in a phylogenetic tree, according to their affinities.

The stage of evolution of the group, which each genus represents, is chiefly characterised by the development of the respiratory organs. Thus, *Dexiobranchæa*, which among all the known genera is the most primitive, only possesses the lateral gill corresponding to that of the Aplysiidæ. *Spongiobranchæa* has, moreover, a very simple posterior gill, a specialisation of the posterior ciliated ring which remains very late in the foregoing genus. *Pneumonoderma* shows a great increase in the complexity of this posterior gill, by the formation of four crests radiating from the posterior quadrangular ring, which corresponds to the membranous ring of *Spongiobranchæa*.

Clionopsis already shows a retrogression, the lateral gill having quite disappeared; and

[1] Spolia atlantica, p. 14.

the posterior gill being generally simplified, but formed, however, on the same plan as in *Pneumonoderma*.

Notobranchæa has also lost the lateral gill; the posterior crest of the terminal gill has also disappeared, and there only remains a gill formed of three radiating crests.

Lastly, *Clione* has lost every vestige of gill, as in *Halopsyche*.

A form closely resembling some very specialised *Dexiobranchæa*,[1] with atrophied median buccal appendage, and with the posterior ciliated ring converted into a respiratory ring, might give rise:—

1. To *Spongiobranchæa*, by the lateral gill becoming rudimentary.

2. To *Pneumonoderma*, by specialisation of the posterior gill, and the development of radiating crests on the annular crest.[2]

Pneumonoderma, by the disappearance of the lateral gill and buccal appendages, and by the atrophy of the posterior lobe of the foot, gave rise to *Clionopsis*.

A form allied to *Pneumonoderma*, in which the lateral gill has disappeared as well as the quadrangular crest of the posterior gill, and in which the latter bears only three radiating crests, might lead to *Notobranchæa*.

This last genus certainly represents the forms from which *Clione* has been derived, by the total disappearance of the branchial apparatus.

[1] The evolution of the buccal appendages in *Dexiobranchæa* illustrates the evolution of the genus. The first specialisation was the production of suckers on the proboscis (ventrally and on the two lateral sides); this state is shown in *Dexiobranchæa simplex*. The ventral suckers then united their peduncles into a single median appendage, as seen in *Dexiobranchæa paucidens*. The number of the lateral suckers then increased, and they were arranged in two rows, as in *Dexiobranchæa minuta*, and *Dexiobranchæa polycotyla*. Lastly, the ventral appendage became atrophied, and, on the other hand, the lateral suckers became more developed, and they were borne on projecting crests of the proboscis, the first indication of the lateral appendages of the following genera, *Spongiobranchæa* and *Pneumonoderma*. This last state is shown in *Dexiobranchæa ciliata*. Therefore the living species of *Dexiobranchæa* must be phylogenetically arranged as follows:—

1. *Dexiobranchæa simplex.*
2. *Dexiobranchæa paucidens.*
3. *Dexiobranchæa minuta.*
4. *Dexiobranchæa polycotyla.*
5. *Dexiobranchæa ciliata.*

[2] In the *Pneumonodermata*, the evolution is chiefly shown in the branchial apparatus. In the most primitive species the lateral gill is still long as in some *Dexiobranchæ*, and the fringes on both lateral and posterior gill are hardly developed. *Pneumonoderma moseleyi* corresponds to this stage. The branchial fringes then became more developed, but the lateral gill continued long—*Pneumonoderma pacificum*. The lateral gill became shorter, and the fringes more distinct, but not yet subdivided—*Pneumonoderma beani*. The fringes became subdivided—*Pneumonoderma violaceum*. Then, by specialisation of the buccal appendages the other species arose—by increase of the number of suckers, *Pneumonoderma peroni*; by decrease, *Pneumonoderma mediterraneum*. The living species of *Pneumonoderma* must therefore be phylogenetically arranged as follows:—

1. *Pneumonoderma moseleyi.*
2. *Pneumonoderma pacificum.*
3. *Pneumonoderma beani.*
4. *Pneumonoderma violaceum.*
5. *Pneumonoderma peroni.*
6. *Pneumonoderma mediterraneum.*

Halopsyche is the most specialised genus of all the Gymnosomatous Pteropoda; it has lost, besides every vestige of a branchial apparatus, the cephalic hood and the proboscis.

These statements may be represented in the following diagram, which shows the mutual relations of the Gymnosomata. This phylogenetic tree only exhibits, of course, the grouping of the living forms according to their reciprocal affinities, and does not at all suggest their mutual descent, which is quite impossible among cotemporary organisms.

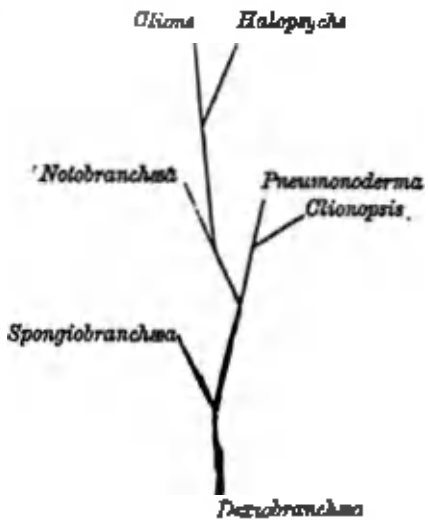

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Fig. 8. *Pneumonoderma mediterraneum*, van Ben. Ventral aspect; magnified four diameters.

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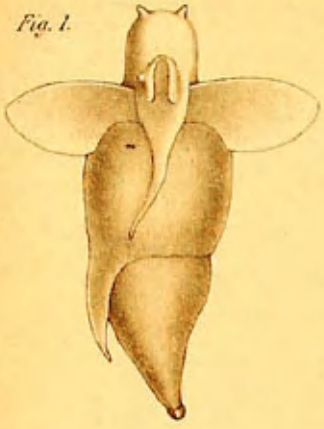
Fig. 1.



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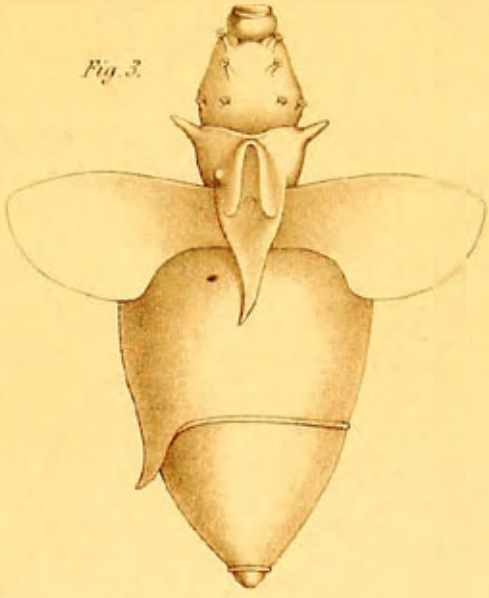

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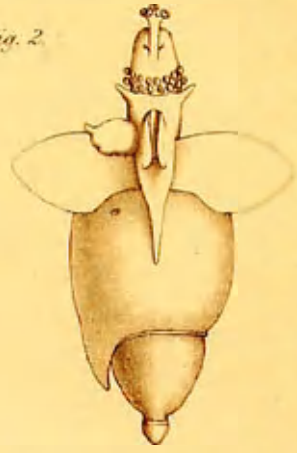

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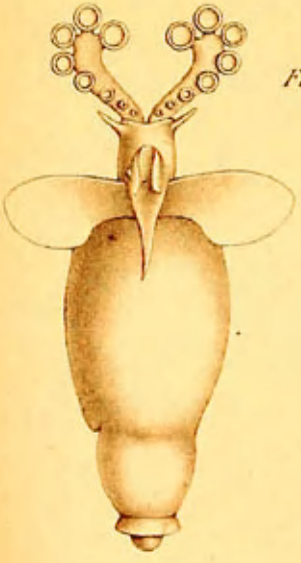

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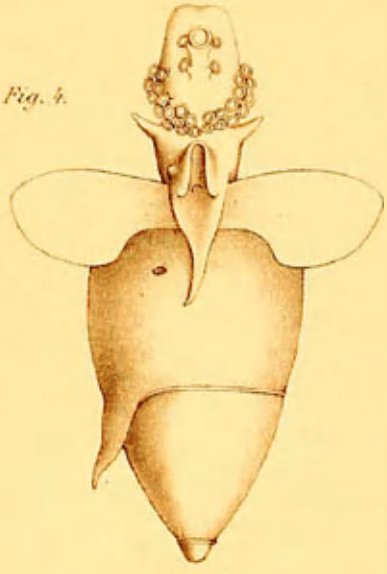

Fig. 8.

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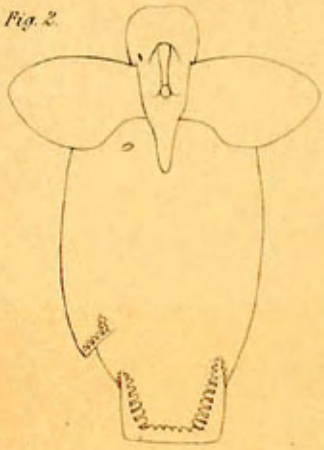

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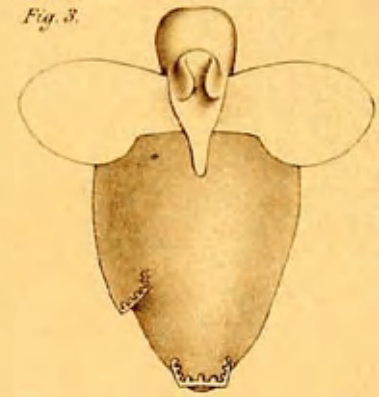

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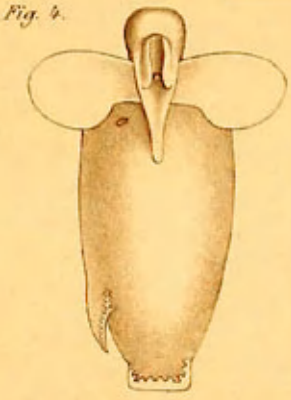

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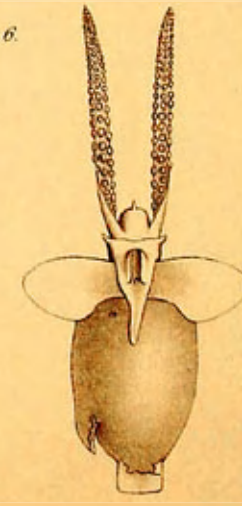

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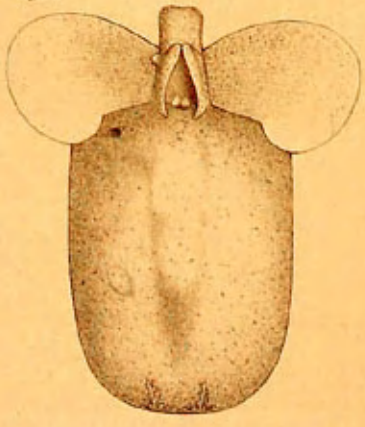

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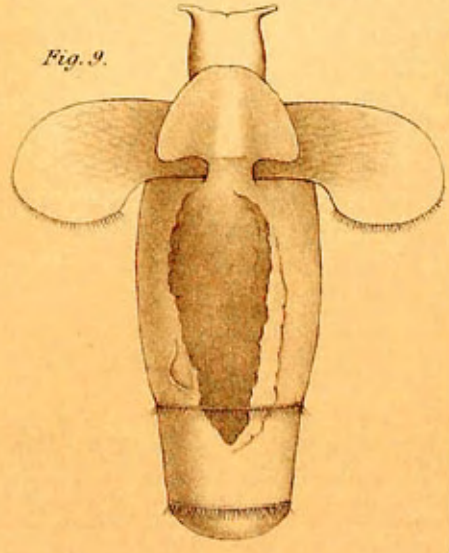

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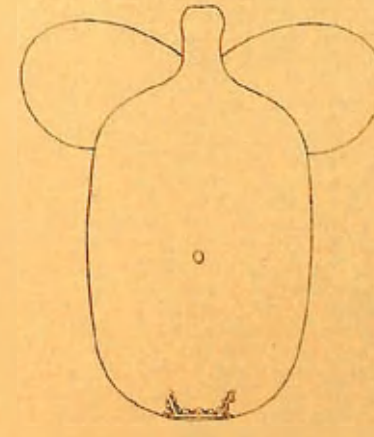

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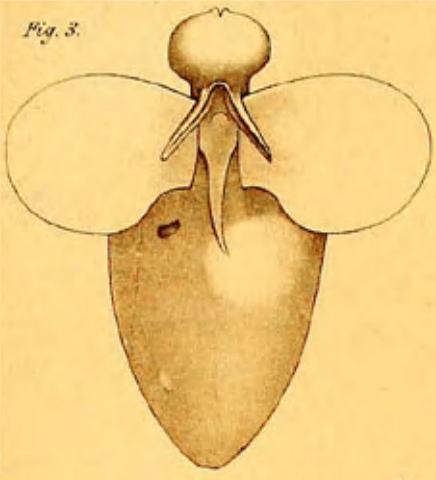

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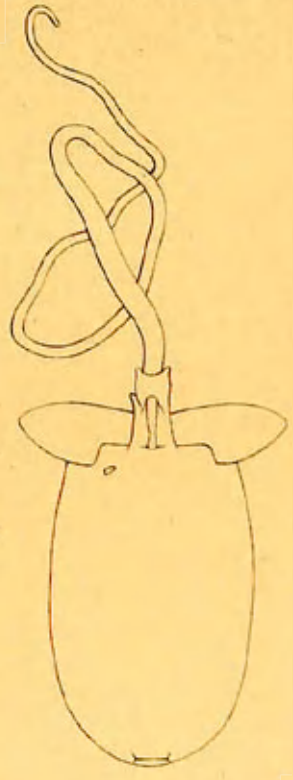

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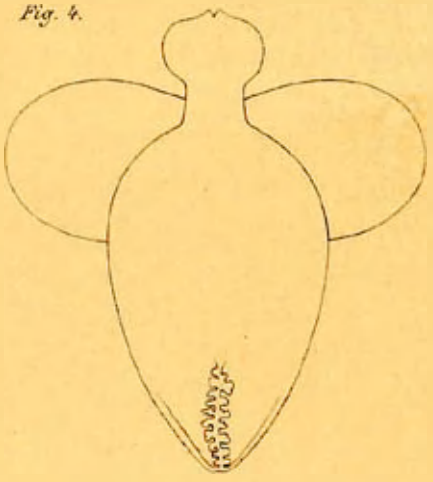

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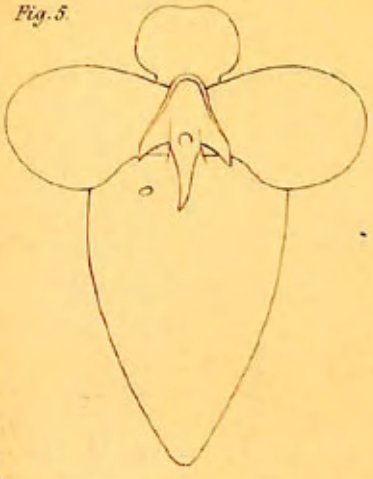

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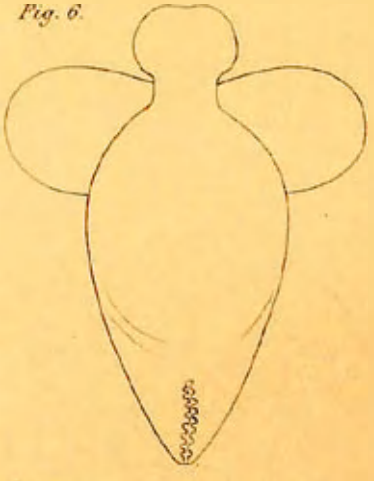

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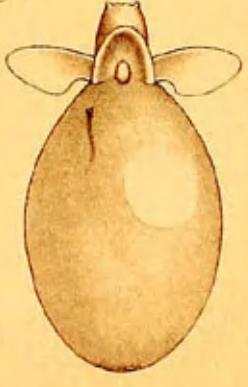

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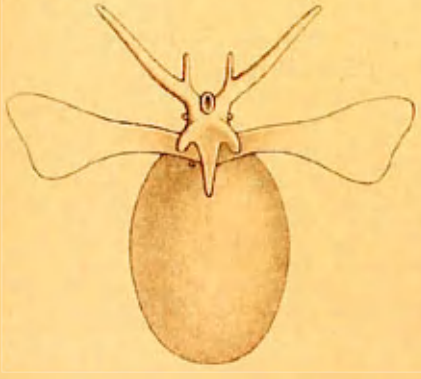

Fig. 9.

Fig. 8.