COMPARATIVE ANATOMY.

BY

C. TH. v. SIEBOLD AND H. STANNIUS.

TRANSLATED FROM THE GERMAN,

AND

EDITED WITH NOTES AND ADDITIONS

RECORDING THE

RECENT PROGRESS OF THE SCIENCE,

BY

WALDO I. BURNETT, M.D.

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ANATOMY

OF THE

INVERTEBRATA.

BY

C. TH. v. SIEBOLD.

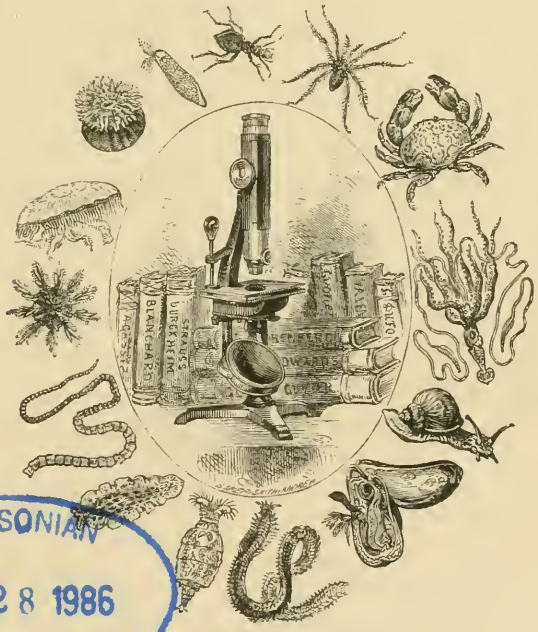

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TABLE OF CONTENTS.

IV. THE ECHINODERMATA.

V. THE HELMINTHES.

VI. THE TURBELLARIA.

VII. THE ROTATORIA.

VIII. THE ANNELIDES.

IX. THE ACEPHALA.

X. THE CEPHALOPHORA.

XI. THE CEPHALOPHODA.

Introductory Note to the Crustacea.

XII. THE CRUSTACEA.

XIII. THE ARACHNOIDAE.

XIV. THE INSECTA.

BOOK THIRD.

ACALEPHAE.

CLASSIFICATION.

§ 53.

The body of Acalephae is composed of a transparent, gelatinous substance, quite resembling the *Corpus vitreum* of the eyes of vertebrata. By desiccation it almost entirely disappears, there remaining only a dry cellular tissue, by which the form of the animal is imperfectly preserved. These animals swim freely in the sea after having attained their development.

In the arrangement of their organs in ray-like processes radiating from a common centre or a longitudinal axis, and where also is situated the digestive apparatus, the quaternary system prevails. Copulatory organs are always wanting. The classification is based, according to the system of *Eschscholtz*, upon difference of external form, and upon the structure of their digestive and locomotive organs.

ORDER I. SIPHONOPHORA.

They take in their food by means of numerous tubes, which exist in place of a stomach. Locomotion is aided, generally, by certain cartilaginous capsules.

Family: Diphyidae.

Genera: *Diphyes, Ersaea.*

Family: Physophoridae.

Genera: *Physophora, Stephanomia.*

Family: Physalidae.

Genus: *Physalia.*

Family: Velellidae.

Genera: *Rotaria, Velella, Porpita.*

ORDER II. DISCOPHORA.

They have a simple central stomach, and move by means of discoid or campanulate contractions of their body.

FAMILY: AEQUORINA.

Genera: *Aequorea, Polyxenia.*

FAMILY: OCEANIDAE.

Genera: *Oceania, Cytaeis, Thaumantias.*

FAMILY: GERYONIDAE.

Genus: *Geryonia.*

FAMILY: RHIZOSTOMIDAE.

Genera: *Cephea, Cassiopea, Rhizostomum.*

FAMILY: MEDUSIDAE.

Genera: *Pelagia, Cyanea, Chrysaora, Medusa, Aurelia, Ephyra, Sthenonia.*

ORDER III. CTENOPHORA.

Their mouth and stomach is simple and central, and they move by means of cilia arranged in longitudinal rows.

FAMILY: BEROIDAE.

Genera: *Beroë, Lesueuria, Medea.*

FAMILY: MNEMIADAE.

Genus: *Eucharis.*

FAMILY: CALLIANIRIDAE.

Genera: *Cydippe, Cestum.*

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Part II. — On the Beroid Medusae of the shores of Massachusetts, in their perfect state of development. See the Mem. Amer. Acad. Arts and Sc. vol. IV. 1850.

Also, Twelve Lectures on Comparative Embryology, delivered before the Lowell Institute, Boston, 1848–49.

Busch. Beobachtungen über Anatomie und Entwickelung einiger wirbellosen Seethiere. Berlin, 1851.

[The above are among the most important larger works; but see, also, many papers of great value, to which I have referred in my notes. — EDITOR.]

CHAPTER I.

SKIN AND CUTANEOUS SKELETON.

§ 54.

Generally, the body of the Acalephae is of a gelatinous substance, composed of polyhedral cells. In some species certain parts of the body have a cartilaginous hardness, but it is only in a few that there is found a cartilaginous or calcareous nucleus, comparable to a rudimentary skeleton.

With the Diphyïdae a large portion of the body has a cartilaginous density, and with the Physophoridae it is often surrounded by plates of a similar nature. The Velellidae have a nuclear skeleton, which in *Rataria* is a simple, elongated disc; but in *Velella* this disc, which is horizontal and of an elongated oval form, is surmounted by a vertical crest. The disc is composed of four pieces joined together by two sutures which cross each other obliquely. The crest, united to the disc along the whole length of the two sutures, and resembling the segment of a circle, is composed of two main pieces, joined in the middle by a third, which is shaped like a wedge.[1]

The disc situated under the skin of the upper surface of *Porpita*, and

[1] *Eschscholtz*, loc. cit. Taf. XV.; and *Lesson*, Acalèphes, loc. cit. Pl. XII. fig. 1; also, *Duperrey*, Voyage loc. cit. Zoophytes, No. 6. fig. 1, A. A.

which encloses between its two lamellae numerous aërial canals, is said to be of a calcareous nature.[2]

All these discs have upon their surface markings of concentric rings and diverging rays.

§ 55.

The Acalephae are surrounded by a very delicate epidermis. Upon various portions of the body, and especially upon the arms, the tentacles, the prehensile filaments and the cirri, there exist cilia and peculiar nettling and prehensile organs. In those species having active irritating properties the nettling organs are situated in a mass under the epidermis.[1]

§ 56.

These nettling organs are generally composed of an oval capsule, containing a spiral filament which is thrown out from the slightest disturbance, and, together with its capsule, is detached from the skin.[1]

In some species, there exist in place of these nettling organs others of a prehensile nature, consisting of an oval capsule in which is a stiff bristle. These last cause no burning sensation, but are the means by which these animals attach themselves to contiguous objects in a bur-like manner. They are situated, grouped in small masses, under the skin of most of the non-nettling Discophora, and their bristles project upon the cirri situated upon the border of the disc, upon the tentacles, the arms and the sexual organs.[2]

2 *Eschscholtz*, loc. cit. p. 176, and *Lesson*, loc. cit. Pl. XII. fig. 3; also, *Duperrey*, loc. cit. No. 7, fig. 3.

1 *Wagener* (*Müller's* Arch. 1847, p. 183, Taf. VIII. fig. 4, 5) has described the peculiar hair-like productions on the sides of *Beroë* and *Cydippe*. They have, near their free extremity, a multitude of pedunculate small buttons, inserted on a clavate swelling.

1 *Wagner* (Icon. zoot. Tab. XXXIII. fig. 8, 10, 11, A. B. C. and Ueber den Bau der Pelagia noctiluca, 1841.); also, in *Wiegmann's* Archiv 1841. Th. I. p. 39) has found in *Pelagia noctiluca* that the nettling capsules are situated among the pigment cells beneath the epithelium of the disc. According to this author, *Oceania*, which has feeble nettling powers, has these capsules only upon the marginal filaments.

Ehrenberg (*Wiegmann's* Archiv 1841, Th. I. p. 71, Taf. III.) has failed to find these organs upon the non-nettling disc of *Cyanea capillata*, although they are found among their prehensile cirri, which have irritating power.

With these, as with the hooked organs of *Hydra*, he thought the capsule was detached before the filament. *Will* (Horæ tergest. pp. 62, 65) did not find these organs in *Cephea*, except on the tentacles of the genital organs; and in *Polyxenia* only on the marginal filaments. *Kölliker* (Beiträge, loc. cit. p. 41) has seen them also about the genitals of *Chrysaora* and *Aequorea*.

The Siphonophora have only the prehensile filaments covered with them. Thus in *Stephanomia*, according to *Milne Edwards* (Ann. d. Sc. Nat. XVI. p. 223, Pl. VIII. fig. 9), they cover the whole surface of these last; while in *Physophora*, *Diphyes* and *Ersaea*, they exist only upon their enlarged portions, according to *Philippi* (*Müller's* Arch. 1843, p. 62, Taf. V. fig. 9), and *Will* (loc. cit. p. 79, 81, Taf. II. fig. 23–25). *

2 *Siebold* (Beiträge zur Naturgesch. der wirbellosen Thiere, 1839, p. 10, 91, Taf. II. fig. 39); also, *Ehrenberg* (Ueber die Acalephen d. rothen Meeres, &c. &c., in the Abhandl. d. Berl. Akad. 1835, p. 205, Taf. IV–VIII.). He has compared these prehensile organs to suckers.

According to *Milne Edwards* (Ann. d. Sc. Nat. XVI. p. 215), and *Will* (loc. cit. p. 80, Taf. II. fig. 24), they are found also upon the body of *Beroë*, and at the extremity of the prehensile filaments of *Diphyes* and *Ersaea*.

According to *Will*, also (loc. cit. p. 51, Taf. I. fig. 19, A. B.), the prehensile filaments of the Ctenophora have two kinds of capsules; one, which upon the least touch bursts and discharges a liquid; the other, of a somewhat different appearance, and which contains a delicate, viscous filament. Similar filaments, he says, are found upon the warts on the body of *Eucharis*.

* For these nettling organs and their intimate structure, see my note under § 27, note 1. — Ed.

CHAPTER II.

MUSCULAR SYSTEM AND ORGANS OF LOCOMOTION.

§ 57.

The Acalephae have a distinct muscular system. Their contractile substance is composed of a net-work of elongated, slender filaments and bands; these, in the utriculoid species, are arranged in a longitudinal and annular manner, but in those of a discoid and campanulate form they are disposed in a circular and radiate manner.

In the extremely irritable tentacles and tactile filaments, the longitudinal fibres abound.[1]

Each fibre is smooth when relaxed, but during contraction appears transversely wavy and plicated.[2]

§ 58.

The contractile and aërial natatory vesicles, which are found in the Physophoridae,[1] and the movable lamellae of the Ctenophora, may well be regarded as accessory organs of locomotion. These last, which are arranged in rows upon the sides of the animal, and which by some anatomists have been regarded as respiratory organs, are not simple cutaneous lobes, but are composed of very long cilia closely united together, and the motion of which is voluntary with the animal.[2]

1 *Will* (loc. cit. p. 48, Taf. I. fig. 11) has observed in the contractile excrescences of the *Eucharis*, not only circular fibres and numerous longitudinal muscles, but large transversely-flattened ones, which were bound together by oblique bands.

2 *Will*, loc. cit. p. 47, 63, Taf. I. fig. 13. According to *Wagner* (Ueber den Bau, &c.; and Icon. zoot. Tab. XXXIII. fig. 30), the muscles of the Discophora have always the transverse striae.

The cartilaginous natatory pieces of the Siphonophora play a completely passive part in the act of locomotion. The swimming is exclusively performed by the energetic contractions of the muscular membrane which lines their cavity, constituting, therefore, a true natatory sac. See *Sars* Faun. litoral. Norveg. p. 42.*

1 Lately, it has been doubted if the Physophoridae can sink and rise in the sea by means of their natatory bladders, because they cannot exhaust the contained air. According to *Olfers* (Abhandl. d. Berl. Akad. 1831, p. 157, 165, Taf. I.), there are two of these bladders in *Physalia*, one of which only has an opening. *Philippi* (*Muller's* Arch. 1843, p. 63) has found neither internal nor external opening to the bladder of *Physophora tetrasticha*. In *Stephanomia* it would not appear, according to the description of *Milne Edwards* (Ann. d. Sc. Nat. XVI. p. 218, Pl. VIII. fig. 1. b. 2), that this organ had an external opening. *Couch* (*Frorieр's* neue Notizen, No. 273, p. 129) denies that *Physalia* has the power to control the air of its bladder. See also below, § 65.

2 *Grant*, Trans. Zool. Soc. London, I. 1835, p. 9.; *Sars*, Beskrivelser loc. cit. Pl. VIII. fig. 18, e.; *Milne Edwards*, Ann. d. Sc. Nat. XVI. p. 201, 216, Pl. IV. fig. 2, 3, Pl. VI. fig. 1. c.; and *Will*, loc. cit. p. 9, 56, Taf. I. fig. 5.

* [§ 57, note 2.] For the muscular system of the Acalephae, see also *Forbes* (loc. cit. p. 3), and *Agassiz* (loc. cit. p. 236). This last-named author has described this system with full details in many genera. It is much more complex than has hitherto been supposed, and I must refer for the details to the memoir in question.

In regard to the structure of these muscles, *Agassiz* remarks: "With all the power of the best *Oberhäuser* Microscope, I have been unable to discover the slightest indication of striae on the muscular cells; nevertheless, it cannot be doubted that they are voluntary muscles." To this view I may add my own of the same nature. — Ed.

CHAPTER III.

NERVOUS SYSTEM.

§ 59.

A nervous system has been found in many Acalephae. With the Ctenophora the œsophagus is surrounded by a ring formed of eight ganglia,[1] and at the opposite extremity of the body there is a simple ganglion. Five nervous filaments pass out from these ganglia, and along the sides of the body are nervous fibres, which ultimately divide into delicate threads.[2]

The tentacles of Medusae are supplied with nervous filaments which issue from a ganglion situated at their base.[3]

CHAPTER IV.

ORGANS OF SENSE.

§ 60.

With many Acalephae, there are, upon the borders and extremities of

1 These eight ganglia, which are connected together by delicate cords, were first observed by *Grant* (Trans. Zool. Soc. Lond. I. p. 10) in *Cydippe pileus*. Compare, also, *Wagner*, Icon. zoot. Tab. XXXIII. fig. 37, A. B. From each of these ganglia two nerves pass off to the side, while a third, traversing the interior of the body, and having two or three swellings, is finally distributed to the intestine. *Patterson* (The Edin. new Philos. Jour. XX. p. 26), and *Forbes* (Ann. of Nat. Hist. 1839, p. 145), have also observed the œsophageal ring in *Cydippe*, but did not perceive the ganglia.

2 *Milne Edwards* (Ann. des Sc. Nat. loc. cit. p. 206, Pl. IV. fig. 1) has observed at the posterior extremity of the body of *Lesueuria vitrea* (a new Beroïd) a ganglionic body which sends out in front four filaments; and upon the sides of this animal a nervous cord, from which pass off delicate branches at regular intervals. At the posterior extremity of the body of *Cydippe*, *Eucharis* and *Medea*, *Will* (*Froriep's* neue Notizen, No. 500, 1843, p. 67, and Horæ tergest. p. 44) has likewise observed a round, yellowish ganglion, with four prolongations, from which pass off twenty-five or thirty nerves.

3 *Ehrenberg* has found along the entire border of the disc of *Medusa aurita*, and between each two tactile filaments, a bifid nervous ganglion. He affirms to have seen also two others similar, at the base of each tentacle surrounding the genital organs. See Abhandl. d. Berl. Akad. 1835, p. 203, Taf. IV. fig. 1, x.; and *Muller's* Arch. 1834, p. 571.*

* [§ 59, note 3.] The nervous system of the Acalephae has been successfully studied by *Agassiz* upon several genera (*Hippocrene*, *Tiaropsis*, *Staurophora*). His results are new, and different from those of previous observers. I cannot do better than to quote his words: "There is, unquestionably, a nervous system in Medusae, but this nervous system does not form large central masses, to which all the activity of the body is referred, or from which it emanates. There is no regular communication by nervous threads between the centre and periphery and all intervening parts; and the nervous substance does not consist of heterogeneous elements, of nervous globules and nervous threads, presenting the various states of complication and combination, and the internal structural differences, which we notice in the vertebrated animals, or even in the Mollusca and Articulata."

"In Medusae the nervous system consists of a simple cord, of a string of ovate cells, forming a ring around the lower margin of the animal (Pl. V. fig. 11, 2, 4, 5), extending from one eye-speck to the other, following the circular chymiferous tube, and also its vertical branches, round the upper portion of which they form another circle. The substance of this nervous system, however, is throughout cellular, and strictly so, and the cells are ovate. There is no appearance in any of its parts of true fibres" (loc. cit. p. 232). That this is the nervous system seems placed beyond all controversy; for, in a private letter, *Agassiz* has informed me that in a new genus (*Rhacostoma*), living on the shores of Massachusetts, he has seen this system at night as an illuminated diagram.— Ed.

their body, button and tongue-like organs, which, as they are connected with neighboring ganglia, may well be regarded as organs of sense.

Their essential structure is a membranous capsule, containing a clear liquid, in which are suspended crystalline corpuscles.

These organs, having sometimes a red pigment, have been taken for eyes; but, as most of them are without pigment, and as the crystalline corpuscles behave in acid like the Otolites of the higher animals, they have more recently been better designated as organs of hearing.

The eight marginal, tongue-like bodies, found upon the disc of *Medusa aurita*, have been regarded as eyes.[1] The sole fact for the support of this opinion is the presence of pigment; for the small hexagonal crystals, irregularly scattered in the interior of these bodies, would scarcely allow them to refract the light like a crystalline lens.

The Ctenophora have only a single organ of this nature, and which is situated near the ganglion at the posterior end of the body. It has been regarded both as an eye and as an organ of hearing.[2]

With many Discophora, these organs appear as pale-yellow, or even colorless marginal corpuscles, having more or less calcareous bodies.[3]

It is yet doubtful whether the otolites of the Acalephae perform the same movements as those of the acephalous and gasteropod mollusca.[4]

1 These marginal corpuscles, already observed in the Medusae by *Gaede* (Beiträge zur Anat. u. Phys. der Medusen, 1816, p. 18, 28), and by *Rosenthal* (Zeitsch. f. Physiol. Bd. I. Hft. 2, 1825, p. 326), were first described as eyes by *Ehrenberg*. See *Müller's* Arch. 1834, p. 571, and Abhandl. d. Berl. Akad. 1835, p. 190, Taf. IV. V.

2 *Milne Edwards* has called this body, in *Lesueuria vitrea* and *Beroë Forskalii*, "*Organe oculiforme*" (Ann. d. Sc. Nat. loc. cit. p. 206, 211, Pl. IV. fig. 1, k. and Pl. V. fig. 4, i.). According to *Will* (*Froriep's* neue Not. No. 599, p. 67, and Horæ tergest. p. 45, Taf. I. fig. 2, 4, 20, b.), the red pigment of these organs is entirely wanting in *Beroë*, *Eucharis* and *Cydippe*, while the hexagonal calcareous corpuscles are very numerous — a fact leading him to conclude that these organs are auditory vesicles.

3 According to *Wagner* (Ueber den Bau, &c., and Icon. zoot. Tab. XXXIII. fig. 31, g. 23, c. and 25), these corpuscles are pale-yellow in *Pelagia noctiluca*, and colorless in *Oceania*, *Cassiopea* and *Aurelia*. In *Cephea*, *Will* has observed only pale-yellow corpuscles, filled with crystals. And, according to him (loc. cit. p. 64, 68), the colorless pedunculated marginal vesicles of *Polyxenia leucostyla* contain, each only a single round otolite, while those of *Cyaeis polystyla* contain numbers, colorless or yellow, and of irregular forms. He has also observed (loc. cit. p. 72, Taf. II. fig 9, 10) that in *Geryonia* the number of these otolites varies from one to nine. *Milne Edwards* (Ann. d. Sc. Nat. XVI. p. 196, Pl. I^c e.) has observed upon the margin of the disc of *Aequorea violacea* vesicles containing two or three spherical corpuscles, and which, probably, are auditory organs. According to *Sars* (*Wiegmann's* Arch. 1841, Th. I. p. 14, fig. 60), and *Will* (loc. cit. p. 75, Taf. II. fig. 21, A. B.), these marginal corpuscles are found upon young Medusae belonging to *Ephyra*.

4 *Will* has never observed with the Otolites of Acalephae similar movements to those of mollusca. *Kölliker* (*Froriep's* neue Not. No. 534, p. 82) has observed vibratile cilia upon the inner surface of the marginal corpuscles of *Pelagia*, *Cassiopea*, *Rhizostomum* and *Oceania*, which are pyriform, and contain many calcareous crystals. In the pedunculated vesicles of *Geryonia*, which contain only a single crystal, these cilia are absent. In none of the Medusae has he found collections of pigment, and in *Oceania* (nov. spec.) only he has observed a mass of brown pigment cells upon the external and superior surface of the base of these corpuscles; in the centre he perceived a round transparent body, and upon the upper surface a circular opening, so that the whole closely resembles an eye, there being, moreover, a kind of pupillary opening, and the traces of an optic nerve from a ganglion.

According to the observations of *Frey* and *Leuckart* (Beitr. &c. p. 39), the group of otolites contained in the auditory organ of a *Cydippe* perform oscillatory movements, due evidently to vibratile cilia situated on the auditive capsule.*

* [§ 560, note 4.] The organs of sense of the Acalephae have been the objects of much study of late, and to *Agassiz* we are indebted for the most minute researches on these obscure points. He has shown the eye-specks to be undoubted organs of sense, from their connection with the nervous system. With the naked-eyed Medusae, he regards them light-perceiving instead of auditory organs. In regard to the single organ found with the Ctenophora, and which *Frey* and *Leuckart* have recently declared to be of an auditory nature, he remarks: "I am inclined to consider this organ, or this speck, as something similar to the central colored speck which occurs in the middle of the disc in Discoid Medusae, and which is particularly distinct in young animals soon after they have been detached from the polyp-like stem on which they grew, as a remnant of the connection which exists between the mother-stem and its progeny in those Medusae which multiply by alternate generations."

CHAPTER V.

DIGESTIVE APPARATUS.

§ 61.

The digestive apparatus of the Acalephae is formed after several very different types. The mouth is sometimes single and central, or there may be many of them. It is often surrounded with arms and retractile filaments, which are endowed with the prehensile and nettling organs just described.

The digestive cavity, which is always lined with ciliated epithelium, has distinct walls, which are united immediately to the parenchyma of the body, leaving, therefore, no surrounding cavity.

With those having a single mouth the stomach is of a variable size, and has often caecal appendages. With *Beroë*,[1] the mouth is very large and free from tentacles, and opens into a very spacious stomach which occupies nearly the whole body. But with *Cestum*, *Cydippe* and *Lesueuria*, the stomach is small, and appears like a cavity in the body;[2] and with *Cytaeis*, *Thaumantias* and *Geryonia*, it is likewise small, and has the shape of a tubular projection.[3]

That of *Medusa* has four saccular folds,[4] that of *Pelagia*[5] six, and that of *Cyanea* thirty-two.[6]

When the mouths are numerous, either, as in the Rhizostomidæ,[7] there are many canals which conduct the food through the arms upon which the mouths are situated into the central stomach; or, as in the Siphonophora, each mouth opens into a particular tubular stomach. With these last, however, a certain number of their tentacles are hollow, and have a mouth at the extremity. As it has been observed that these suck in food and digest it, their orifices have been regarded as mouths, and their cavities as stomachs.[8]

1 *Milne Edwards*, Ann. d. Sc. Nat. XVI. pp. 5, 6.

2 *Eschscholtz*, loc. cit. Taf. I. II.; and *Milne Edwards*, loc. cit. Pl. III.

3 *Will*, loc. cit. Taf. II.

4 *Baer*, in *Meckel's* deutschs. Arch. VIII. 1823, Taf IV. fig. 2; also, *Ehrenberg* in Abhandl. d. Berl. Akad. 1835, Taf. III. fig. 1.

5 *Wagner*, Icon. zoot. Tab. XXXIII. fig. 5.

6 *Gaede*, loc. cit. Taf. II.

7 *Eysenhardt*, Nov. Act. physico-med. X. part II. p. 391, Tab. XXXIV. fig. 1 (*Rhizostomum Cuvieri*).

8 This is so, for examples, in *Diphyes* (*Will*, loc. cit. Taf. II. fig. 22); in *Physalia* (*Olfers* Abhandl. d. Berl. Akad. 1831, p. 162, Taf. I.); in *Stephanomia* (*Milne Edwards*, Ann. d. Sc. Nat. XVI. Pl. VII. IX. X.); and in *Physophora* (*Philippi*, *Müller's* Arch. 1843, Taf. V. fig. 1, 4). *Philippi*, however, affirms that in this last genus these canals are organs of absorption, and that the true stomach, which has a simple mouth, is concealed at the base of the tentacles (loc. cit. p. 63, Taf. V. fig. 10).

I think, however, that this opening belongs to the respiratory system, as also does a similar opening in *Velella* and *Porpita*, which *Lesson* (Voyage de Duperrey, loc. cit. p. 49, 56, No. 6, fig. B.; and No. 7, fig. C. C.) has regarded as a mouth.

The tubular tentacles of these animals are nothing but stomachs; and *Lesson* himself has called them "*poches stomacales*," since they digest food. It would, moreover, be strange that these organs, which, in *Physalia*, have been admitted to be stomachs, should perform another function in *Physophora*, *Velella*, and *Porpita*, where their structure is the same. But further researches are

(Loc. cit. p. 316.) On a preceding page he says: "That this may be the case seems probable when we consider the relation of the two sorts of apparatus in the two types. The upper nervous ring in *Sarsia* bears the same relation to the central alimentary cavity, and to the pigmented disc, that the ganglion and eye-speck of *Beroë* bear to the chymiferous system, which opens above its gelatinous disc, notwithstanding these openings." (p. 248.) This point, fully as interesting from its zoological importance as from its morphological relations, can be settled only by a knowledge of the embryology of these animals. — Ed.

The Acalephæ have no true digestive tube. But, as such, has been regarded a system of vascular canals filled with water, and which, departing from the stomach, traverse the whole body. But these, although sometimes seen to contain fæces, seem to belong more properly to the respiratory system.[9]

In none of the Acalephae has there been found anything like an hepatic organ.[10]

CHAPTER VI.

CIRCULATORY SYSTEM.

§ 62.

Until lately, the longitudinal and circular canals which, in some Acalephae, are spread out through the entire body, have been regarded as belonging to a vascular, sanguineous system. But more recently these have properly been considered as aquatic-respiratory organs, there having been found, moreover, other vessels of exceedingly thin walls, and of a sanguineous nature.

These last constantly accompany and surround in a tubular manner the aquiferous canals; and it is quite rare that small branches are distributed to the general parenchyma.

The delicate walls of these vessels have neither longitudinal nor circular fibres, neither are they lined with ciliated epithelium. They circulate a

required to thoroughly settle this point. See below, the respiratory organs. See also *Hollard*, who unhesitatingly regards the canals, which, with *Velella*, communicate externally by a central opening, as a digestive cavity, and thinks he has observed in their walls brownish spots representing the hepatic cells; see Ann. d. Sc. Nat. III. 1845, p. 249, Pl. IV. bis.

9 The aquiferous canals of the respiratory system having been regarded as intestinal tubes, their orifices, which in the Ctenophora are situated at the extremity of the body, and in the Discophora upon the borders, have been considered as anal openings; and especially so, since in these two orders, accidental fæces in these canals are expelled through these orifices. See *Will*, loc. cit. p. 28, and *Ehrenberg*, Abhandl. d. Berl. Akad. 1835, p. 189, Taf. I. IV. fig. 2, z.*

10 Acalephæ possess an extraordinary digestive power, which is the more singular as no secretory organ has been found on the sides of their stomach. *Mertens* (Mém. d. l'Acad. de St. Petersburg, loc. cit. p. 400, Taf. I. fig. 5, 6, a.; and p. 518, Taf. VIII. fig. 4, Taf. IX. fig. 1, f.), however, affirms to have seen in *Cestum* and *Cydippe* four vessels in this situation, which are perhaps hepatic organs. The orange-colored cords found upon the sides of the stomach of *Stephanomia*, and which *Milne Edwards* (Ann. d. Sc. Nat. XVI. p. 222, Pl. VII. IX. X.) has taken for genital organs — may they not also be hepatic organs? †

* [§ 61, note 9.] Upon the nutritive system of the Acalephae, see *Forbes* (loc. cit. p. 4), but especially *Agassiz* (loc. cit.), who has studied the subject with conscientious care. There is no distinction between the alimentary canal proper and the vascular system, for the one opens by large tubes into the other. The Acalephs, therefore, circulate *chyme*, and here we have the rudest form of circulation. If this idea is once well considered, the relations of their nutritive apparatus in general will be quickly appreciated.

The variations in the shape and form of the digestive apparatus are wide and numerous, but their importance is rather in Zoology. See *Agassiz* for the details of *Sarsia*, *Hippocrene*, *Tiaropsis*, *Staurophora*, *Pleurobranchia*, *Bolina*. — Ed.

† [§ 61, note 10.] *Kölliker* (*Siebold* and *Kölliker's* Zeitsch. IV. Hft. 3, 4, p. 313) has observed with *Velella* and *Porpita* a glandular mass, corresponding most probably to a liver. It had before been regarded as such by *Delle Chiaje*, but *Kölliker* has given it a special description. It consists of a brown mass which communicates with the bottom of the stomachal cavity by branched, anastomosing ducts. — Ed.

colored fluid and colored corpuscles; and these corpuscles are not found except in those vessels surrounding the aquiferous canals.

There is no regular circulation, but the shifting motion of the blood hither and thither is due to irregular contractions of various parts of the body.[1]

CHAPTER VII.

RESPIRATORY SYSTEM.

§ 63.

The entire body of the Acalephae is traversed by canals which receive water from the stomach, or directly from without, and which is ejected through openings upon the extremity of the body and on the margin of the disc.

These aquiferous canals are lined with a delicate, ciliated epithelium, by means of which accidental particles of food or fæces are quickly removed. They have been regarded both as digestive and as sanguineous organs. But that they are respiratory organs is highly probable, not only from their structure,—the cilia producing a constant renewal of water,—but also from the fact that they are surrounded by real sanguineous vessels.

This aqueous circulation is oscillatory from one side of the body to the other, being interrupted only by those contractions of the body which occur when fresh water passes from the stomach into the canals.[1]

1 These new details upon the sanguineous system of the Acalephae are due to *Will* (Horæ tergest. p. 34, and *Frorieр's* neue Not. No. 599, 1843, p. 66). In *Beroë*, he has been able to clearly distinguish the sides of these vessels from those of the aquiferous canals contained in their interior, for the first are covered with numerous red pigment cells.

The blood of this animal has a greenish hue, and contains spherical or slightly elongated red corpuscles, with large nuclei. But, beside these, *Will* has found in *Cydippe* other nucleated cells of a greenish color. In *Polyxenia*, there is no sanguineous system separate from the aquiferous canals, which, in *Cytaeis* and *Geryonia* are quite surrounded by them. The vessels of *Cephea* contain brown corpuscles; and *Will* has concluded that the reddish threads found along the aquiferous canals of this animal, and which *Ehrenberg* (Abhandl. d. Berl. Akad. 1835, p. 195, Taf. VI. fig. 3, ♀, and *Muller's* Arch. 1834, p. 568) has taken for striated muscles, are really blood-vessels. Profound researches must decide the real relations of the aquiferous canals to the sanguineous system filled with a violet liquid of *Velella*, as described by *Costa* (Ann. d. Sc. Nat. XVI. p. 188, Pl. XIII. fig. 3). It should be mentioned that the blood-system of the Acalephae, which *Will* has described with so much positiveness, is not verified either by *Bergmann* or *Frey* and *Leuckart* (Beitr. p. 38), after numerous special researches.*

1 If, and especially with the Discophora, these canals have been taken for digestive tubes, it is because fæces and particles of food have been here found, and which have been ejected through the openings on the borders of the body. But the real function of these openings is to discharge the water unfit for respiration; and it is only during the ingestion of this liquid that these foreign particles are thus introduced. This communication between the respiratory and digestive systems reminds one of the Polyps, where (as in the Anthozoa) the openings in the stomach allow its contents to pass into the cavity of the body, which last may be likened to the aquiferous system. On the other hand, the opinion that these canals are blood-vessels would be supported by the Ctenophora, since here they are filled with a red liquid; but, according to *Will* (Horæ tergest. p. 34), this liquid is not in these canals, but in proper blood-vessels surrounding them. He denies, also, that these blood-vessels of the Ctenophora open upon the surface of the body, or that the blood escapes outward mixed with fæces.

* [§ 62, note 1.] A true circulatory system has not been observed also by *Dana* (Struct. and Class. of Zoophytes, 1846, p. 12), by *Forbes* (Brit. Naked-eyed Medusae, 1848, p. 6), by *Agassiz* (Contributions to the Nat. Hist. of the Acalephae of North America, Mem. Amer. Acad. Boston, 1850, p. 260), and by *Busch* (Beobacht. üb. Anat. u. Entwick. einiger wirbellosen Seethiere, 1851, p. 13). It may, therefore, be concluded that these animals have no system of this kind, and especially so as *Agassiz* failed to notice it after the most intimate research upon the Beröid Medusae (loc. cit. p. 313), which were the objects of *Will's* study. —Ed.

§ 64.

With the Ctenophora, this respiratory system consists of an infundibuliform cavity, communicating with the stomach by two orifices, situated at its base and surrounded by sphincters.

Numerous aquiferous canals pass out of this cavity, traverse the body in a longitudinal direction, and finally anastomose with an annular vessel surrounding the mouth; but, beside these, there are two short canals which pass directly to the posterior extremity of the body, where they open externally.

With *Eucharis* and *Cydippe*, these canals are differently distributed; thus, two go to the tentacles, two to the sides of the stomach, and four to the sides of the body. The same is true with *Beroë*, excepting that those to the tentacles are wanting. The lateral canals divide, at a short distance from the cavity, into as many branches as there are sides. With *Cydippe*, the excretory canals are simple; with *Eucharis* they are provided with vibratile lamellae, and with *Beroë* with branching appendages.[1]

With the Discophora, numerous aquiferous canals pass from the stomach or its appendages, traverse the disc in a radiating manner, sometimes bifurcating, and terminate at the borders of the disc in an annular vessel which opens externally by numerous orifices.

In *Cytaeis*, *Geryonia* and *Thaumantias*, there are four of these canals, arranged in a crucial manner;[2] and in *Aequorea* there are seventy-four disposed in a ray-like way.[3]

In *Medusa aurita*, there pass from the four folds of the stomach sixteen of these canals, eight of which are simple, and eight bifurcating numerously before reaching the marginal vessel of the disc.[4] With *Sthenonia* and *Aurelia*[5] they are very numerous and widely branched.

With *Medusa aurita*, the terminal openings of the annular vessel are eight, and regularly alternate with the organs of hearing there situated.[6] But in *Cephea* these openings are said to be directly beneath these last-named organs.[7]

With the Siphonophora, an aqueous system has not yet been well made out. There is, however, with some, an elongated cavity which is perhaps respiratory, and which, in some species, opens into the stomach, and in others directly upon the outer surface.[8]

1 *Will* (Horæ tergest. p. 30, Taf. I.) has made very minute researches upon the aquiferous system of *Eucharis*, *Cydippe* and *Beroë*. That of *Beroë ovatus*, *Forskalii*, and of *Lesueuria vitrea*, has been carefully described and figured by *Milne Edwards* as a circulatory system (Ann. d. Sc. Nat. XIII. p. 320; XVI. p. 203, 213, Pl. III.–VI.).

2 *Will*, loc. cit. Taf. II. fig. 5, 7, 8, 14, 16.

3 *Milne Edwards*, Ann. d. Sc. Nat. XVI. p. 197, Pl. I. fig. 1.

4 *Rosenthal*, Zeitsch. f. Physiol. I. Hft. 2, Taf. XI.; also, *Ehrenberg*, Abhandl. d. Berl. Akad. 1835, Taf. I. bis. III.

5 *Eschscholtz*, loc. cit. Taf. IV.; also *Brandt*, Mém. de l'Acad. d. Sc. de St. Petersburg, IV. 1838, Pl. IX. X. XI.

6 *Ehrenberg*, *Müller's* Arch. 1834, p. 566; also, Abhandl. &c. loc. cit. p. 188, Taf. I. fig. 1, w. and Taf. IV. fig. 2, z.

7 *Will*, loc. cit. p. 60.

8 In *Diphyes*, this canal terminates in this way by an oval dilatation, lined with ciliated epithelium, and has perhaps properly been regarded by *Will* (loc. cit. p. 78, Taf. II. fig. 22, a.) as a respiratory organ. A similar cavity, with a cœcal appendage, is found in *Ersaea* (*Will*, loc. cit. p. 81, Taf. II. fig. 27–31, d. e.). If the arms provided with openings, of the *Physophorae*, are really stomachs, then the cavity beneath them, which has a canal passing along the axis of the animal, should be taken as belonging to the aquiferous system, for it receives water by an opening at the base of the anus. This same opening has been taken for a mouth by *Philippi* (*Müller's* Arch. 1843, p. 63, Taf. V. fig. 10). According to *Lesson* (*Duperrey*, Voyage. loc. cit. No. 6, fig. B.), there is between the suckers of *Velella* an orifice which leads from before backward into a large branching canal. This structure, hitherto regarded as a digestive

CHAPTER VIII.

ORGANS OF SECRETION.

§ 65.

The air-cavity of certain Siphonophora, which is surrounded by a double membrane, ought probably to be regarded as an organ of secretion; for, according to many naturalists, the air contained could not have been derived from without, and consequently was secreted by the sides of the internal membrane.[1]

CHAPTER IX.

ORGANS OF GENERATION.

§ 66.

Reproduction by *fissuration* and *gemmation* with the Acalephae has been observed only in the youngest states of certain Medusae.[1] But repro-

cavity, belongs probably to the aquiferous system. That which in *Porpita* has been taken for a mouth, belongs probably, also, to the same system. I would not, however, deny that another signification may be given to the so-called respiratory and digestive organs of the Siphonophora.

If one prefers, with *Philippi*, to regard the opening between the tentacles of *Physophora*, *Velella* and *Porpita*, as a mouth, then the cavity of these tentacles should belong to the aquiferous system. Moreover, these tentacles, as to their form and mobility, remind one of the pedicles of the Echinoderms; but it is remarkable that they can absorb food.

Sars (Faun. littoral. Norveg. p. 34, 42, Tab. VI. fig. 3, gg. and Tab. VII. fig. 3, e.) has observed in the interior of the cartilaginous, natatory pieces of the Physophoridae and Diphyidae, aquiferous canals which are probably of a respiratory nature.

Hollard, likewise, regards the hollow and tubuliform tentacles of *Velella* as aquiferous tubes, and in this way, as the tentacular feet of the Echinoderms, includes them in the aquiferous system. See Ann. d. Sc. Nat. III. 1845, p. 250.

1 Many naturalists entirely deny the presence of openings in these aërial cavities, and do not admit that they are filled with gas. Thus *Philippi* (*Muller's* Arch. 1843, p. 63) affirms to have found neither external opening nor air in the pouch at the end of the longitudinal canal of *Physophora tetrasticha*. *Olfers* (Abhandl. d. Berl. Akad. 1831, p. 165) has not been able to find in *Physalia* the opening of the internal sac, said to be near the one of the external sac. In fact, *Bennett* (Proc. Zool. Soc. London, 1837, p. 43; and *Wiegmann's* Arch. 1838, II. p. 332), with the same species, has not seen an opening of this cavity, and was unable to force air from it. Future researches must determine if these pouches have not a respiratory function.

1 See, upon this subject, the Embryology of these animals, below. It is not yet demonstrated that adult Acalephae reproduce by fissuration; and although *Mertens* (Mém. d. l'Acad. de St. Petersburg, II. p. 494, Pl. I. fig. 2–4, and p. 527) has observed detached corpuscles from the body of *Cestum* and *Cydippe* swim freely about, and rapidly enlarge, yet his observations are here limited.

In the same way, *Will* (Horæ tergest. p. 42) has seen analogous bodies detached from *Eucharis*, and has found in the water others supposed to belong to the Ctenophora, but has not traced their further condition.

Propagation by buds has also been found with the Acalephs, through the excellent researches of *Sars* (Fauna littoral. Norveg. p. 11, Tab. IV. fig. 8–12), for this observer has seen on the external surface of the tubuliform stomach of *Cytaeis octopunctata*, and upon the four ovaries of *Thaumantias multicerrata*, small campanuliform Acalephs resembling their parent, in the process of development, and which were finally detached. In the genus *Agalmopsis* which is allied to *Agalma*, *Sars* has observed (Ibid. p. 38, Tab. VI. fig. 14–17) campanuliform bodies sprout out between the prehensile filaments and the tubuliform stomach, and which were finally detached, swimming freely like the Discophora. According to *Sars*, also (Ibid. p. 43, Tab. VII. fig. 11, b. 13, b. and 14), there is, likewise, an analogous mode of propagation with *Diphyes*.*

* [§ 66, note 1.] See also *Huxley* (Ann. Nat. Hist. VI. p. 394), who has described the reproductive processes of the Diphyidae, and shown that they multiply by gemmation as well as by ova. See, also, *Muller's* Arch. 1851, p. 380, Taf. XVII. — Ed.

duction by eggs, and consequently by the means of proper genital organs, has been observed in all the families.

With the Ctenophora,[2] both sexes are combined in the same individual; but with the Discophora, the individuals are of one sex alone.[3]

§ 67.

The eggs are spherical, and surrounded by an exceedingly thin envelope. The vitellus is of a whitish violet or yellow color, and contains a germinative vesicle, and germinative dot.[1]

The spermatic particles, which have generally the form of Cercaria (that is, a head and a filiform tail), are very active, and suffer no change in water.[2]

In some Siphonophora, they appear to have a linear form, and attain a very great size.[3]

§ 68.

The genital organs are not developed except at the epoch of procreation, and this period is very brief. On this account, their existence has often entirely escaped the notice of observers.

The male and female organs so closely resemble each other, as to color, form and position, that they are easily confounded. They consist either of elongated pouches, or of riband-like bands, which are situated in different parts of the body. In the first case, the sperm and eggs escape through particular excretory canals; in the second, they escape directly outwards from the ovaries or testicles, or pass first through large cavities which communicate externally.

As they have no copulatory organs, the water is the medium of fecundation. In this way the unaffected spermatic particles are brought in direct contact with the eggs.

2 *Will*, *Froriep's* neue Not. No. 599, p. 66.

3 *Siebold*, *Froriep's* neue Not. No. 1081, 1836, p. 33.*

1 *Wagner* (Prodrom. loc. cit. Taf. I. fig. 2; and Icon. zoot. Tab. XXXIII. fig. 15–17) and *Siebold* (Beiträge z. Naturgesch. wirbelloser Thiere. loc. cit. Taf. I. fig. A. B.) have figured the eggs of *Cyanea pelagia*, and of a *Medusa*.

2 The spermatic particles of *Eucharis* and *Beroë* consist of a round body, having a delicate and very movable tail (*Will*, loc. cit. Taf. I. fig. 6, 24). In *Cydippe* they are similar (*Krohn*, *Froriep's* neue Not. No. 356, 1841, p. 52). This is likewise true of those of the *Discophora*; see *Siebold*, Beiträge loc. cit. Taf. I. fig. c. (*Medusa*); *Kölliker*, Beiträge loc. cit. Taf. I. fig. 8, 9, 10; and *Milne Edwards*, Ann. d. Sc. Nat. XVI. Pl. I. fig. 1, d. (*Rhizostomum*, *Chrysaora* and *Aequorea*); *Wagner*, Icon. zoot. Tab. XXXIII. fig. 20, and *Will*, Horæ tergest. Tab. II. fig. 12 (*Pelagia* and *Geryonia*).

The spermatic particles of the Discophora, see Kölliker in the Neue schweiz. Denkschr. VIII. p. [illegible] Taf. II. fig. 18 (*Cassiopeia*). †

3 It may be that the stout linear and active bodies, seen by *Will* (loc. cit. p. 78, 81, Taf. II. fig. 26) in the respiratory cavity, the stomach and the general cavity of the body of *Diphyes* and *Ersaea*, and which he was inclined to regard as Entozoa, are the spermatic particles of these animals, since they quite resemble those of *Alcyonella* and *Cristatella*.

According to *Sars* (Faun. littor. &c. p. 38), the spermatic particles of *Agalmopsis* have a cercaria-form. ‡

* [§ 66, note 3.] Reproduction by fissuration has been observed with the Discophora by *Kölliker* (*Siebold* and *Kölliker's* Zeitsch. IV. p. 325); he witnessed this phenomena with *Stomobrachium mirabile*. It does not appear, however, that he has observed this process with adult forms; for he remarks that there is reason to believe that this *Stomobrachium* is only a young, imperfect form of his *Mesonema coerulescens*. — Ed.

† [§ 67, note 2.] The spermatic particles of the Acalephae have invariably, I think, a cercaria-form, like those of the Polyps, and like which, also, they are developed in special daughter-cells. — Ed.

‡ [§ 67, note 3.] These bodies mentioned by *Will* as spermatic particles have since been examined by *Huxley* (loc. cit.), who thinks they are not of this nature, a view which is otherwise probable from the fact that he found no male generative sacs, and also because, as I have shown (see my note after § 46, note 5), these particles with *Alcyonella* have a cercaria-form. — Ed.

§ 69.

The position of the sexual organs varies in the different orders, in the following manner:

1. With the Ctenophora, which are hermaphrodites, they are situated along the sides, under the form of elongated utricles, the testicles being on one side and the ovaries on the other. They have a nodulated appearance, and from the lower part of each passes off an excretory duct, which runs toward the mouth, but the terminal opening of which has not yet been well made out.[1]

2. With many Discophora, these organs are arranged like rays, passing from the centre to the border of the disc. In *Oceania*, *Cytaeis*, *Geryonia* and *Thaumantias*, the four saccular ovaries or testicles form at the centre of the disc a cross, which is traversed by four aquiferous canals.[2] Their excretory ducts pass towards the base of the stomach, but their terminal openings are not distinct.[3] In the disc of *Aequorea violacea*, seventy-four ray-like bands are spread out, and the free plicated borders of these hang beneath the inferior surface of the disc, thus permitting the free escape of the eggs and sperm into the water.[4]

3. Another group of the Discophora have at the base of their tentacles four large openings, which lead into as many cavities in the disc.[5] At the base of these cavities, which formerly were regarded as respiratory organs, the genital organs are situated in the form of plicated bands. These as four bands (testicles or ovaries) are bent either into an angle or the arc of a circle, forming sometimes a star with four rays,[6] and sometimes a four-lobed rosette.[7] If these cavities increase in number, the genital organs increase in the same proportion.[8] The border of these organs is generally provided with numerous tentacles which project into the cavity.[9] In the riband-like testicles numerous small sacs are observed; each one of these opens separately into the genital cavity, while the eggs, on the contrary, are separated from the similarly-formed ovary only by a gradual constriction of the latter.[10]

4. With the Siphonophora, all the relations of these genital organs still require much investigation. With the Diphyidae, they consist of sacs communicating with the general cavity of the body.[11] During the epoch

1 *Will*, Horae tergest. p. 38, Taf. I. fig. 22, 23.

2 *Wagner*, Icones. zoot. Tab. XXXIII. fig. 26, a. a.; *Will*, loc. cit. Taf. II. fig. 5, 7, 8, 14, 16; *Blainville*, Manuel d'Actinol. 18[illegible] XXVII. fig. 3; and *Sars*, Beskrivelser loc. cit. [illegible]. 12, 13.

3 *Will*, loc. cit. p. 71.

4 *Milne Edwards*, Ann. d. Sc. Nat. XVI. p. 198, Pl. I. fig. 1, a. b.

5 *Gaede*, Beiträge loc. cit. Taf. I. fig. 1, c. (*Medusa*); and *Lesson* in *Duperrey*, Voyage loc. cit. No. 12, 13 (*Chrysaora*).

6 *Rhizostomum*.

7 *Chrysaora*, *Medusa*, *Pelagia* and *Aurelia*. See *Ehrenberg*, Abhandl. d. Berl. Akad. 1835, Taf. I. fig. 1; *Wagner*, Icon. zoot. Tab. XXXIII. fig. 1; and *Brandt*, Mém. de l'Acad. de St. Petersburg, IV. Pl. IX. X. With the male and the female *Cephea*, I have found the testicles and the ovaries disposed exactly as with the M[illegible]

8 In *Cassiopea*, these organs are [illegible] in number.

9 *Medusa* and *Pelagia*; see *Ehrenberg*, loc. cit. Taf. VII.; and *Wagner*, Icon. zoot. Tab. XXXIII. fig. 13.

10 *Siebold*, Beiträge loc. cit. Taf. I. fig. 20, 23; and *Kölliker*, Beiträge loc. cit. p. 40.

11 In *Diphyes* and *Ersaea*, a sac filled with cells opens into the general cavity of the body, and communicates beside with the stomachs and respiratory cavities. *Will* (Horae tergest. p. 78, 81, Taf. II. fig. 23, c.) regards this sac as a sexual organ; and *Meyen* (Nov. Act. physico-med. XVI. Suppl. 1, 1834, p. 214, Tab. XXXVI. fig. 2, h. and fig. 6, 7) asserts to have seen eggs in it. According to *Philippi* (*Müller's* Arch. 1843, p. 63, Taf. V. fig. 10, a. b.), the grape-like clustered genital organs, with *Physophora*, are situated between the prehensile organs; the smallest containing in each lobule six to ten eggs, and the largest a granular liquid (Sperm?).

Hollard (Ann. d. Sc. Nat. III. 18[illegible] [illegible] Pl. IV. bis. fig. 33, 34) has found both [illegible] of ovaries [illegible] of the tubuliform tentacles (stomachs). [illegible] p. 37, Pl. V.) has also

of procreation, the females of some Discophora are easily distinguished from the males by the numerous pouches of their tentacles, and in which eggs and newly-hatched young are carried for a short time.[12]

§ 70.

As yet, the development of a few only of the Acalephae has been traced. It is attended by a remarkable metamorphosis.

After the usual segmentation of the vitellus, ovoid embryos resembling infusoria are developed; these turn freely on their axis, and swim about in the water by means of ciliated epithelium.[1] Shortly after, they become attached by the anterior extremity to some object. Upon the opposite free extremity tentacles appear, and between them the mouth. The animal has then the form of a Polyp.[2] It is during this period that the young animal reproduces by *gemmation*,[3] and sometimes by transverse *fissuration*. This last mode occurs in the following remarkable manner:

The polyp-like animal increases in length, and its body divides transversely into many segments. Around each of these segments eight bifid processes are developed; after this, each segment is successively separated from before to behind, and they float about for a time as eight-rayed Acalephae, but soon attain, however, their adult condition.[4]

seen genital organs of the same form between the tentacles of *Agalmopsis*; but he found at the same time (loc. cit. p. 38, 43), in the campanuliform individuals produced from buds, testicles with *Agalmopsis*, and ovaries with *Diphyes*. It may therefore be justly supposed that these various Siphonophora are compound, sexless individuals, which, like the Hydrina and Sertularina, reproduce by alternation of generation, — that is, by buds, — individuals having sex.

12 *Medusa aurita* and *Cyanea capillata*; see *Ehrenberg*, Abhandl. &c. loc. cit. Taf. III. fig. 1, 2, Taf. VIII. fig. 1; also, *Sars* in *Wiegmann's* Arch. 1841, I. p. 19.

1 The development and metamorphosis of *Medusa aurita* and of *Cyanea capillata* have been observed by *Siebold* (Beiträge loc. cit. p. 21, Taf. I. II.; and *Froriep's* neue Not. No. 166, 1838, p. 177); and by *Sars* (*Wiegmann's* Arch. 1841, I. p. 19, Taf. I.–IV.). In the first stage of development (see *Ehrenberg*, Abhandl. &c. loc. cit. Taf. VIII. fig. 15–18; also, *Siebold*, Beiträge loc. cit. Taf. I. fig. 17–19; and *Sars*, *Wiegmann's* Arch. loc. cit. Taf. I. fig. 1–6), these infusoria-like Medusae have been regarded by *Baer* as the larvæ (*Meckel's* Deutsches Arch. VIII. 1823, p. 389).

2 *Siebold*, Beiträge loc. cit. p. 29, Taf. I. fig. 25–33, Taf. II. fig. 34; and *Sars*, *Wiegmann's* Arch. loc. cit. Taf. I. fig. 7–31. During my last visit at Trieste (autumn of 1847), I convinced myself that the young of *Cephea Wagneri* are developed wholly like those of Medusae, by passing from infusoria-like forms to polypoid young animals.*

3 The reproduction of the polyp-form Medusae by buds has been observed by *Sars* in *Cyanea capillata*. He has also seen them develop pedicles from the end of which new individuals would appear, which resembled Polyps. See *Wiegmann's* Arch. loc. cit. p. 26, Taf. I. fig. 37, 41, 42, 38, 39, 40.

4 These young Medusae, whilst composed of rings, have been taken for a new genus (*Scyphistoma*) of Polyps by *Sars* (Isis. 1833, p. 222, Taf. X. fig. 2). *Steenstrup* (Ueber d. Generationswechsel, p. 17) has regarded them as nurses of the Medusae. At a latter period, when the rings have been separated and have acquired the bifid prolongations, *Sars* (Isis. 1833, p. 224, Taf. X. fig. 4; and Beskrivelser, &c., p. 16, Pl. III.) has described them as a new species of Medusae (*Strobila octoradiata*). But lately he has perceived that they are the young of *Medusa aurita* (*Wiegmann's* Arch. 1837, I. p. 406); it did not occur to him, however, that these young constitute, very probably, the genus *Ephyra* of *Eschscholtz* (see *Wiegmann's* Arch. 1841, Th. I. p. 10). It will probably be discovered that many small campanulate or discoid Medusae are only the young of other Acalephae; for it is very likely that they all undergo a similar metamorphosis. It may also prove that many naked Polyps are only transitionary forms of known species of Acalephae. In this connection the observation of *Dujardin* (Comp. rend. 1843, p. 1132) deserves the attention of naturalists. In tracing the development of one of the Discophora allied to *Oceania*, he observed that this animal in its early condition separated from a corallum resembling that of *Syncoryne*, and was of a form quite like an *Eleutheria*. However various these developing forms may be, that one must be regarded as the real one which exists during the development of the testicles and ovaries.†

* [§ 70, note 2.] See, also, for recent researches on the development of *Cephea*, *Ecker*, Bericht üb. die Verhandl. d. naturf. Gesellsch. in Basel. VIII. 1849, p. 51; *Busch*, Beobachtungen üb. die Anat. &c. Berlin, 1851, p. 30; and *Frantzius*, in *Siebold* and *Kölliker's* Zeitsch. f. Zool. IV. p. 118, June, 1852. — Ed.

† [§ 70, note 4.] In regard to the development of the Acalephae, it may be mentioned that recent researches, few as they are, have verified some

of the hypotheses suggested in the above note. Hitherto there has been much confusion on this subject, from the want of complete series of observations; even now the whole class can be regarded only in a somewhat transitionary state, in a zoological point of view. Many genera which have hitherto been regarded good and permanent will no doubt, as *Siebold* has remarked, prove to be only undeveloped forms of well-known species. As already stated, *Agassiz* regards the Hydroid Polypi as true Acalephae, and the analogy which exists between the embryos of Medusae and Polypi may be the foundation of many other important changes. At present, however, broad generalizations must be deferred until we have extensive and serial researches in the embryology of these animals. For separate details on the development of some forms, see *Busch*, loc. cit. (*Sarsia*, *Lizzia*, *Cephea*, *Eudoxia*, *Diphyes*); *Huxley*, loc. cit. (Diphyidae, Physophoridae); *Agassiz* and *Desor*, loc. cit. (Medusidae). — Ed.