MEMOIRS

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY,

AT

HARVARD COLLEGE.

VOL. IX.

CAMBRIDGE, MASS., U.S.A.
1882–1884.

University Press:
John Wilson and Son, Cambridge.

CONTENTS.

Selections from Embryological Monographs. Compiled by A. Agassiz, W. Faxon, and E. L. Mark : —

I. Crustacea. By W. Faxon. pp. 28. 14 Plates. July, 1882.

II. Echinodermata. By Alexander Agassiz. pp. 45. 15 Plates. July, 1883.

III. Acalephs. By J. W. Fewkes. Polyps. By E. L. Mark. pp. 52. 13 Plates. September, 1884.

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. IX. No. 1.

SELECTIONS

FROM

EMBRYOLOGICAL MONOGRAPHS.

COMPILED BY

ALEXANDER AGASSIZ,
WALTER FAXON, and E. L. MARK.

I.—CRUSTACEA.

By WALTER FAXON.

WITH FOURTEEN PLATES.

CAMBRIDGE:
Printed for the Museum.
July, 1882.

NOTICE.

The present number of the Memoirs is the first of a series of "Selections from Embryological Monographs," which it is proposed to issue as Vol. IX. of the Memoirs of the Museum, so as to give to the student in an easily accessible form a more or less complete iconography of the embryology of each important group of the animal kingdom. This selection is not intended to be a hand-book, but rather an atlas to accompany any general work on the subject. The plates will be issued in parts, as fast as practicable, each part covering a somewhat limited field, and occasional appendices may be published to prevent the plates from becoming antiquated.

The quarto illustrations will be accompanied by a carefully prepared explanation, and by a bibliography, in octavo, to be made as complete as possible. The Bibliography (by Walter Faxon) which accompanies this number (Crustacea) has been published as No. 6 of Vol. IX. of the Bulletin of the Museum.

The parts devoted to Echinoderms, Acalephs, and Polyps are well advanced.

The phenomena connected with the fecundation and maturation of the egg, and the history of the formation of the embryonic layers, will be treated in a separate part, without regard to the systematic zoölogical connection of the observations.

A number of original drawings will be incorporated with these selections wherever they supplement published material.

The work was planned as early as 1873. I hoped then to publish it with the collaboration of Dr. A. S. Packard, Jr. Other duties prevented this plan from being carried out. In 1875, Professor John McCrady kindly consented to become my collaborator, but his removal from Cambridge stopped the undertaking in its earliest stages.

ALEXANDER AGASSIZ.

Museum of Comparative Zoölogy,
Cambridge, Mass., U. S. A.

July, 1882.

PLATE I.

1 – 16. *Development of* Pycnogonida. *Figures from* Anton Dohrn, P. P. C. Hoek, *and* George Hodge.

a b. Abdomen.	*r.* Proboscis.
n. Nerve-ganglion.	*α.* Spine on first segment of first pair of appendages.
o c. Eye.	*β.* Rectum.

The Roman numerals indicate the appendages in their consecutive order.

1, 3 – 14, from Dohrn, Untersuchungen über Bau und Entwicklung der Arthropoden. 2. Ueber Entwicklung und Bau der Pycnogoniden. Jenaische Zeitschr., V., Taf. V., VI., 1870.

1. Egg of *Pycnogonum littorale* after cleavage. The nuclei are seen within the cleavage-spheres. Double egg-membrane.
2. Section of segmented egg of *Nymphon brevicaudatum*, hardened in absolute alcohol, and colored with picro-carmine. The protoplasm and deutoplasm have not yet separated, and the cleavage is total. Each segment has a nucleus. The faint lines within the segments denote the yolk particles, which appear as if vesicular, an appearance perhaps caused by the action of the alcohol. The egg is furnished with a distinct but very thin membrane. From Hoek, Report on the *Pycnogonida* of the Challenger Expedition, Pl. XIX. fig. 3, London, Edinburgh, and Dublin, 1881.
3. Egg of *Pycnogonum littorale* at a later stage than fig. 1. I, II, III, rudiments of anterior three pairs of appendages of embryo.
4. Embryo of the same, later stage. *r*, proboscis.
5. The same, later stage, profile view. *o c*, eye. *α*, spine arising from base of first pair of appendages.
6. Nearly fully developed embryo of the same, from ventral side.
7. Hatched larva of the same, ventral view. The protonymphon stage of Hoek. The anterior pair of appendages is chelate, and the two following pairs are furnished with a sharp terminal claw. The spine on the first pair of appendages emits a byssus-like thread secreted by a gland in the proximal segment of the appendage. This thread probably serves to fasten the larva to the ovigerous legs of the adult.
8. Eye of larva of *Achelia lævis*.
9. Intermediate stage between larva and adult of *Achelia lævis*. The three pairs of appendages of the larva have become much reduced, especially the second and third. The spine (*α*) on the mandible is disappearing. The fourth and fifth pairs of appendages (IV, V) are well developed, and behind them are seen the rudiments of the two remaining pairs (VI, VII) as lateral outgrowths of the body. The mouth at the end of the proboscis leads into an œsophagus provided with masticating apparatus (seen at the base of the proboscis in the figure). The intestine sending diverticula into the appendages is represented by heavy shading. *β*, rectum. *a b*, abdomen. $n^1 - n^4$, first to fourth sub-œsophageal nerve-ganglia.
10. The same, older. The proboscis has increased in size. The spine on the mandible has disappeared. The second pair of appendages has lost its claw. The third pair is reduced to a short stump, which develops again in the male into the ovigerous or accessory appendages. The sixth and seventh pairs have attained their complete form. n^5, fifth sub-œsophageal nerve-ganglion.
11. Second appendage (palpus) of adult male *Achelia lævis*.
12. Third appendage (ovigerous or accessory) of the same.
13. Second appendage of female.
14. Third appendage of the same.
15. Adult *Achelia lævis*, dorsal view. At the base of the palpi is seen the oculiferous tubercle bearing the eyes. From Hodge, List of the British Pycnogonoidea, with Descriptions of several new Species. Ann. Mag. Nat. Hist., [3.] XIII., Pl. XIII. fig. 12, 1864.
16. Adult *Nymphon gracile*. The three pairs of larval appendages are now represented by I (antennæ, pedipalpi, or mandibles, of authors), II (palpi), and III (ovigerous or accessory appendages). The anterior pair are innervated from the supra-œsophageal ganglion, and may be homologous with the antennæ of Crustacea. The second and following pairs receive nerves from the sub-œsophageal ganglia. The third pair of appendages serves, in the male, to carry the eggs. The nervous system is represented by the dotted lines. From Hoek, Ueber Pycnogoniden. Niederländisches Arch. Zool., III., Taf. XVI. fig. 18, 1877.

17 – 30. *Development of* Trilobita. *Figures from* Joachim Barrande, *Système Silurien du Centre de la Bohême*, I., Pl. VII., XXX., Prague et Paris, 1852.

17 – 22. *Sao hirsuta.*

17. Youngest stage. The body is unsegmented, the future thorax being only faintly indicated by transverse furrows in the hinder part of the median lobe, and by three pairs of minute lateral spines. The small upper figure shows the natural size of this stage, the figure on the right a profile view.
18. Later stage. The thorax is now clearly differentiated from the head, and consists of three ankylosed segments.
19. Older form. The hinder division of the body now consists of five ankylosed segments, with no division into thorax and pygidium.
20. Still later stage, signalized by the appearance of two *free* segments behind the head, which allow a demarkation to be now drawn between a thorax, composed of free segments, and a pygidium of ankylosed segments. As the trilobite develops, the thorax gains new segments at the expense of the temporary pygidium, until in the adult the thorax contains seventeen segments, the permanent pygidium being formed of two.
21. Stage with four free or thoracic segments, and three or four ankylosed (pygidium).
22. Stage with six free and three ankylosed segments.

23 – 30. *Trinucleus ornatus.*

23. Young stage, with head and pygidium, no thoracic segments. The pygidium shows traces of segmentation indicating two or three rings.
24. Older stage, with one thoracic segment. As development proceeds, new thoracic segments are interposed between the one last formed and the pygidium, until in the adult the thorax consists of six segments. These new thoracic segments are probably formed from the anterior part of the pygidium at the successive moults.
25. Stage with two thoracic segments.
26. Stage with three thoracic segments.
27. Stage with four thoracic segments.
28. Stage with five thoracic segments.
29. Smallest known individual with the full number (six) of thoracic segments. Natural size.
30. Fully grown adult.

PLATE II.

Development of XIPHOSURA (*Limulus Polyphemus*). *Figures from* A. S. PACKARD, ANTON DOHRN, *and* ALEXANDER AGASSIZ.

h. Dorsal vessel.
l. Liver.
m. Mouth.
m t. Metastoma.
n. Nerve-cord.
o c. Compound eye.
o c l. Ocellus.
α. Inner egg-membrane.
VII. Seventh pair of appendages.
VIII. Eighth " "
IX. Ninth " "

1–17, 20, from Packard, Development of *Limulus Polyphemus*. Mem. Boston Soc. Nat. Hist., II., Pl. III.–V., 1872.

1. Spermatozoa, magnified about 400 diameters.
2. Early form of ovarian egg, magnified 130 diameters.
3. Embryo within the egg. *m*, mouth. *α*, inner egg-membrane, the "protoderm" or "amnion" of Packard, "chorion" of Dohrn. Outside the inner membrane is seen the outer egg-membrane, the "chorion" of Packard, "exochorion" of Dohrn. The rudiments of the six anterior pairs of appendages have appeared. The anterior pair of appendages of *Limulus*, as shown by A. Milne-Edwards and Packard, are innervated from the œsophageal commissure, and are probably homologous with the mandibles of Crustacea. Balfour, moreover, has shown that in the spiders the anterior pair of appendages (cheliceræ) in the embryo are innervated from a post-oral ganglion, and are equivalent to the mandibles of insects, rather than to the antennæ as commonly supposed. Around the edge of the oval germ is a thin ridge, destined to be the lower edge of the carapace.
4. The embryo in a later stage. Letters as before.
5. Older stage seen from below. The seventh and eighth pairs of appendages, VII, VIII, have appeared. Above the lower margin of the carapace are seen the indications of the somites, the sutures extending upward, but not reaching the dorsal side of the egg. The six anterior pairs of appendages have lengthened and become bent upon themselves.
6. Later stage of the embryo, viewed from the side. The body has now a decided ventral flexure. The ninth pair of appendages, IX, have made their appearance, the posterior division of the body has become clearly differentiated from the anterior portion, and its somites well marked. The six anterior pairs of appendages have become jointed. *l*, liver.
7. Rudimentary gills from an older individual.
8. Terminal part of sixth pair of appendages.
9. Dorsal view of the embryo just before hatching. Trilobitic stage. The egg-membrane, "amnion," (the outer, or "chorion" of Packard, having been cast off before this period,) is not represented in the figure. The egg is now .13 in. in diameter. The embryo has already undergone its first moult within the egg. *h*, dorsal vessel. *o c*, compound eye. *o c l*, ocellus. At an earlier period than that represented in this figure the ocelli are situate on the under side of the head, just in front of the mandibles. A little later they appear on the front edge of the carapace. By the expansion and extension of this edge they are finally brought to the upper side of the head, a little way from the front edge, as in the figure.
10. Ventral view of the same stage. *m t*, metastoma or lower lip. *n*, nerve cord.
11. Terminal portion of third pair of appendages. Same stage as the two preceding figures.
12. Newly hatched young, viewed from in front and above.
13. The same, viewed from behind and above.
14. Dorsal view of newly hatched young. The segmentation of the posterior division of the body has become obscured.
15. Ventral view of the same.
16. Seventh pair of appendages of larva, which form the operculum of the adult.
17. One of the eighth pair of appendages of larva, bearing the gills. The two-jointed inner ramus is distinctly formed.
18. Young at the time of hatching. From Dohrn, Untersuchungen uber Bau und Entwickelung der Arthropoden. 12. Zur Embryologie und Morphologie des *Limulus Polyphemus*. Jenaische Zeitschr., VI., Taf. XIV. fig. 4, 1871.
19. Larva, from a sketch by A. Agassiz, made at Naushon Island, Mass., Dec. 19, 1864. The line on the right of the figure indicates the natural length of the larva.
20. Larva after the first moult subsequent to hatching (about three weeks after hatching). It is now ¼ in. long. The spine has acquired a considerable length. The arrows indicate the course of the circulation as seen in the living larva, the feathered arrows denoting the arterial currents, the simple arrows the course of the venous blood. The dendritic outline in the head is the liver sending two lobes backward into the hinder part of the body alongside the dorsal vessel, which lies in the median line. The dorsal vessel, is furnished with seven pairs of venous openings. Below the dorsal vessel, indicated by the fine lines within it, the intestine is seen extending back toward the spine.

PLATE III.

Development of Cirripedia. *Figures from* Fritz Müller, W. Lilljeborg, Charles Darwin, P. P. C. Hoek, Carl Claus, Alexander Agassiz, *and* C. Spence Bate.

1. Dorsal spine.
2. Ventral spine.
a. Fold of blastoderm.
a b. Abdomen.
b. Fold of blastoderm
b l. Blastoderm.
c p. Carapace.
c t. Embryonic cuticle.
d. Suctorial disk.
d p. Deutoplasm.
f. Frontal sense-thread.
f h. Frontal horn.
g l. Gland at base of frontal horn.
i. Intestine.
l b. Labrum.
n c. Nucleus.
o c l. Ocellus.
o v. Ovary.
p c. Polar cell.
p h. Posterior horn.
p p. Protoplasm.
s Spermatozoa ?
t. Testis.
v t. Yolk.
α. Orifice of brood-cavity.
β Chitinous shield.
γ. Crown.
δ. Chitinous plate.
ϵ. Rootlike organs.
ζ. Cleavage sphere.
ξ Tail.
ϕ. Anterior part of adult *Peltogaster*.
ω. Thorax.

The Roman numerals denote the appendages of the body in their consecutive order.

1–7. Development of *Rhizocephala*.

1–6, from Müller, Die Rhizocephalen, eine neue Gruppe schmarotzender Kruster. Arch. Naturgesch., XXVIII., Taf. I., 1862 ; Die zweite Entwickelungstufe der Wurzelkrebse (*Rhizocephala*). Ibid., XXIX., Taf. III., fig. 1, 1863.

1. Egg from the brood-chamber of *Lernæodiscus Porcellanæ*, with four cleavage spheres. Magnified 90 diameters.
2. First larval stage, or nauplius, of the same, from below, magnified 180 diameters. *c p*, margin of carapace. *l b*, labrum. *o c l*, ocellus. *v t*, remains of the yolk. I, II, III, first, second, and third pairs of swimming-feet. There is no mouth at this stage. A pair of frontal sensory threads is present, although not represented in the figure.
3. Second or pupa stage in the development of the same. The dark oval body is the nauplius eye, now of extraordinary dimensions. Paired eyes are not present. The carapace has become folded together so as to enclose the body. The second and third pairs of appendages of the nauplius have been discarded, the first pair have become prehensile, adapted for the attachment of the larva, and six pairs of swimming-feet (VI–XI) are present on the thorax. ξ, posterior or abdominal part of the body, ending in a pair of two-jointed processes, each bearing two terminal setæ. The pupa attaches itself by the prehensile antennæ to the abdomen of its host, throwing out rootlike filaments which entwine about its intestine or ramify through its liver, drawing nourishment therefrom. The remaining appendages are cast off.
4. Adult, attached to the ventral side of the abdomen of a *Porcellana*. Slightly magnified.
5. A smaller specimen removed from its host, viewed from the ventral side, magnified 15 diameters. *o v*, ovary, *t*, testis. α, orifice of the brood-chamber. β, chitinous shield. γ, crown.
6. The portion of the adult *Lernæodiscus* which lies within the *Porcellana*, magnified 25 diameters. *i*, intestine of the *Porcellana*. γ, crown. δ, chitinous plate. ϵ, rootlike processes growing about the intestine of the *Porcellana*.
7. Exuviæ of *Peltogaster sulcatus*, pupa stage, fixed by the prehensile antennæ (I) in the opening of the mantle of the adult, magnified 200 times. ϕ, anterior end of adult *Peltogaster*. From Lilljeborg, Supplément au Mémoire sur les Genres *Liriope* et *Peltogaster* H. Rathke. Nova Acta Reg. Soc. Scient. Upsal. [3.] III., Pl. VIII. fig. 34, 1860.

8–12. Development of *Cryptophialus minutus*, from Darwin, A Monograph on the Subclass *Cirripedia*. *Balanidæ*, Pl. XXIV., London, 1854.

8. Oval embryo. 35 times the natural size.
9. Later stage. Two horns (I) are developed at the anterior part of the body, and one, representing the abdomen (*a b*), at the posterior end. On same scale as the last figure.
10. Later stage. The posterior horn has shrunk. The two anterior horns have approached each other on the future ventral surface and contain within them the prehensile antennæ of the later stage. At this stage the larvæ adhere by the tips of the anterior horns to the inner tunic of the sac of the parent. On same scale as the last figure.

11. Pupa stage, on four times the scale of three previous figures. In this stage it crawls freely about in the sac of the mother. 1, prehensile antennæ with a disk-segment. There are no other appendages developed. *oc*, compound eye. The ventral surface between the sides of the carapace is formed of thin structureless membrane. On this surface, close to the posterior end, is a small orifice through which three pairs of bristles project, attached to a rudimentary abdomen. No mouth exists.
12. Adult male on same scale as the last figure. The prehensile antennæ now serve to fix the male, by a cement, to the female. *a*, orifice of sac.

13–25. Development of *Balanus*.

13–21. *Balanus balanoides*, from Hoek, Zur Entwickelungsgeschichte der Entomostraken. I. Embryologie von *Balanus*. Niederländisches Arch. Zool., III., Taf. III., IV., 1876.

13. Egg some time after fecundation. *pc*, polar cell? *s*, spermatozoa?
14. Later stage. The formative yolk (*pp*) has collected at the blunt pole of the egg and become sharply separated from the nutritive yolk (*dp*).
15. The formative yolk has divided into four cleavage products, which enclose a part of the nutritive yolk at the centre of the egg. *nc*, nucleus of one of the cleavage spheres. *ζ*, third cleavage sphere, the fourth being entirely concealed in the figure.
16. Optical section of the same at a later phase. The formative yolk (*bl*) has completely surrounded the nutritive yolk (*dp*), which has also split up into numerous parts. *a*, *b*, folds in the blastoderm which are the commencement of the formation of the appendages of the embryo.
17. More advanced stage from the dorsal side. The three nauplius appendages are seen. *cp*, dorsal shield or carapace. *ct*, cuticle shed by the embryo.
18. Embryo nearly ready to hatch. *lb*, labrum or proboscis. *ocl*, nauplius eye. *ω*, hinder extremity.
19. Nauplius larva, just escaped from the egg. *i*, intestine.
20. The same after the first moult. *f*, frontal sensory thread. The frontal horns of the carapace, and many of the setæ of the swimming appendages are shortened through a partial invagination.
21. The dorsal spine in the process of evagination.
22. *Balanus* larva from Naples before passing into the pupa stage, seen from below. I, anterior antenna. Through the transparent cuticle is seen the anterior appendage of the next stage, with the sucking-disk on the third segment whereby the pupa attaches itself. The mandibles of the adult are probably developed in the base of the third pair of nauplius appendages (III). IV, first pair of maxillæ. V, second pair of maxillæ. VI–XI, six pairs of thoracic biramous swimming-feet of the Cypris stage, corresponding to the five pairs of natatory feet of *Copepoda*, and the generative appendages of the following segment. *fh*, frontal horns of the carapace. *gl*, gland at base of frontal horn. This gland is connected with a hollow spine lying within the frontal horn, and its function is doubtful. *ph*, posterior horns of the carapace. *oc*, compound eye. 1, dorsal spine of abdomen. 2, ventral spine of abdomen. From Claus, Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems, Taf. XVI. fig. 1, Wien, 1876.
23. About the same stage of a *Balanus* from Newport, R. I., profile view. From a sketch by A. Agassiz, August 26, 1872.
24. Cypris stage of a *Balanus* from Newport, R. I., reared from the stage of Fig. 23, August 26, 1872, profile view. Median and paired eyes are present as before. The carapace has become a bivalve shell, the two valves united along their dorsal margin. The anterior antennæ are now furnished with a suctorial disk for attachment, in the centre of which is the opening of the duct of the antennary or cement gland. The second and third pairs of nauplius appendages have disappeared, unless a small papilla, the rudiment of the mandible of the adult, is a vestige of the third. The six posterior pairs of feet (VI–XI) have developed into long two-branched swimming-feet, replaced in the adult by the six pairs of cirrhi. *ξ*, abdominal portion of the body. From a sketch by A. Agassiz, August 26, 1872.
25. Anterior antenna of Cypris stage of *Balanus balanoides*. *d*, suctorial disk by means of which the larva attaches itself. From Bate, On the Development of the *Cirripedia*. Ann. Mag. Nat. Hist., [2.] VIII., Pl. VIII. fig. 18, 1851.

PLATE IV.

a e n.	Anterior hypoblast cell.	*p n ♂.*	Male pronucleus.
a n.	Anus.	*p n ♀.*	Female pronucleus.
c e n.	Central hypoblast cell.	*t.*	Testis.
c r.	Cirrhi.	*v d.*	Vas deferens.
e c.	Epiblast.	*v m.*	Vitelline membrane.
g e n.	Beginning of the genital system.	α.	Frontal papilla.
i.	Intestine.	β.	Spiral canal.
l b.	Labrum.	γ.	Gland.
l e n.	Lateral cells, containing hypoblastic elements.	ϵ.	Gland.
m s.	Cells containing the elements of the mesoblast.	ζ.	Tactile organ.
m t.	Metastoma or paragnathite.	η.	Cement gland.
n.	Nervous system.	ϑ.	Receptaculum seminis.
n'.	Secondary supra-œsophageal nerve-ganglion.	λ^1.	Tergum.
n c.	Nucleus.	λ^2.	Scutum.
o c.	Eye.	λ^3.	Carina.
o c l.	Simple eye.	λ^4.	Carino-lateral compartment.
o e s.	Œsophagus.	λ^5.	Lateral compartment.
o v d.	Oviduct.	λ^6.	Rostrum.
p c.	Polar cell.	ξ.	Tail.
p m s.	Primitive mesoblast cell		

The Roman numerals denote the appendages in their consecutive order. See explanation of Fig. 28, *infra*.

1 – 5. *Development of* Cirripedia, *continued. Figures from* Alexander Agassiz *and* Carl Claus.

1 – 4. Stages in the development of a *Balanus* from Newport, R. I., reared in confinement directly from the larvæ represented on Pl. III. figs. 23, 24, and showing the metamorphosis of the free-swimming larva into the sessile adult. From drawings by A. Agassiz, August 29, 1872.

1. The bivalve shell of the Cypris stage is becoming split up through calcification into the compartments and opercular valves of the adult. *c r*, cirrhi, representing the swimming-feet of the Cypris stage
2. Later stage, seen from above. The cirrhi are retracted within the shell.
3. Still older stage, side view. λ^1, tergum. λ^2, scutum.
4. Seen from above, cirrhi retracted within the operculum. λ^1, tergum. λ^2, scutum. Surrounding these opercular valves are seen the marginal compartments. λ^3, carina. λ^4, carino-lateral compartment. λ^5, lateral compartment. λ^6, rostrum.
5. Pupa stage of *Lepas fasciculata*. *o c l*, median eye. *o c*, paired eye. ξ, abdomen. I, prehensile antennæ. From Claus, Die Cypris-ähnliche Larve (Puppe) der Cirripedien. Schriften Gesellsch. Beförd. gesammt. Naturwissensch. Marburg, IX., Suppl. 5, Taf. 1. fig. 2, 1869.

6 – 28. *Development of* Copepoda. *Figures from* Carl Claus, Alexander v. Nordmann, *and* Carl Grobben.

6 – 13. *Achtheres percarum*. 6 – 11, 13, from Claus, Ueber den Bau und die Entwicklung von *Achtheres percarum*. Zeitschr. wissensch. Zool., XI., Taf. XXIII., XXIV., 1861.

6. Larva at the time it leaves the egg. Only the two anterior pairs of appendages of the typical nauplius are present (I, II), and both of them are simple and unsegmented. Beneath the cuticle may be seen the six following pairs of appendages: mandibles (III), maxillæ (IV), maxillipeds (V, VI) and two pairs of swimming-feet (VII, VIII), which become functional after the next moult. α, frontal papilla, in which is the opening of the coiled canal, β. This is filled with a viscid secretion probably brought into play when the larva attaches itself to its host.
7. Mouth-parts under the cuticle of the same stage, seen from the side. The letters *l b* are in the place of the labrum. Directly below is seen one of the pair of protuberances which lie on each side of the labrum, followed by the mandibles (III), maxillæ (IV), and two pairs of maxillipeds (V, VI).
8. Hinder part of the body of same stage, the cuticle having been removed so as to expose the swimming-feet and the caudal fork.

9. Larva after first ecdysis, about twelve hours after leaving the egg. Cyclops stage. The larva now has a large dorsal shield and four free posterior segments. Eight pairs of appendages are present, two pairs of antennæ (the second pair two-branched), mandibles, maxillæ, two pairs of maxillipeds, and three pairs of swimming-feet. The longer branch of the second antennæ is furnished with a claw for fixing the larva. The two pairs of maxillipeds (V, VI) are said by Claus to be developed as two branches of one appendage, representing the second maxillæ of the higher Crustacea. The three pairs of swimming-feet are then probably homologous with the three pairs of maxillipeds of Decapoda. The first free segment of the body carries the second pair of swimming-feet. *o c l*, ocellus. γ, glands lying on each side of the eye.

10. Mouth-parts of the same stage, magnified 400 times. The mouth is situated at the end of a sort of proboscis formed by the prolongation of the labrum, *l b*, and the lower lip. The mandibles (III) are small, and the maxillæ (IV) are small and furnished with a palp.

11. Later stage of male larva, already parasitic on the perch. The posterior segmented part of the body has acquired a new segment at the expense of the anterior unsegmented portion. The swimming-feet have disappeared as well as the spiral duct, although a remnant of the frontal papilla (α) persists. The outer maxillipeds (V) have become united at their ends, whence a long rod (δ) projects, which attaches the young animal to its host. *i*, intestine. *n*, nerve. *t*, testis. *v d*, vas deferens. ϵ, gland near the end of vas deferens.

12. Adult male, lateral view. The outer maxillipeds separate again. From v. Nordmann, Mikrographische Beiträge zur Naturgeschichte der wirbellosen Thiere, Zweites Heft, Taf. V. fig. 2, Berlin, 1832.

13. Sexually mature female, seen from below. Natural length, 3^{mm}. The female is five times as long as the male. The outer maxillipeds remain fused and develop a sucking-disk. *o v d*, ovidnct. ζ, tactile organ. η, cement gland (part of the female sexual apparatus, opening into the oviduct near the genital orifice). ϑ, receptaculum seminis.

14 – 29. *Cetochilus septentrionalis*, from Grobben, Die Entwicklungsgeschichte von *Cetochilus septentrionalis* Goodsir. Arbeiten Zoolog. Inst. Univ. Wien, III., Taf. XIX. – XXII., 1881.

14. Egg before the first cleavage, in optical section. Natural size, .17^{mm} diameter. The protoplasm and deutoplasm are evenly distributed, and the egg is colorless. *v m*, vitelline membrane, a product of the yolk. *p c*, second polar cell, the first usually being formed before the vitelline membrane, and hence escaping from the egg. *p n* ♀, female pronucleus. *p n* ♂, male pronucleus. The exact origin of the polar cells was not traced in this case, but there seems little reason to doubt Grobben's interpretation of the structures as above given.

15. After the union of the male and female pronuclei, the resulting cleavage nucleus lies excentrically nearer the animal pole of the egg, as indicated by the polar cell. A total meridional cleavage is followed by an equatorial cleft, and four cleavage-spheres are formed, as shown in the figure. *n c*, nucleus of one of the cleavage-spheres. At the core of the egg a small segmentation-cavity is already observable. The next cleavage is meridional, and the resultant eight-celled stage passes by equatorial cleavage into a sixteen-celled phase. The enclosed segmentation-cavity has now enlarged, and become the receptacle for the deutoplasm ejected from the yolk. The polar cell now becomes involved with the cleavage products and pressed into the interior of the egg.

16. The next cleavage is in a plane perpendicular to the preceding, and thirty-two cells are thus formed. A period of rest of several hours' duration ensues before the cleavage is carried further. At this stage a differentiation appears among the constituent cells. In the two previous figures, the egg was seen from the side. In this figure, the egg is turned so that the ventral side is toward the reader. It is now seen that one of the ventrally situated cells has divided into two unequal parts, a small cell (*a c n*) and a large one (*c c n*), the other cells being arranged bilaterally with reference to them. The central larger cell (*c c n*) is prominent on account of the greater amount of deutoplasmic elements and coarsely granulated protoplasm. From this cell are formed later the central portion of the hypoblast. From the subsequent development, it appears that the smaller cell (*a c n*), too, is a hypoblast cell. The four cells (*l c n*) lying on each side of the larger and smaller cells, contain hypoblastic and epiblastic elements. The cell (*m s*) in the median line behind the central hypoblast cell contains, besides epiblastic elements, all the elements of the mesoblast.

17. Optical section of a later stage, lateral view. The polar cell (*p c*) has been pressed in between the cleavage cells into the cleavage cavity. All the cells take part in bounding this cavity, excepting the small anterior hypoblast cell (*a c n*). In one of the cells at the upper left hand is seen a nuclear amphiaster preliminary to the division of the cell.

18. Later stage. The cleavage has now proceeded much further. The central hypoblast cell (*c c n*) is divided into two. The four lateral are in the process of division, and of the resulting cells those lying near the central hypoblast cells and marked *l c n* in the figure, together with the central (*c c n*) and small anterior cell (*a c n*), go to form the hypoblast, while the rest of the cells formed from the lateral cells belong to the epiblast. From the division of the cell marked *m s* in Fig. 16, we now have four cells. The two larger, anterior (*p m s*), contain all the elements of the mesoblast, and are called the primitive mesoblast cells. The two smaller, posterior, are epiblast cells. The anterior hypoblast cell (*a c n*) alone is undivided. All three germinal layers are now formed, and show a bilateral arrangement. In the next stage the central hypoblast cells are divided by a transverse cleft into four. The primitive mesoblast cells have also divided, so that there are four cells in this layer.

19. The mesoblast cells now retreat from the periphery of the egg into the cleavage cavity. The hypoblastic cells also sink in toward the centre, and the formation of a gastrula is thereby brought about. The figure shows the gastrula stage in horizontal optical section.

20. Gastrula at a somewhat earlier stage, in longitudinal optical section. Owing to the small size of the cleavage cavity, and the large size of the hypoblast cells, the gastrulation is slow and difficult. When the (now eight) lateral and anterior hypoblast cells begin to sink, the four central hypoblast cells also sink a little, but as the former sink deeper, they compress the latter in such a way that they present the appearance shown in the figure. *e c*, epiblast.

21. Gastrula seen from the side. The epiblast is seen in optical section. *g m*, gastrula mouth.

22. Later stage. The gastrula mouth is closing up. Later it disappears entirely. That this side answers to the later ventral side is highly probable.

23. Stage when the second pair of antennæ, II (the first appendages to appear), have begun to appear. Optical cross-section. The other two pairs of nauplius appendages soon follow. The œsophagus of the nauplius arises from an invagination of the epiblast.

24. Nauplius just hatched, seen from below. The intestine (*i*) as yet has no anal opening. Under the bilaterally disposed ectoderm cells, at the posterior extremity of the body, are seen the primitive mesoblast cells (*p m s*). From these are developed the mesodermic structures of the later-formed somites. The duration of the egg-development is about twenty-four hours.

    Note.—In the nauplius of *Cyclops serrulatus* and *Ergasilus Sieboldi*, Grobben detected the presence of a dorsal organ equivalent to that in *Phyllopoda*, &c. See Arbeiten Zoolog. Inst. Wien, II, p. 262, Taf. XVI. figs. 61, 62, 1879.

25. Later stage, lateral view. In the posterior part of the body, the rudiment of the genital system (*g e n*) has already appeared. The intestine is now furnished with an anus (*a n*).

26. A little older metanauplius larva, lateral view. The fourth pair of appendages (maxillæ) have appeared. *n*, brain. *n'*, secondary brain, a thickening of the ectoderm, interpreted by Grobben as a rudimentary organ representing the compound eyes of *Phyllopoda* and their ganglia, which do not develop further in the *Copepoda*.

27. Anterior portion of the same stage, seen from below. *o e s*, œsophagus. *o c l*, eye.

28. A little older metanauplius than that represented by Fig. 26, from below. The anterior and posterior maxillipeds (V, VI) have now made their appearance, as well as the first pair of swimming-feet (VII). Under the cuticle is also seen the second pair of swimming-feet (VIII), which become free at the next moult. According to Claus and Grobben the so-called two pairs of maxillipeds of *Copepoda* really represent but one pair of appendages, the anterior pair being the outer branches, the posterior pair the inner branches. Both together will then represent the second pair of maxillæ of other Crustacea, and the first pair of swimming-feet will be the homologue of the first maxillipeds of *Decapoda*. Assuming this view to be correct, the reader must bear in mind that, in the figures of *Copepoda* on this plate, the Roman numerals higher than V must be lessened by one.

29. First Cetochilus stage, from ventral side. The third pair of swimming-feet (IX) has appeared. *m t*, metastoma or paragnathite. At subsequent moults, new thoracic segments and appendages are developed, until the adult state is attained.

PLATE V.

a.	Anus.	*o v.*	Ovary.
b r.	Gill	*p c.*	Polar cell ?
d p.	Deutoplasm.	*s t.*	Stomach.
e p.	Epiblast.	*v m.*	Egg membrane.
g e n.	Genital cells.	*α.*	Adductor muscle of the shell.
g m.	Gastrula mouth.	*β.*	Antennary muscle.
h.	Heart.	*γ.*	Shell gland.
hy.	Hypoblast.	*δ.*	Muscular impression.
i.	Intestine.	*ϵ.*	Chitinous support of the caudal fork.
l.	Liver.	*ζ.*	Threads (nervous ?) connected with the setæ of the shell.
l b.	Labrum.	*η.*	Cephalic plate.
m.	Mouth.	*ϑ.*	Maxillary somite.
m s.	Mesoblast.	*ι.*	Rudiment of sensory seta.
m t.	Metastoma.	*κ.*	Shell.
n′.	Primary brain.	*λ.*	Dorsal organ.
n″.	Secondary brain.	*μ.*	Inner membrane of fold over the eye.
o c.	Compound eye.	*ν.*	Seta.
o c l.	Simple eye.	*ν′.*	Olfactory setæ.
o e s.	Œsophagus.	*ξ.*	Caudal fork.

The Roman numerals denote the appendages of the body in their consecutive order.

I – 12. *Development of* Ostracoda (*Cypris*). *Figures from* Carl Claus, Beiträge zur Kenntniss der Ostracoden. I. Entwickelungsgeschichte von *Cypris*. Schriften Gesellsch. Beförd. gesammt. Naturwissensch. Marburg, IX., Taf. I., II., 1868.

1. First larval (nauplius) stage of *Cypris ovum*. Differs from the typical nauplius form in having a bivalve shell, and in the second and third pairs of appendages not being biramous. *α*, adductor muscle of the shell. *β*, antennary muscle. *s t*, stomach. *i*, intestine.
2. Third appendage of the same stage, locomotive in function. At its base is seen the rudiment of the future mandible. The appendage terminates in a hooklike seta.
3. Second stage of *Cypris fasciata*. Two new pairs of appendages have appeared, viz. the first pair of maxillæ (IV) and the first pair of feet (VI). The fifth pair of appendages (second maxillæ, "maxillipeds" of some authors) are not developed till later. The first pair of feet (VI) bear a terminal claw for adhering. The masticatory part of the mandible (III) is well developed. III′, mandibular palpus. *m t*, metastoma.
4. Third stage of *Cypris fasciata*. V, rudiment of second maxilla. The first maxilla (IV) has acquired its large setose appendage (IV′).
5. Fourth stage of *Cypris fasciata*.
6. Fifth stage of the same. The second maxillæ (V) have developed into ambulatory appendages, terminated by a hook similar to that borne during the previous stages by the sixth pair of appendages. The latter have lost their hook. *γ*, shell gland. *l*, liver. *δ*, muscular impression on the shell.
7. Second maxilla (V), first foot (VI), and caudal fork (*ξ*) of the same stage.
8. Sixth stage of the same. All the appendages of the adult are now present, the second pair of feet (VII) having appeared. The second maxillæ (V) are beginning to lose their ambulatory function, and become converted into masticatory organs through the enlargement of their cutting blades and reduction of the palp. The hook at the end of these appendages has disappeared, and one reappears at the end of the first pair of feet (VI). *ξ*, abdomen or caudal fork. *ϵ*, chitinous support of the caudal fork.
9. First foot of the same, sixth stage.
10. Caudal fork of the same, sixth stage.
11. Seventh stage of the same. All the appendages have practically acquired their permanent form. I, first antenna. II, second antenna. II′, basal segment of second antenna. III, mandible with four-jointed palpus. IV, first maxilla with gill-plate. V, second maxilla with jaw-process and leg-like palpus. At the base of the latter there is a small gill-plate, not seen in the figure. VI, first leg. VII, second leg. Both pairs of legs are now jointed. *o v*, rudiment of the ovary.
12. Adult female of the same. *ζ*, network composed of groups of cells from which fine threads proceed to the setæ of the cuticle.

The marine genera of *Ostracoda* have an abbreviated metamorphosis.

13 – 24. *Development of* Cladocera. *Figures from* Carl Grobben *and* G. O. Sars.

13 – 22. Development of the summer egg of *Moina rectirostris*. From Grobben, Die Entwickelungsgeschichte der *Moina rectirostris*. Arbeiten Zoolog. Inst. Univ. Wien, II., Taf. XI. – XIV., 1879.

The summer eggs are parthenogenetically developed within the brood-cavity of the parent.

13. Egg during the cleavage process. The cleavage is superficial. *p c*, a body supposed to be a polar cell, although its origin from the germinative vesicle was not ascertained. It is present at the time the egg is laid.

14. Gastrula stage in longitudinal optical section. *g m*, gastrula invagination. The gastrula month seems to close completely at a later stage. *h y*, hypoblast. *e p*, epiblast. *m s*, mesoblast. The mesoblastic cells are withdrawn from the surface of the blastosphere into the interior just before the gastrula invagination takes place. *g c n*, two of the four cells which subsequently are split into eight and pass into the interior of the embryo, take a position under the hypoblast, and develop into the genital organs. These genital cells were distinguishable before the cleavage was completed. *d p*, deutoplasm. η, cephalic plate, from which the supra-œsophageal ganglion and eye are developed.

15. Embryo in the nauplius stage, ventral view. I, anterior antennæ. II, posterior antennæ. These first appeared in an earlier stage as simple buds, before the first and third pairs of appendages began to form. They are now two-branched. III, Mandible. The mouth (*m*) and œsophagus (*o e s*) are forming from an invagination of the epiblast. The œsophagus is short and abuts blindly against the intestine (*i*).

16. Later stage, ventral view. Behind the mandibles is seen a maxillary segment (ϑ), although no trace of the maxillæ has yet appeared. Behind the maxillary segment are two thoracic segments with slight rudiments of their appendages (VI, VII). η, cephalic plate in optical section. *i*, mid-gut, the product of the hypoblastic germ-layer. The œsophagus (*o e s*) is longer, but still terminates blindly. The place where the rectum is to arise is indicated by a thickening of the body-wall at the posterior extremity.

17. Later stage from ventral side. Four pairs of feet (VI – IX). The two maxillary segments are united, and show no appendages yet. On the outer side of the second antennæ is a protuberance (ι) connected with the development of a sensory seta which occupies the corresponding part in the adult. The genital cells have divided into a right and left portion. The shell (κ) begins to appear as a fold of the dorsal integument in the maxillary region.

18. The next stage, from below. The fifth foot (X) has appeared. The four anterior feet are becoming differentiated into an inner branch, outer branch, and branchial appendage (in the third foot, these parts are indicated by the characters VIII, VIII′, and *b r*‴). The first maxilla (IV) has appeared.

19. Embryo in the next following stage, lateral view. Observe the dorsal flexure of the body. *l b*, labrum. The second antennæ (II) begin to show segmentation in both their branches. The second maxilla (V) has now made its appearance. This is commonly said to be wanting in the adult *Daphnidæ*, but persists in a rudimentary condition in adult *Moina*, according to Grobben. All five pairs of feet have outer branches, except the first (VI), the single branch here corresponding to the inner branch of the other legs. Near the origin of the shell there is seen a group of cells (λ) higher than their neighbors and furnished with larger nuclei. These go to form the dorsal organ. γ, shell gland, as yet unprovided with an outlet, and probably developed from the mesoblost. The cephalic plate, at a period earlier than this, separated into an anterior portion (n') and a posterior portion (n''). The former develops into the brain proper (in the stage figured it has not yet become freed from the integument), the latter forms the retina of the eye. This has already separated from the surrounding epiblast which closes over it and develops into the compound eye. This eye is a paired structure at its first appearance. *a*, anus opening into the invagination of the epiblast which forms the rectum. π, rudiment of the large posterior sensory seta.

20. Next stage, from below. The mandible (III) now shows a division into a palp and masticatory portion.

21. Later stage, from below. ν, primary sensory seta on first antenna. The pigment is forming in the eye. In the median line is seen a furrow, widening posteriorly, formed by an invagination of the epiblast which makes the nerve-cord. The mandible (III) has lost its palp.

22. Embryo shortly before hatching, lateral view. The embryo has now essentially the characters of the adult, excepting the secondary sexual characters. ν', olfactory setæ. *h*, heart. About two days and a half are consumed in the development of the embryo. The dorsal organ is become reduced to a rudiment at the time of hatching, and is not found in the adult *Moina rectirostris*. In *M. paradoxa*, on the contrary, it persists throughout life.

23. Young *Sida crystallina* at the time of quitting the brood-cavity of the mother, lateral view. λ, provisional dorsal organ. This is the homologue of the dorsal organ in other *Cladocera*. λ', unpaired horseshoe-shaped dorsal organ. λ'', paired dorsal organ. γ, shell gland. ν, primary sensory seta. ν', olfactory setæ. From Grobben, Ibid., Taf. XVI. fig. 56.

24. *Leptodora hyalina*. Larva just escaped from the winter egg, seen from below. The body shows no trace of segmentation. I, first pair of antennæ. II, second pair of antennæ (only the basal portion is represented on the left-hand side of the figure). III, third pair of appendages, representing the mandibular palpi. In the adult the mandibles are destitute of a palpus, as in other *Cladocera*. Behind the third pair of appendages are seen the rudiments of the six pairs of feet of the adult in the form of small buds. *o c l*, ocellus, which persists in the adult. The adult form is gradually attained after the third moult. While the young developed from the winter eggs thus undergo a postembryonal metamorphosis, the summer eggs develop without metamorphosis, as is the case with most *Cladocera*. No ocellus is present at any stage in the development of the summer eggs. From G. O. Sars, Om en dimorph Udvikling samt Generationsvexel hos *Leptodora*. Forhandl. Vidensk.-Selsk. Christiania, Aar 1873, Tab. 1. fig. 1.

PLATE VI.

a. Anus.
a p. Appendage.
b l. Blastoderm.
b r. Gill.
c p. Carapace.
e p. Epiblast.
f. Frontal sensory papilla.
h. Heart.
h y. Hypoblast.
i. Intestine.
l. Liver.
l b. Labrum.
m. Mouth.
m s. Mesoblast.
m t Metastoma.
n. Nerve.
o c. Paired eye.
o c l. Unpaired eye.
p d. Proctodæum, or hind-gut.
r e. Outer branch of appendage.
r i. Inner branch of appendage.
s d. Stomodæum, or fore-gut.
α Five anterior thoracic somites.
β. Antennal gland.
γ. Shell gland.
δ. Papilla through which the shell gland opens.
ε. Outer egg-membrane.
ζ. Inner egg-membrane.
η. Contour of body.
ϑ. Cellular membrane.
ι. Muscular wall of intestine.
κ. Epithelium of intestine.
λ. Dorsal organ.
μ. Appendage connected with sexual function.
ν. Larval membrane.
ξ. Caudal fork.
π. Rudiment of dental apparatus in stomach.
ρ. Communication between liver and intestine.
σ. Hypodermis.

The Roman numerals indicate the appendages of the body in their consecutive order.

1–10. *Development of* PHYLLOPODA (*Apus cancriformis*). *Figures from* CARL CLAUS, Zur Kenntniss des Baues und der Entwicklung von *Branchipus stagnalis* und *Apus cancriformis*. Abhandl. Königl. Gesellsch. Wissensch. Göttingen, XVIII., Taf. VI.–VIII., 1873.

1. Nauplius larva, on its escape from the egg, from the ventral side. Behind the mandibles (III) is seen the beginning of the formation of the five anterior somites. *o c l*, ocellus. The darker portion is the intestine.
2. The same larva seen from above, the appendages removed. *c p*, rudiments of dorsal shield or carapace. *i*, intestine. *l*, liver. α, five anterior thoracic somites. λ, dorsal organ.
3. Second larval stage, from ventral side. IV, first maxilla. *f*, frontal sense papilla. New thoracic somites have been added posteriorly. VI, VII, VIII, appendages of three anterior thoracic somites. ξ, caudal fork.
4. The same, from dorsal side.
5. Third larval stage, from below. 1 mm. long. The mandibles have developed a powerful cutting blade at their base. The rudimentary second maxillæ (V) have appeared, and four new thoracic appendages. β, antennal gland, probably homologous with the "green gland" of *Malacostraca*.
6. Fourth larval stage, from below. 1 to 1¼ mm. long. New somites continue to form at the hinder end of the body, and appendages to arise from the somites already formed. There are now seventeen pairs of appendages, including the three pairs of nauplius limbs, formed or in the process of formation. Behind the unpaired eye the paired eyes are beginning to be formed. The so-called liver forms three diverticula on each side of the head. γ, shell gland. The dorsal shield has grown backward so as to cover the four anterior thoracic somites. III, mandible. III′, mandibular palp. *l b*, labrum.
7. Fifth larval stage, from below. 1½ mm. long. The appendages have begun to appear as far back as the nineteenth (XIX), and about six somites are marked off by transverse segmentation back of this. The mandibular palp is now much reduced. *o c*, paired eye.
8. Mouth parts of the same stage. III, mandible. III′, mandibular palp. IV, first maxilla. V, second maxilla. δ, papilla in which the shell gland opens.
9. Foot of the twelfth pair from a female larva with dorsal shield 2 mm. long. *r i*, ramus internus, comprising six joints or lobes. *r e*, ramus externus. *b r*, branchial sac or epipodite.
10. Foot of the first pair from a larva with dorsal shield 2½ mm. long. Letters as in the last figure. Through successive moults the nauplius appendages become atrophied, the second antennæ being especially reduced in size, and the mandibular palp disappearing altogether.

11–21. *Development of* Isopoda. *Figures from* Anton Dohrn, Heinrich Rathke, *and* N. Bobretzky.

11–18. *Asellus aquaticus.* From Dohrn, Die embryonale Entwicklung des *Asellus aquaticus.* Zeitschr. wissensch. Zool., XVII., Taf. XIV., XV., 1867.

11. Segmented egg. ϵ, outer egg-membrane, chorion. According to Dohrn an inner membrane lies close upon the yolk.

12. The blastoderm (*bl*) now envelopes the whole food-yolk.

13. The blastoderm has become thickened on what will become the ventral side of the embryo.

14. The inner egg-membrane (ζ) has separated from the yolk. *a p*, rudiments of the two first-formed appendages, referred by Dohrn (correctly ?) to the two pairs of maxillæ.

15. Embryo twelve hours later than fig. 14. η, contour of the median portion of the body. λ, dorsal organ. Rudiments of the two pairs of antennæ (I, II), mandibles (III), two pairs of maxillæ (IV, V), maxillipeds (VI), and the six anterior pairs of thoracic legs (VII–XII) have appeared.

16. The embryo lies coiled within the egg, the *dorsal* flexure being so strong that the end of the abdomen and back of the head are in contact. The abdominal part of the body is now well developed and bears four pairs of appendages, the three anterior of which are rudiments of the gills, the fourth (XIX) being the terminal appendage of the adult. VII–XII, six pairs of thoracic legs. μ, appendage developed between the sixth pair of legs and the first pair of gills, later connected with sexual functions. The metastoma (*m t*) is now present. *l*, liver. *a*, anus.

17. Later stage. The abdominal appendages are now bilobed. Previous to this stage the chorion has been cast off. The former inner membrane (ζ) now becomes the outer egg-membrane. The blastoderm at a stage much earlier than this has shed a cuticle (ν) which now, as a larval membrane, forms a sac enveloping the embryo up to the time of hatching.

18. Mouth parts of young before leaving the brood-sac of parent. *l b*, labrum. III, mandible. III′, mandibular palp. *m t*, metastoma. IV, first maxilla. V, second maxilla. VI, VI′, VI″, maxilliped. Within the transparent cuticle of the appendages are seen the setiferous appendages of the next stage.

19. Young *Asellus aquaticus* before leaving the brood pouch of parent. The seventh thoracic somite and its appendages are not yet developed. Beneath the abdomen are seen three pairs of gills and the terminal appendages (XIX). From Rathke, Abhandlungen zur Bildungs- und Entwickelungs-Geschichte des Menschen und der Thiere, Erster Theil, Taf. I. fig. 17, Leipzig, 1832.

20, 21. *Oniscus murarius.* From Bobretzky, Zur Embryologie des *Oniscus murarius*, Zeitschr. wissensch. Zool., XXIV., Taf. XXII., 1874.

20. Longitudinal section through embryo. *s d*, fore-gut, or stomodæum. *p d*, hind-gut, or proctodæum. *e p*, epiblast. *m s*, mesoblast. *h y*, hypoblast cells. According to Bobretzky these cells originate from the blastoderm and pass into and gradually absorb the food-yolk, increasing until they occupy the whole of the yolk space. *n*, thickening of the epiblast along the median ventral line of the embryo from which is developed the nerve cord. *n′*, thickening of the epiblast which goes to form the brain. ϑ, cellular membrane lying within the inner egg-membrane. This membrane, which partially engirdles the embryo at this stage, originates as a heap of thickened epiblastic cells on the dorsal side of embryo. These cells become attached to the inner egg-membrane (which seems to be made up of vitelline membrane and a larval skin together), spread and separate from the embryo excepting at one point where the connection persists by means of a short neck (λ). This structure is homologous with the dorsal organ of *Asellus*, *Moina*, &c.

21. Longitudinal section through an embryo at a much later stage. The invaginated portion of the epiblast which forms the stomodæum is becoming differentiated into œsophagus and stomach. π, rudiment of masticatory apparatus in the stomach. From the hypoblast cells have been formed the epithelial lining of the liver (*l*) and the mid-gut, or mesenteron. The mesenteron is not in communication with the stomach, and there is no line of demarkation between it and the epiblastic proctodæum. *m*, mouth. *a*, anus. *i*, intestine. *l b*, labrum. Below the mouth the section passes through the lower lip or metastoma. *h*, heart, arising in the mesoblastic tissue. κ, epithelium of intestine. ι, muscular outer coat of intestine, derived from the mesoblast. The outer part of the wall of the liver is also formed at the expense of the mesoblast, and below the stomach is seen a mass of mesoblast cells out of which is developed at a later stage the muscles which move the masticatory apparatus of the stomach. ρ, communication between liver and intestine. The nervous system (*n*, *n′*) has become separated from the outer epiblast which now covers it in (σ).

PLATE VII.

a.	Anus.	*o c.*	Eye.
a p.	Appendage.	*o c l.*	Ocellus.
b l.	Blastoderm.	α.	Larval skin.
d p.	Deutoplasm.	β.	Egg-membrane.
e p.	Epiblast.	δ.	Amœboid cell.
i.	Intestine.	ε.	Segmentation cleft.
m s.	Mesoblast.	ζ.	Yolk sphere.
n.	Nerve.	λ.	Dorsal organ.
n c.	Nucleus.		

The Roman numerals indicate the appendages of the body in their consecutive order.

1–10. *Development of* Amphipoda. *Figures from* B. Ulianin *and* Adolphe de la Valette St. George.

1–7. *Orchestia.* From Ulianin, Zur Entwicklungsgeschichte der Amphipoden. Zeitschr. wissensch. Zool., XXXV., Taf. XXIV., 1881.

1. Egg with four cleavage spheres. β, chorion. The cleavage is superficial. In each of the four cleavage products is a nucleus surrounded by protoplasm (δ) which sends amœboid processes out into the investing deutoplasm. These nuclei with the investing layer of protoplasm are the "amœboid cells" of Ulianin. They afterwards increase by division, come to the surface of the yolk, and from them is formed the blastoderm.
2. Section through one of the cleavage spheres of the same. δ, amœboid cell, not yet transported to the surface.
3. Section of egg at later stage. The "amœboid cells" (δ) have migrated to the periphery of the egg, divided, and from them has been formed the blastoderm (*b l*).
4. Later stage, superficial view. The blastoderm has largely increased at the expense of the "amœboid cells."
5. Section of an egg a little younger than the one represented in Fig. 4, to show the formation of the mesoderm cells by division of the blastoderm cells.
6. Section of egg at later stage, passing through the dorsal organ or "micropyle apparatus." *e p*, epiblast. *m s*, mesoblast. λ, micropyle apparatus, arising as a patch of thickened epiblastic cells.

   Note. — Ulianin homologizes the dorsal organ of Crustacea with the shell gland of Mollusca.
7. Section through embryo after the appearance of the appendages. λ, dorsal organ. The cells have become invaginated so as to form a sac. *d p*, deutoplasm. ζ, yolk sphere. *n c*, nucleus of yolk sphere, with protoplasmic investment.

8–10. *Gammarus pulex.* From La Valette St. George, Studien über die Entwickelung der Amphipoden. Abhandl. naturforsch. Gesellsch. Halle, V., 1860.

8. Egg from brood-pouch of parent, showing the enclosed embryo. All the limbs are formed before the embryo quits the egg. Note the ventral flexure of the embryo compared with the dorsal flexure of the Isopod embryo (Pl. VI.). λ, dorsal organ, connecting the embryo with the first larval skin which surrounds the whole embryo. *d p*, food-yolk.
9. Portion of the dorsal surface of the same, more highly magnified, to show the connection of the embryo with the larval skin through the dorsal organ. After the epiblastic invagination is formed, as shown in Fig. 7, the whole surface of the epiblast secretes a thin structureless cuticula (larval membrane), which separates from the underlying epiblast at all points excepting within the invagination. Here the cuticula remains attached to the epiblast until the atrophy of the dorsal organ. β, egg-membrane. α, larval skin. λ, dorsal organ.
10. Portion of the upper half of the body. *o c*, eye. *d p*, remains of food-yolk. α, larval skin with the so-called micropyle (λ) torn away from the sac of the dorsal organ (λ′) which lies in fourth segment of the body.

11–19. *Development of* Stomatopoda. *Figures from* Walter Faxon, Carl Claus, *and* W. K. Brooks.

11. Youngest known stage of Stomatopod larva of the *Erichthus* type of development (*Erichthoidina*), seen from below. The line on the left of the figure indicates the length of this larva. The body consists of an anterior unsegmented portion bearing an ocellus (*o c l*), a pair of stalked eyes (*o c*), two pairs of simple antennæ (I, II), a pair of mandibles (III) without palpi, and two pairs of maxillæ (IV, V). From the dorsal side of this head portion is developed a large shield or carapace produced into a rostrum in front, and extending backward so as to cover most of the middle or thoracic region of the body, but entirely free from the underlying segments back of the head. Behind the head is a region composed of eight segments, the five anterior of

which are provided each with a pair of two-branched swimming appendages, the three posterior being destitute of limbs. The five pairs of swimming legs represent the five pairs of grasping legs or maxillipeds of the adult stomatopod. (These are homologous with the three pairs of maxillipeds and two anterior pairs of legs of the *Decapoda*.) The three following segments, which are without limbs, are the three posterior thoracic somites of the adult, which are destined to bear the three pairs of ambulatory limbs. The posterior, broad, unsegmented tail represents the long segmented abdomen of the adult. The specimen here figured was on the point of moulting and within the anterior part of the tail plate are seen two abdominal segments which will become free after the moult. The posterior border of the tail of the next stage is also seen through the transparent cuticle. *a*, anus. On either side of the anus is seen a cœcal, glandular body. From a sketch by Faxon, made at Newport, R. I., August 23, 1876.

12. Part of the border of the tail fin of the same, more highly magnified. In the next stage known, the two abdominal somites seen within the telson in Fig. 11 become free, and the anterior one develops a pair of rudimentary bilobed appendages. These appendages are the first abdominal. The first pair of antennæ become two-branched. As the development proceeds the inner branch of the second pair of maxillipeds increases in size and acquires a terminal claw, while the outer branch is aborted. The abdominal somites and appendages develop gradually in succession from before backwards.

13–16. From Claus, Die Metamorphosen der Squilliden. Abhandl. Königl. Gesellsch. Wissensch. Göttingen, XVI., Taf. II., III., 1871.

13. Older Erichthoid larva (*Erichthoidina spinosa*) of 7 mm., lateral view. Both pairs of antennæ are now furnished with a lateral branch. The first and second maxillipeds (VI, VII) have lost their external branch and approximate the form of the same parts in the adult. Gill-plates have developed from the basal joint of each (not shown in the figure). The three following pairs of limbs have become much reduced in size. The abdomen now consists of the full number of somites, each with its pair of appendages (XIV–XIX). The last pair (XIX) is very small.

14. Older stage (*Erichthoidina armata*), seen from the ventral side. 9 mm. long. The three posterior pairs of maxillipeds (VIII–X) have undergone atrophy, being now reduced to mere rudiments. The three posterior thoracic segments are still without a trace of appendages. *n*, abdominal nerve-cord.

15. Still older form, or Erichthus stage (*Erichthus Edwardsi*), 16 mm. long, from the Indian Ocean. The three posterior pairs of maxillipeds (VIII–X) have again grown out in their permanent shape, and behind them each of the three posterior segments of the thorax has developed a pair of small buds (XI–XIII), the first rudiments of the three pairs of ambulatory appendages of the adult. The third flagellum of the first antenna is present. VII′, gill-plate attached to base of the large grasping leg (VII).

16. Later or Squillerichthus stage (*Squillerichthus triangularis*) of a Stomatopod from Zanzibar. The three pairs of ambulatory appendages are much enlarged and two-branched. On the five anterior pairs of abdominal limbs are seen the rudiments of gills. The sixth abdominal appendage has now outgrown the others and has its permanent form.

From Claus's observations it is probable that the larvæ of the Erichthoid type of development belong to the genus *Gonodactylus*.

17–19. Development of *Squilla empusa*, from Beaufort, N. C., to illustrate the *Alima* type of Stomatopod development. From Brooks, The Larval Stages of *Squilla empusa* Say. Chesapeake Zoölogical Laboratory, Scientific Results of the Session of 1878, Pl. IX., X., 1879. The outline of Fig. 18 is corrected after a drawing of the same stage by Alexander Agassiz.

17. Youngest stage observed, magnified about 75 diameters, seen from below. This is probably the stage in which the larva leaves the egg. (Cf. Paul Mayer, Mittheil. Zoolog. Stat. Neapel., II. p. 219, who has seen an *Alima* larva come out of the egg of a *Squilla*, probably *S. mantis*.) This stage corresponds in a general sense to the stage in the development of the *Erichthus* type where the three posterior pairs of maxillipeds have atrophied (fig. 14). There are no two-branched swimming-feet on the thorax, and no thoracic limbs of any kind back of the great grasping legs or second maxillipeds (VII), although three free somites are present. The three posterior thoracic somites are represented by a long unsegmented region. The abdomen has five segments and the terminal fin, the four anterior segments carrying swimming-feet (XIV–XVII), represented only on one side of the figure. *n*, nerve-cord. *ocl*, ocellus.

18. Next stage observed, ventral view. All the thoracic segments are now present.

19. Older stage, ventral view. The ocular segment has become marked off at the front end of the body. The six posterior pairs of thoracic limbs (three posterior pairs of maxillipeds and the three ambulatory limbs of the adult) have begun to form as minute buds (VIII–XIII). The fifth pair of abdominal limbs (XVIII) is present in a very rudimentary condition, and the nerve-ganglion of the sixth abdominal somite is seen, although the somite itself is not yet freed from the telson.

PLATE VIII.

a.	Anus.	*n.*	Nerve ganglion.
ab.	Abdomen.	*oc.*	Eye.
br.	Gills.	*ocl.*	Ocellus.
cp.	Carapace.	*pp.*	Protoplasm
ct.	Cuticle, larval skin.	*r.*	Rostrum
dp.	Deutoplasm.	α	Contour of body
f.	Frontal sense-organ.	β.	Larval skin.
i.	Intestine.	γ.	Chorion.
l.	Liver.	ϵ.	Place of attachment of branchial apparatus.
lb.	Labrum.	ζ.	Abdominal muscles.
mt.	Metastoma.	λ.	Dorsal organ.

The Roman numerals denote the appendages of the body in their consecutive order

1 – 4. *Development of* Stomatopoda, *continued. Figures from* W. K. Brooks *and* Walter Faxon.

1. Larva of *Squilla empusa*, older than the one represented on Plate VII. fig. 19. Ventral view. The antennulary segment has become marked off at the anterior end of the body, and the third flagellum of the adult antennule is present. The second antenna has a rudimentary three-jointed inner branch or flagellum. The six posterior thoracic appendages have acquired essentially their permanent form. The sixth abdominal somite has become free and bears a pair of large swimmerets (XIX) similar in form to those of the adult. The abdominal appendages of the left side are omitted in the figure. From Brooks, Ibid., Pl. XI.
2. Still older stage of the same, dorsal view. Length 17 mm. The abdominal appendages are not shown in the figure, excepting the last pair (XIX). From a sketch by Faxon, made at Newport, R. I., August 24, 1876.
3. The specimen represented in fig. 2, moulted on the 25th of August, assuming the form shown in fig. 3, from the lower side. It is now 19 mm. long, and has the characters of the adult *Squilla empusa*. All the abdominal limbs are present, but are omitted in the figure with the exception of the last pair (XIX) and the right one of the first pair. From a sketch by Faxon.
4. Part of the border of the telson of the same, more highly magnified.

5 – 8. *Development of* Cumacea. *Figures from* Anton Dohrn, Untersuchungen über Bau und Entwickelung der Arthropoden. 1. Ueber den Bau und die Entwickelung der Cumaceen. Jenaische Zeitschr., V., Taf. II., 1870.

5. Early stage in the development of the embryo of *Cuma Goodsiri*. α, contour of the body. β, larval skin. γ, chorion. λ, dorsal organ. Behind the dorsal organ a deep fold gives the embryo a marked dorsal flexure. Through this dorsal flexure and dorsal organ the embryo exhibits a striking resemblance to the embryo of Isopods. Cf. Plate VI. The sixth pair of appendages, however, unlike the corresponding pair in the Isopod embryo, at this early stage is two-lobed and resembles the six following pairs of appendages. Rudiments of all the appendages are present from the first to the twelfth. *cp*, carapace commencing as a fold in the region of the maxillæ. *l*, liver.
6. Later stage of the same. The outer membrane has been cast off. The caudal appendages (XIX) are present.
7. Later stage. The embryo now approaches the Decapod type. The larval skin has been shed, the dorsal organ has disappeared, and the dorsal flexure is exchanged for a ventral one. The bulk of the first maxilliped (VI) is formed from the exopodite while the similar second maxilliped (VII) represents the endopodite alone, the external branch having entirely disappeared. X′, XI′, rudimentary exopodites of the tenth and eleventh pairs of appendages. The twelfth pair is now devoid of external branch.
8. Larva ready to leave the brood-sac. ϵ, place of attachment of the branchial apparatus. The last pair of thoracic legs has not yet developed, nor the appendages of the abdomen except the last pair (XIX). The abdominal appendages are never developed in the female. The eyes, which are not shown in the figures, are developed on each side of the head, and coalesce at a later period to form the median sessile eye of the adult.

9 – 17. *Development of* Nebalia Geoffroyi. *Figures from* Elias Metschnikoff, ИСТОРІЯ РАЗВИТІЯ *NEBALIA*. ЗАПИСКЪ ИМП. АКАДЕМІИ НАУКЪ, XIII., САНКТПЕТЕРБУРГЪ, 1868 [Development of *Nebalia*. Mem. Imper. Acad. Sci., XIII., St. Petersburg, 1868].

9. Early stage showing partial segmentation (telolecithal). $\frac{7}{1}^{5}$.
10. Later stage. The blastoderm cells now form a cap over one pole of the egg. $\frac{7}{1}^{5}$.
11. So-called nauplius stage of the embryo. The rudiments of the two pairs of antennæ and mandibles are present (I, II, III). *a b*, abdomen.
12. Later stage in the development of the embryo. The seven anterior pairs of appendages are now present. *l b*, labrum. *a*, anus.
13. Still older phase. The dotted line from VIII passes a little forward of its proper place in the figure.
14. Embryo at the time of leaving the egg. Most of the appendages are present. The body is still enveloped in a larval skin, *c t*, and the abdomen is bent upwards. $\frac{7}{1}^{5}$.
15. Older larva after the larval skin has been cast off. IV′, external branch of first maxilla. *o c*, eye. *c p*, carapace. $\frac{7}{1}^{5}$.
16. Later stage. *r*, rostrum. IV′, appendage of the first maxilla extending backwards over the branchial feet. VI–XIII, branchial feet. Behind these are four pairs of abdominal swimming-feet. *a b*^{8}, eighth somite of abdomen bearing the two terminal styliform appendages (ξ). $\frac{7}{1}^{5}$.
17. One of the phyllopod appendages. 1, inner branch. 2, middle branch. 3, outer branch. $\frac{15}{1}^{0}$.

18 – 22. *Development of* Schizopoda. *Figures from* Elias Metschnikoff *and* Carl Claus.

18. Nauplius of *Euphausia*, just hatched. A mouth opening is seen between the bases of the third pair of appendages, but there is no anal orifice. From Metschnikoff, Ueber den Nauplius zustand von *Euphausia*. Zeitschr. wissensch. Zool., XXI., Taf. XXXIV., 1871.
19. Later stage of the same. *o c l*, ocellus. *l b*, labrum. *m t*, metastoma or lower lip. IV, rudiment of first maxillæ. V, second maxillæ. VI, first maxilliped. The carapace is now present. The specimen figured was about to moult, and within the third pair of nauplius appendages are seen the mandibles of the next stage, when the function of these appendages becomes masticatory. From Metschnikoff, *op. cit.*
20. Later stage (protozoëa) of a *Euphausia* larva from the Atlantic Ocean, seen from the ventral side. 1½ mm. long. The hind body (thorax and abdomen) has now acquired great length. The segmentation of the body is beginning in the region back of the first maxillipeds, i. e. in the thoracic region, the hinder or abdominal portion being yet uninvaded by segmentation. *f*, frontal sense-organ, similar to that shown on previous plates in larvæ of *Cirripedia*, *Apus*, &c. Grobben (Arbeiten Zoolog. Inst. Wien., II. p. 262, Taf. XVII. figs. 74–76, 1879) has shown that the larva of *Euphausia* also has a "dorsal organ" equivalent to that which we have seen in the embryos of many of the lower Crustacea. *i*, intestine. *a*, anus. ζ, longitudinal muscles of the abdomen. From Claus, Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems, Taf. I., 1876.
21. Still later stage (zoëa) of the same, lateral view. 2⅔ mm. long. The thoracic region behind the first maxilliped (VI) is divided into its full number of seven somites, although they are extremely short. The abdomen is also divided into six somites. The telson is not yet separated by a suture from the sixth segment. Underneath the cuticle of the anterior portion of the terminal segment are the rudiments of the posterior pair of abdominal appendages (not seen in the lateral view). The larva, unlike the typical zoëa, lacks the second pair of maxillipeds, and the antennæ are still large swimming-organs. As the development proceeds, the thoracic and abdominal appendages develop as two independent series from before backwards, the abdominal series being completed before the thoracic series. *o c*, eye. From Claus, *loc. cit.*
22. Second and third maxillipeds (VII, VIII) and the first and second ambulatory appendages (IX, X) of a *Euphausia* 4½–5 mm. long. VII′, etc., outer branches of appendages. *b r*, gills. From Claus, *loc. cit.*

PLATE IX.

a.	Anus	*l b.*	Labrum.
a b.	Abdomen.	*o c.*	Compound eye.
c p.	Carapace.	*o c l.*	Simple eye.
c t.	Cuticle.	*p l.*	Procephalic lobe.
d p.	Dentoplasm.	*r.*	Rostrum.
f.	Frontal sensory organ.	*a.*	Tail fold.
i.	Intestine.	*λ.*	Dorsal organ.
l.	Liver.		

The Roman numerals signify the consecutive order of the appendages.

1 – 10. *Development of* Schizopoda, *continued (Mysis). Figures from* Édouard Van Beneden *and* P.-J. Van Beneden.

1 – 6. *Mysis ferruginea.* From Édouard Van Beneden. 1 – 3, Recherches sur la Composition et la Signification de l'Œuf, Pl. X. Mém. Cour. Acad. Roy. Belgique, XXXIV., 1869. 4 – 6, Recherches sur l'Embryogénie des Crustacés. II. Developpement des Mysis. Bull. Acad. Roy. Belgique, [2.] XXVIII., Pl. III., 1869.

1. Egg showing the commencement of partial segmentation.
2. Later stage in the segmentation. The blastoderm now forms a zone of small extent at one pole of the egg.
3. The blastoderm has extended over the whole surface of the yolk. On the ventral side the cells have a roundish form, while on the dorsal side they are very much flattened.
4. Later stage. *p l*, anterior expansion of the ventral side of the blastoderm to form the procephalic lobes. *a*, fold of the blastoderm which separates the hinder portion (*a b*) of the embryo from the anterior section of the body.
5. Later stage. The embryo is now ready to leave the egg. The three nauplian appendages, two pairs of antennæ, and mandibles (I, II, III) are present, and the embryo is invested with a delicate cuticle. λ, dorsal organ. While within the egg, it will be observed that the body has a ventral flexure, as in Decapod Crustacea.
6. Embryo after it is freed from the egg-membranes. The body now assumes a dorsal flexure.

7 – 10. *Mysis chamæleo.* From P.-J. Van Beneden, Recherches sur les Crustacés du Littoral de Belgique. Mém. Acad. Roy. Belgique, XXXIII., 1860.

7. It has been seen by the previous figures that the *Mysis* embryo leaves the egg with three pairs of appendages like a nauplius. The larva undergoes its further development within the incubatory pouch of the parent. The nauplius skin is not discarded, but accommodates itself to the growth of the larva, forming a protective case, within which the young *Mysis* develops. In the species here figured, the nauplius skin terminates in a pair of setiferous appendages. Within the nauplius skin, the larva has become provided with the full number of cephalo-thoracic appendages in the form of simple buds. These afterwards assume the schizopodous character, the abdominal appendages appear, and the segmentation of the body sets in.
8. Larva just after the nauplius skin has been cast off, much less enlarged than the preceding figure. The stalked eyes (*o c*) are now conspicuous. They have developed from the procephalic lobes of the embryo. The full number of abdominal appendages (XIV – XIX) is now seen, the posterior pair largely developed.
9. Later stage, shortly before leaving the incubatory pouch of the parent.
10. Appendages from the first to the fourteenth (first abdominal) inclusive, to show the double nature of the appendages.

11 – 21. *Development of* Peneus. *Figures from* Fritz Müller *and* Carl Claus.

11 – 16. From Müller, Die Verwandlung der Garneelen. Arch. Naturgesch., XXIX., Taf. II., 1863.

11. Nauplius stage of a *Peneus*, from Desterro, Brazil. .4 mm. long.
12. Older stage (metanauplius), seen from the side. .5 mm. long. The carapace (*c p*) has commenced, a large labrum (*l b*) is present, together with the rudiments of four pairs of appendages (two pairs of maxillæ and two pairs of maxillipeds) behind the nauplian appendages. A short forked tail has also formed.
13. Third pair of nauplius appendages of a somewhat older stage. At its base is seen the rudiment of the masticatory mandible of later stages.

14. Later stage (protozoëa). The carapace has increased in size. Compound eyes and frontal sense organs (*f*) have appeared, and the appendages (IV–VII) which before were functionless rudiments have developed into biramous swimming organs. The mandible has become reduced to a cutting blade without palpus. The hinder portion of the body has greatly increased in size, and behind the seventh pair of appendages is the indication of a number of somites.

15. Mouth parts of the same, seen from below. The labrum (*l b*) is produced into a prominent spine.

16. Paired eyes of a little older larva.

NOTE.— Although the stages represented in the preceding figures were captured free-swimming on the surface of the sea, and no connection directly established between the several stages or with the parent, there is no reason to doubt the correctness of Müller's identification of the forms as young stages of *Penæus*.

17 – 21. From Claus, Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems, Taf. II., III., Wien, 1876.

17. Protozoëa stage of *Penæus*. 1¼ mm. long. *o c l*, ocellus. *o c*, paired eyes under the carapace, as in adult of genus *Alpheus*. *f*, frontal sense-organ, similar to that of *Phyllopoda*. Behind the second maxillipeds (VII) are six free thoracic segments. Under the cuticle of the first of these are seen the rudiments of the third maxillipeds (VIII). The abdomen (*a b*) has no free segments yet, but under the skin can be seen the segmentation which causes the six abdominal somites of the next stage.

18. Six thoracic somites and abdomen of a somewhat larger larva, zoëa form. The five anterior somites are now free, the sixth is not yet separated from the telson. It appears that the somites of the thorax and abdomen develop in regular succession from before backwards. The third maxilliped (VIII) is now a free bilobed bud, and behind it are seen the rudiments of the following five pairs of thoracic feet. In the abdominal section of the body the last pair of limbs is apparent as a small bilobed process (XIX) on the sixth somite, and perhaps the slightest trace of the other five pairs is already perceptible.

19. Older zoëa form of the same. The paired eyes are now freed from the carapace and mounted on long stalks. The five posterior pairs of thoracic appendages (those of the left side have been removed in the figure) have developed into prominent biramous sacs, while the third maxillipeds (VIII) are furnished with setæ on each branch. The abdomen has become very long, the telson is separated from the sixth somite by a movable joint, and the posterior appendages (XIX) have assumed the shape of powerful swimmerets. The second antennæ still serve as locomotive organs, in which office the muscular abdomen now assists. The five anterior abdominal somites have not yet developed appendages, at least to any functional degree. The development of the sixth abdominal appendages thus anticipates the development of the anterior pairs, probably on account of their functional importance as swimming organs.

20. Schizopod or Mysis stage of a *Penæus*. 16 mm long. As in the adult *Mysis*, the biramous thoracic feet now serve as swimming organs. All the abdominal limbs are present. The first antennæ have lost their long setæ, and grown an inner branch which becomes the inner flagellum of the adult appendage. The second antennæ have resigned their locomotive office, and their outer branch has become reduced to the antennal "scale" (II′). The nauplius eye has disappeared, and mandibular palpi have developed. The transition from the Mysis stage to the adult is easy, the most marked change consisting in the reduction of the external branches of the five pairs of ambulatory appendages to rudimentary structures.

21. Telson of the same stage.

PLATE X.

Development of SERGESTIDÆ (*Lucifer*). *Figures from* W. K. BROOKS.

NOTE. — The figures on this plate are copied from the original drawings. I am greatly indebted to Dr. Brooks for sending me his drawings and proof of the text of his memoir in advance of its appearance in the Philosophical Transactions of the Royal Society of London, 1882. The memoir is entitled "*Lucifer:* a Study in Morphology."

a.	Anus.	*n'.*	Supra-œsophageal nerve ganglion.
a^1.	First somite of abdomen.	*o c.*	Compound eye.
a^4.	Fourth somite of abdomen.	*o c l.*	Simple eye.
a b.	Abdomen.	*o e s.*	Œsophagus.
c p.	Carapace.	*r.*	Rostrum.
c t.	Embryonic cuticle.	*r e.*	External branch of appendage.
g m.	Gastrula mouth.	*r i.*	Internal branch of appendage.
h.	Heart.	*s t.*	Stomach.
i.	Intestine.	α.	Cells which form food-yolk, or possibly mesoblast.
l b.	Labrum.	β.	Auditory organ.
l.	Yolk-cells around stomach.	γ.	Antennal gland.
m t.	Metastoma.	ϑ.	Shell gland.
n.	Sub-œsophageal portion of nervous system.	ξ.	Posterior extremity of abdomen or telson.

The Roman numerals indicate the appendages of the body in their consecutive order; the Arabic numerals denote the somites. In *Lucifer* the thirteenth somite and its appendages (last thoracic) are not developed in any stage.

1. Egg undergoing segmentation. There are eight segmentation spheres in the stage figured. The segmentation is regular and total, and a segmentation cavity is formed in the centre of the egg.
2. Optical section of egg at later stage. One pole has become flattened, and the cell, α, which lies in the centre of the flattened area, has its broad end directed toward the segmentation cavity, while the other cells have their broad ends at the surface of the egg. Most of the food-yolk has disappeared from the other cells, which are now quite transparent, while the cell α contains as much food-yolk as ever.
3. As the segmentation proceeds, the flattened area in fig. 2 becomes a deep pit, and a gastrula results as shown in fig. 3. The cell α divides in two and becomes pushed into the segmentation cavity. Whether the two cells α in fig. 3 represent the whole of the cell α in the preceding figure, or whether they are only the inner ends of the same, into which the deutoplasmic elements have withdrawn, and which have then become split off from the outer ends, was not determined. Their further history was not obtained. Brooks inclines to the belief that they represent the inner ends of the cell α in fig. 2, and are not mesoblastic, but go to form a food-yolk like the inner ends of the yolk pyramids in centrolecithal eggs.
4. Ventral view of embryo artificially removed from the egg thirty hours after oviposition. *l b*, labrum. *m t*, metastoma. I, first antenna. II, second antenna. III, mandibles. IV, V, VI, buds representing the two pairs of maxillæ and the first pair of maxillipeds of the adult. When the embryo was set free, the body was enveloped in a delicate cuticle, which in the individual figured has been torn off from all the appendages except the first antennæ.
5. First free nauplius stage, about thirty-six hours after oviposition, lateral view. $\frac{8}{100}$ in. long. The swimming appendages have become segmented, and the rudiment of the abdomen or telson (ξ) is apparent. The anus is yet absent. *o c l*, ocellus.
6. Second larval stage, or metanauplius, lateral view. $\frac{9}{100}$ in. long. *c p*, carapace. *o e s*, œsophagus. *i*, intestine. *l*, yolk-cells around the stomach (*s t*). *n*, sub-œsophageal part of nervous cord. *n'*, supra-œsophageal nerve ganglion. The anus is now present on the ventral side of the terminal portion of the abdomen.
7. Third larval stage, or first protozoëa stage, raised from the stage represented in fig. 6, dorsal view. $\frac{20}{100}$ in. from tip of rostrum to base of spines on telson. The hind-body is now about as long as the carapace, and is divided into four somites and a long unsegmented portion (*a b*) The four somites (8–11) are those which subsequently bear the third pair of maxillipeds and the three following pairs of legs. A larva was taken from the sea agreeing with this one in size and every respect except that the free segments of the hind body were wanting. It is therefore probable that the larva figured is near the end of the first protozoëa stage. VII, second maxilliped. *r*, rostrum. *h*, heart. The mandibles have become reduced to cutting blades in this stage.
8. Fourth larval stage, or second protozoëa stage, raised from the preceding form, lateral view. $\frac{27}{100}$ in. from tip of rostrum to fork of telson. *o c*, rudiment of compound eye. ϑ, shell gland opening at the base of the first or second maxilla.

9. Mandibles, same stage, seen from below. The right and left mandibles are not symmetrical.
10. First maxilla of left side, same stage, posterior surface.
11. Second maxilla of left side, same stage, posterior surface. *re*, exopodite or rudimentary scaphognathite.
12. First maxilliped of left side, same stage.
13. Second maxilliped of left side, same stage. Resembles the first maxilliped, but is much smaller.
14. Fifth larval stage, or last protozoëa stage, raised from the preceding stage, ventral view. $\frac{3}{100}$ in. long. This stage is Dana's genus *Erichthina*. The second antennæ are still the chief organs of locomotion. The hind-body has increased in length, and now consists of nine free somites and an unsegmented posterior portion. The outer edges of the first (8) are marked by enlargements which appear to be rudiments of the third maxillipeds. 12, twelfth somite (counting the first antenna as the appendage of the first somite). This is the posterior thoracic somite, the thirteenth or last thoracic of the typical Decapod, being never developed in *Lucifer*. Following immediately upon the thirteenth somite is the first abdominal (a^1). a^4, fourth abdominal somite. The posterior unsegmented portion represents the fifth and sixth abdominal somites and the telson.
15. Sixth larval stage, or zoëa stage, raised from the preceding stage, ventral side. About $\frac{50}{100}$ in. long. This stage is comparable, so far as the appendages are concerned, with the Elaphocaris stage of *Sergestes*. The third maxillipeds (VIII) and the four following pairs of thoracic appendages (IX–XII), as well as the swimmerets or appendages of the sixth abdominal somite (XIX), are present in a rudimentary shape as bilobed buds. All the somites of the abdomen are now well marked except the sixth, which is not yet clearly separated from the telson. The somite which carries the last pair of thoracic legs in the typical Decapod is wanting here and throughout the development of *Lucifer*. *n*, abdominal nerve ganglion.
16. Lateral view of the same stage.
17. Seventh larval stage, or first schizopod stage, viewed from below. About $\frac{70}{100}$ in. long. This stage is Dana's genus *Sceletina*, and represents in a general way the Acanthosoma stage of *Sergestes*. Up to this time the larva has swam chiefly by means of the antennæ. In this stage the antennæ lose their locomotor function, which is now assumed by the long biramous appendages which have developed from the bud-like processes on the thoracic segments of the preceding stage. The compound eyes are mounted upon short stalks. The second antennæ have become quite small. The thoracic appendages (VI–XII) are much alike in structure and with the telson and swimmerets (XIX) serve to propel the animal through the water. The telson is separated from the sixth abdominal somite.
18. Ninth larval stage, or third (last) schizopod stage, lateral view. Between this stage and the one represented by fig. 17 one intervenes similar to fig. 17, but a little larger and furnished with abdominal appendages in the form of small buds. In the stage represented by fig. 18 the abdominal appendages are quite large, but still rudimentary. The abdomen is now very much longer in proportion to the carapace than it was in the zoëa stages, and flattened from side to side. The outer branch of the second antennæ is reduced to a scale.
19. Second and third maxillipeds (VII, VIII) and the four following appendages of the thorax, left side, seen from above, same stage.
20. Young *Lucifer* produced from the moulting of a larva like that shown in fig. 18, lateral view. About $\frac{1}{8}$ in. long. It now corresponds in many respects with the Mastigopus stage of *Sergestes*, and has a form essentially like that of the adult *Lucifer*. The flagellum of the first antenna, however, is much shorter than in the adult, and the neck of the carapace is short. The thorax is relatively smaller than in the last stage. The last pair of thoracic feet (XII in fig. 18) have disappeared, together with the outer branches of all the other thoracic appendages, maxillipeds included. The abdominal appendages have their perfect form. II, inner branch or flagellum of second antenna. II′, outer branch or scale of second antenna. β, auditory organ in proximal segment of first antenna. γ, antennal gland.
21. Inner surface of mandible of adult.
22. Second maxilla of adult. *ri*, inner branch. *re*, outer branch, or scaphognathite.

PLATE XI.

Development of Decapoda, *continued. Figures from* N. Bobretzky, Walter Faxon, Paul Mayer, Fritz Müller, Carl Claus, *and* Ferd. Richters.

a.	Anus.	*o c.*	Eye.
a b.	Abdomen.	*o c l.*	Ocellus.
b l.	Blastoderm.	*p d.*	Proctodæum, or hind-gut.
b r.	Gill.	*p l.*	Procephalic lobe.
c p.	Carapace.	*p p.*	Protoplasm.
d p.	Deutoplasm.	*p y.*	Yolk pyramid.
e p.	Epiblast.	*r e.*	Exopodite.
g m.	Gastrula mouth.	*r i.*	Endopodite.
h.	Heart.	*s d.*	Stomodæum, or fore-gut.
hy	Hypoblast.	*v m.*	Vitelline membrane.
l b.	Labrum.	α.	Tail fold.
m s.	Mesoblast.	β.	Epipodite.
m t.	Metastoma.	γ.	Antennal gland.
n.	Nerve.	δ.	Palpus.
n c.	Nucleus.	ε.	Epipodite.

1–9. *Palæmon.* From Bobretzky, КЪ ЭМБРІОЛОГІИ ЧЛЕНИСТОНОГИХЪ. Запис. Кіевскаго Общества Естествоиспытателей, III., T. IV., V., VI., 1873. [On the Embryology of Arthropods. Mem. Kieff Naturalists' Soc., III., Pl. IV., V., VI., 1873.]

1. Egg undergoing cleavage, superficial view. The cleavage is regular. Whether the first clefts reach the centre of the yolk or not Bobretzky was unable to determine, owing to the imperfection of his sections. At any rate the deutoplasm soon invades the core of the egg to such a degree that the subsequent clefts do not attain to the centre, and the segmentation becomes superficial.
2. Section of later stage of the cleavage. The cleavage products now have the form of long pyramids whose apices are fused in the deutoplasmic mass in the centre of the egg. The clear protoplasm, involving the nuclei, has collected at the bases of the pyramids. Later the boundaries of the pyramids become obliterated, while their protoplasmic bases become separated from the deeper food-yolk and form the cells of a superficial blastoderm.
3. Gastrula stage, superficial view.
4. Gastrula stage, section. *b l*, epiblastic layer. *h y*, hypoblast. *d p*, deutoplasm.
5. Section showing the closure of the blastopore or gastrula mouth. *m s*, mesoblast, originating from the walls of the gastrula cavity.
6. Nauplius stage. *l b*, labrum. *a b*, abdomen. I, first antenna. II, second antenna. III, mandible. *p l*, procephalic lobe.
7. Longitudinal section through nauplius stage. The hypoblast cells have increased and passed into and absorbed the whole yolk, forming a solid mass of hypoblast in which the outlines of the cells are almost obliterated. *p d*, invagination of epiblast which forms the hind-gut. *s d*, invagination of epiblast which forms the fore-gut (œsophagus and stomach). α, tail fold, between which and the proctodæum lies the rudimentary abdomen. *l b*, labrum.
8. Superficial ventral view of embryo at a later stage. The maxillæ (IV, V) and maxillipeds (VI, VII, VIII) are seen as bilobed buds. *c p*, fold which forms the carapace. *o c*, eye, formed in the procephalic lobes.
9. Longitudinal section of late stage in the development of the embryo. A portion of the nuclei of the hypoblast cells have migrated to the periphery of the yolk, and the cells have assumed a pyramidal form, similar to the cleavage pyramids in Fig. 2. The protoplasm segregates in the bases of the pyramids, while their apices become lost in the central deutoplasmic mass, in which all trace of nuclei has disappeared. The wall of the mesenteron thus comes to form a single layer of pyramidal cells enclosing, and merging into, a central mass of food-yolk. The protoplasmic ends of the hypoblast pyramids finally separate as cellular layer, which forms the lining of the mid-gut and liver in the adult. Connection is formed first with the proctodæum, or hind-gut, and later with the stomodæum (œsophagus and stomach). The latter connection is not made until all the food-yolk in the mesenteron has been absorbed. *n*, ventral nerve cord ; *n'*, supra-œsophageal nerve ganglion. These originate from the epiblast; the latter from the procephalic lobes. *h*, heart arising in the mesoblastic tissue.

10–14. *Palæmonetes vulgaris*. From Faxon, On the Development of *Palæmonetes vulgaris*, Pl. I., III., IV. Bull. Mus. Comp. Zoöl., V., 1879.

10. First larval (zoëa) stage, ventral view. The three pairs of maxillipeds (VI–VIII) serve as swimming organs. Behind these are the rudiments of the two following pairs (IX, X). The hinder thoracic somites are not distinguishable, while the abdomen has six well-developed somites. Compare with this retardation in the development of the thoracic region (which obtains generally among the higher *Decapoda*) the order of development of the somites in the more primitive *Decapoda* like *Peneus* (Pl. IX.) and *Lucifer* (Pl. X.), in the *Schizopoda* (*Euphausia*, Pl. VIII.), or in *Apus* (Pl. VI.). These show the normal order of appearance of the somites to be a regular sequence from before backwards. The terminal segment of the body, which represents the sixth abdominal somite and the telson, ends in a broad plate instead of a fork like that in the larva of *Peneus* (Pl. IX.). The caudal plate bears seven setæ on each side. The line on the right indicates the natural length of the larva.

11. Fifth larval stage, cephalo-thorax viewed from below. All the thoracic legs are functional excepting the penultimate pair (XII). All of them are two-branched excepting the last pair (XIII).

12. Later larval stage, seen from the side. The last thoracic legs lack exopodites. The telson is separated by a movable joint from the sixth somite of the abdomen.

13. Rostrum of a later stage.

14. Rostrum of adult.

15–20. *Palæmonetes varians*, from fresh water, Italy. From Mayer, Carcinologische Mittheilungen. IX. Die Metamorphosen von *Palæmonetes varians* Leach. Mitth. Zoolog. Station Neapel, II., Taf. X., 1880. This species, which is also found in salt water in Northern Europe, has an abbreviated development compared with *P. vulgaris*. In the first larval stage it is furnished with the full number of functional cephalo-thoracic appendages, the last three pairs being simple. The first five pairs of abdominal appendages are also present in a rudimentary form.

15. First maxilliped, first larval stage.

16. First maxilliped, third stage.

17. First maxilliped, fifth stage.

18. First cheliped, first stage.

19. First cheliped, third stage.

20. First cheliped, fifth stage.

21. *Palæmon Potiuna*, a fresh-water prawn from Blumenau, Brazil, in the condition in which it leaves the egg. All the appendages, including those of the abdomen, are present, as well as the gills. From a photograph of a drawing by Müller. See Zoolog. Anzeig., III., p. 152, 1880.

22–37. Development of *Loricata* (*Palinurus*, *Scyllarus*).

22–25. From Claus, Ueber einige Schizopoden und niedere Malacostraken Messina's. Zeitschr. wissensch. Zool., XIII., Taf. XXV., XXVI., 1863.

22. Embryo of *Palinurus vulgaris* before hatching. The body when extended measures about 1½ mm. in length. The last two thoracic and all the abdominal appendages are wanting. *o c l*, ocellus.

23. Young Phyllosoma larva (*Scyllarus ?*) 2 mm. long. The head and thorax now have the characteristic disk-shape of Phyllosoma. The abdomen is reduced to a rudiment, and the last two thoracic somites are no longer distinguishable. The first maxillipeds are wanting in this stage.

24. Older Phyllosoma, 4 mm. long. The first maxillipeds (VI) are sprouting out again, and rudiments of the last two pairs of thoracic appendages (XII, XIII) have appeared. *γ*, antennal gland. In the head are seen the bilateral diverticula of the stomach, the median cephalic artery, and anteriorly the brain ganglion.

25. Older Phyllosoma, 14 mm. long, 6½ mm. broad. All the thoracic legs are now developed and also the abdominal appendages.

26–37. From Richters, Die Phyllosomen. Zeitschr. wissensch. Zool., XXIII., Taf. XXXI., XXXII., 1873.

26. Mandible of Phyllosoma (larva of *Palinurus*).

27. Mandible of a *Palinurus* 25 mm. long. *δ*, palpus.

28. First maxilla of Phyllosoma.

29. First maxilla of a *Palinurus* 25 mm. long. *δ*, palpus.

30. Second maxilla of Phyllosoma. *r c*, scaphognathite.

31. Second maxilla of a *Palinurus*, 25 mm. long.

32. First maxilliped of Phyllosoma. *r c*, exopodite. *ε*, epipodite.

33. First maxilliped of a *Palinurus* 25 mm. long.

34. Abdominal appendage of Phyllosoma.

35. Abdominal appendage of a young *Palinurus*.

36. Telson and last pair of abdominal appendages of Phyllosoma.

37. Telson and last pair of abdominal appendages of a young *Palinurus* 25 mm. long.

PLATE XII.

Development of Decapoda, *continued.* *Figures from* T. H. Huxley, N. Bobretzky, Heinrich Reichenbach, Heinrich Rathke, Walter Faxon, William Stimpson, Alexander Agassiz, *and* Paul Mayer.

a. Anus.
a b. Abdomen.
b r. Gill.
c p. Carapace.
e p. Epiblast.
d p. Deutoplasm.
g m. Gastrula mouth.
h. Heart.
h y. Hypoblast.
l b. Labrum.
m. Mouth.
m e. Mesenteron, or mid-gut.
m s. Mesoblast.
n. Ventral nerve cord.
n'. Supra-œsophageal nerve ganglion.
n c. Nucleus.
o c. Eye.
p d. Proctodæum, or hind-gut.
p l. Procephalic lobe.
r e. External branch of appendage.
r i. Internal " "
s d. Stomodæum, or fore-gut.
s p. Spine.
v. Yolk.
v m. Vitelline membrane.
α. Epithelium of ovisac.
β. Membrana propria.
γ. Stalk of ovisac.
δ. Basal portion of abdominal appendage.
ε. Inner branch " "
ζ. Outer " " "
η. Egg-case.
ϑ. Median spine.
ι. Lateral spine.
μ. Mesoblast cell splitting off from hypoblast cell.

The Roman numerals denote the appendages in their consecutive order.

1 – 10. Development of *Astacus.*

1 – 3. From Huxley, The Crayfish, London and New York, 1880.

1. Spermatozoön of *Astacus fluviatilis* developing in a seminal cell. × 850.

2. Mature spermatozoön of the same, viewed *en face.*

3. Two-thirds grown egg of the same, contained in its ovisac. α, epithelium of ovisac. β, membrana propria, or structureless membrane investing the ovisac. *v m*, vitelline membrane. *v*, yolk. *n c*, germinative vesicle containing germinative spots. γ, stalk of ovisac.

4 – 7. From Bobretzky, КЪ ЭМБРІОЛОГІИ ЧЛЕНИСТОНОГИХЪ. Зап. Кіев. Об. Ест., III., Т. I., 1873. [On the Embryology of Arthropods, Mem. Kieff Naturalists' Soc., III., Pl. I., 1873.]

4. Portion of egg of *Astacus* in the gastrula stage. *d p*, food-yolk. *g m*, gastrula mouth. *e p.* epiblast. *h y*, hypoblast. *m s*, mesoblast.

5. Smaller portion of the same, more highly magnified, to show the origin of the mesoblast cells. μ, mesoblast cell splitting off from one of the hypoblast cells at the mouth of the gastrula cavity.

Note. — According to Reichenbach there are formed later, during the nauplius stage of the embryo, secondary mesoblast cells by a sort of endogenous formation within the hypoblast cells on the ventral side of the embryo. These cells wander out from the hypoblast, spread under the epiblast, and mingle with the primary mesoblast cells.

6. Later stage of the same. The gastrula mouth has closed, and the gastrula cavity has become the mesenteron (*m e*). *a b*, abdomen. *p d*, proctodæum, or hind-gut. *s d*, stomodæum, or fore-gut.

7. Later stage of the same. The hypoblast cells have absorbed the whole yolk, and assumed the form of long pyramids, enclosing the cavity of the mesenteron. The bases of these pyramids are directed outward, and contain the nuclei and protoplasmic portion of the cells. The protoplasmic bases of the pyramids then separate from the deeper portions to form the epithelial lining of the mid-gut of the adult (liver and anterior portion of the intestine). The inner portion of the pyramids becomes food-yolk in the cavity of the mesenteron. In the stage represented, the fore-gut (œsophagus and stomach) and hind-gut (posterior part of the intestine) have not yet opened into the mid-gut. *h*, heart, formed in the mesoblastic tissue. *n'*, *n*, supra- and sub-œsophageal portions of nervous system, formed from the epiblastic germ-layer. *c p*, fold which forms the carapace.

8. Nauplius stage of the embryo of *Astacus fluviatilis.* I, first antenna. II, second antenna. III, mandible. *l b*, labrum. *a*, anus. *c p*, carapace. *p l*, procephalic lobes. *o c*, optic pit, epiblastic invagination in the procephalic lobes concerned in the formation of the supra-œsophageal ganglion and nervous elements of the eye. *h*, heart. From Reichenbach, Die Embryonalanlage und erste Entwicklung des Flusskrebses. Zeitschr. wissensch. Zool., XXIX., Taf. X. fig. 8, 1877.

9. Embryo of *Astacus fluviatilis* just before leaving the egg. The carapace has been cut away from the side turned toward the observer, in order to show the gills. The first and last pairs of abdominal appendages are undeveloped; otherwise the embryo has the essential characters of the adult, and undergoes no marked metamorphosis after leaving the egg. From Rathke, Untersuchungen über die Bildung und Entwickelung des Flusskrebses, Taf. I. fig. 16, Leipzig, 1829.
10. *Astacus fluviatilis*, two lately hatched young attached by their chelipeds to one of the abdominal appendages of the mother. Four times natural size. δ, protopodite; ϵ, endopodite; ζ, exopodite of the abdominal appendage of the mother. η, ruptured egg-cases. From Huxley, *op. cit.*, p. 41.
11. Spermatozoön of *Homarus Americanus*. From a drawing by Faxon.
12. Embryo of *Homarus Americanus*. VIII, third maxilliped. The dotted line rests on the exopod. The longer endopod extends beyond the tip of the exopod. The endopods of the succeeding pairs of appendages are concealed by the exopods. *h*, heart. From a drawing by Stimpson, June 6, 1852.
13 – 16. From drawings by Faxon, Newport, R. I., July 18, 1881.
13. First antenna of embryo of *Homarus Americanus* just before hatching. The shaded part indicates the antenna of the larva seen through the cuticle of the embryo.
14. Second antenna of the same.
15. Tail of the same. ϑ, median spine of the tail of the first larval stage. ι, lateral spine of tail of first larval stage. All the spines of the enclosed larval tail are shortened by invagination.
16. Tail of first larval stage of the same. The larva is about to moult, and the tail of the following larval stage is seen through the cuticle.
17. First larval stage of *Homarus Americanus*. Leaves the egg in the Mysis condition. Natural size, about 8 mm. long. From a drawing by A. Agassiz, Nahant, Mass., July 1, 1866.
18 – 30. Development of *Paguridæ*.
18. Section of egg of *Eupagurus Prideauxii* before cleavage. The nucleus has divided into eight, four of which are seen in the section. Each nucleus is surrounded by a thin layer of protoplasm which sends out thread-like processes into the surrounding yolk. The segmentation is at first total, but after the fourth phase the cleavage spheres fuse in the deutoplasmic centre of the egg, and the subsequent cleavage is superficial. From Mayer, Zur Entwicklungsgeschichte der Dekapoden. Jenaische Zeitschr., XI., Taf. XIII. fig. 1, 1877.
19. The same after the fourth cleavage. *n c*, nuclei surrounded with a layer of protoplasm. From Mayer, *op. cit.*, Taf. XIII. fig. 4.
20 – 23, 25–30. From drawings by Faxon, Newport, R. I., August, 1881.
20. First larval stage of *Pagurus*. Leaves the egg in the zoëa form, the first and second maxillipeds serving as locomotive organs, the third maxillipeds (VIII) present but rudimentary. No thoracic or abdominal appendages. The sixth abdominal segment is fused with the telson. The posterior thoracic segments are potential merely.
21. First antenna of the same.
22. Second antenna of the same. *s p*, spine. *r i*, rudimentary flagellum. *r e*, squamiform appendage.
23. One half of the hind border of the tail of the same, armed with seven setæ, the sixth of which (counting from inner side) is reduced to a small curved hair. Within the tail, represented by light shading in the figure, are seen the caudal setæ of the next larval stage. It appears that the inner seta of the first stage will be replaced by two (1′, 1) in the second larval stage.
24. Tail of embryo of *Eupagurus Prideauxii*. The seta numbered 6, which becomes a rudiment in the first larval stage, is well developed. All the setæ are feathered except the outer ones, 7. From Mayer, *op. cit.*, Taf. XV. fig. 43.
25. Tail of second larval stage of *Pagurus*, from Newport, R. I. Comparison with Fig. 23 shows that a new seta (1′) has been developed on the inner side of the seven primary setæ of the first larval stage.
26. Mouth parts of the same. *l b*, labrum. *m t*, metastoma. III, mandible. IV′, IV″, IV‴, first maxilla. V′, V″, V‴, V⁗, second maxilla.
27. Third larval stage of *Pagurus*. The exopods of the third maxillipeds have become functional swimming organs. Rudiments of the chelipeds (IX) and two or three following pairs of thoracic appendages have appeared, and they are simple from the time of their first appearance. There is thus a syncopation of the Mysis stage in *Pagurus* and in *Anomoura* generally. In the suppression of the Mysis stage and in the late functional development of the third pair of maxillipeds, the *Anomoura* resemble the *Brachyura* rather than the typical *Macroura* like *Palæmonetes vulgaris* (see Pl. XI.). In the structure of the second antennæ, spatulate form of the terminal segment of the abdomen, and the appearance of the posterior abdominal appendages (XIX) in advance of the rest, *Pagurus* agrees in its development with *Palæmonetes vulgaris*. XIX, last pair of abdominal limbs. Their inner branch is commencing to grow as a small lobe from the proximal end. The sixth segment of the abdomen is now a free segment.
28. First antenna of the same.
29. Second antenna of the same.
30. Telson and appendage of sixth abdominal somite. $\kappa\epsilon$, rudimentary inner branch of appendage. The Arabic numerals indicate the correspondence of the setæ of the telson with those in the earlier larval stages.

PLATE XIII.

Development of DECAPODA, *continued. Figures from* ALEXANDER AGASSIZ *and* WALTER FAXON.

b r. Gill.	*l b.* Labrum.	*r e.* External branch of appendages.
c t. Embryonic cuticle.	*m t.* Metastoma	*r i.* Internal " "
h. Heart.	*o c.* Eye.	*s t.* Stomach.
i. Intestine.	*r.* Rostrum.	

The Roman numerals denote the appendages of the body in their consecutive order.

1–9. Development of *Paguridæ* (continued from Pl. XII.).

1. Larva of *Pagurus*, from Newport, R. I. Later stage than the one represented by fig. 27 on the previous plate. Viewed from the dorsal side. The abdomen now carries five pairs of appendages, on the second to the sixth somites. From a drawing by A. Agassiz, Newport, R. I., August 4, 1875.

2–4. From drawings by Faxon, Newport, R. I., August, 1878.

2. Larva of *Pagurus* of about the same age as the one represented by fig. 1. Lateral view.

3. The same, ventral view.

4. One half of the hind border of the telson of the same. Seta 4 has become very short, so that the armature of the telson at first sight appears to be the same as in the first larval stage (Pl. XII. fig. 23).

5–9. From drawings by A. Agassiz.

5. Older stage of a *Pagurus* from Naushon Island, Mass., August 23, 1865. 2½ mm. long. This is the genus *Glaucothoë* of Milne-Edwards, *Prophylax* of Latreille. The two sides of the body and the appendages are still symmetrical, except in the greater development of the chela of the right side. The two posterior pairs of thoracic appendages are much shorter than the anterior pairs. All the abdominal somites bear appendages except the first.

6. Abdomen of the same, from the ventral side.

7. One of the abdominal appendages of a little older stage, when the abdomen begins to curl to one side.

8. Young *Pagurus* from Newport, R. I., August 23, 1875, at the age when it takes up its abode in a Molluscan shell.

9. Abdomen of a little younger specimen than fig. 8, showing the atrophy of the curled side. Newport, R. I., July 24, 1876.

10. Zoëa stage of *Porcellana* (*Polyonyx*) *macrocheles*. First stage after shedding the embryonic cuticle. VIII, rudimentary third maxilliped. From a drawing by A. Agassiz, Newport, R. I., August 31, 1865.

11. Last zoëa stage of the same. 16 mm. from tip of rostrum to tips of posterior horns of carapace. The first antennæ are now two-branched. The five posterior thoracic appendages (IX–XIII) are present in a rudimentary shape, bent up under the carapace. The telson is not distinct from the sixth abdominal somite. The second, third, fourth, and fifth abdominal somites carry simple unsegmented appendages. From Faxon, On some Young Stages in the Development of *Hippa*, *Porcellana*, and *Pinnixa*, Pl. II. fig. 1. Bull. Mus. Comp. Zoöl., V., 1879.

12. Third maxilliped of the same stage, more highly magnified. *r i*, inner branch. *r e*, outer branch. From Faxon, *op. cit.*, Pl. II. fig. 12.

13. Five posterior pairs of thoracic appendages (chelipeds and ambulatory limbs) of the same stage, removed from the body. *b r*, gills.

14. Young *Polyonyx* following at a single moult the zoëa represented in fig. 11. Dorsal view. Length of carapace, 2 mm. It has now all the essential characters of the adult. The sixth abdominal segment is now separated from the telson by a movable joint, and bears a pair of appendages (XIX). From a drawing by A. Agassiz, Newport, R. I., August 30, 1865.

15. Adult specimen of the same, from South Carolina, twice the natural size, viewed from above. Observe the width of the carapace compared with that of the young stage represented by fig. 14. From Faxon, *op. cit.*, Pl. III. fig. 11.

16–18. *Carcinus mœnas*. From Faxon, On some Points in the Structure of the Embryonic Zoëa, Pl. I. Bull. Mus. Comp. Zoöl., VI., 1880.

16. Young just after it leaves the egg (protozoëa stage). ¼ mm. long. Within the transparent embryonic cuticle may be seen the zoëa as it will appear at the next moult. The cuticle of the abdomen is unsegmented, has no rostral or dorsal spines, nor appendages back of the second maxillipeds. The two pairs of antennæ are enormously developed as in nauplii or the protozoëa of *Peneus*, &c. VIII, IX, X, third maxilliped and first two ambulatory appendages of the adult, seen through the cuticle.

17. Caudal fin of the same stage. The tail is forked and bears on each side seven spines (1–7). At this stage the tail of the Brachyuran larva can be compared part for part with the fourteen-spined caudal fork of the larvæ of the lower *Decapoda*, e. g. *Peneus*. (See Pl. IX. figs. 14, 18.) The shaded portion represents the tail of the following stage, seen through the transparent cuticle. 1′–5′, spines on the tail of the next (zoëa) stage, much shortened by invagination. 4′ becomes the great lateral prong of the tail of the zoëa. (See Pl. XIV. fig. 2.)

18. The same in the process of moulting the protozoëa cuticle. *c t*, cuticle peeling off from the abdomen. After the cuticle has fallen off from the tail the little hooks which terminate the caudal fork of the zoëa are used to tear the embryonic membrane from the anterior parts of the body. The great dorsal spine of the zoëa which has been bent down forwards upon the back is now unfolding and lifting the cuticle as it rises.

PLATE XIV.

Development of DECAPODA, *continued.* *Figures from* WALTER FAXON *and* CARL CLAUS.

a.	Anus.	*s p.*	Spinous process of second antenna of zoëa.
a b.	Abdomen.	*s t.*	Stomach.
b r.	Gill.	α.	Dorsal spine.
h.	Heart.	β.	Ophthalmic artery.
i.	Intestine.	γ.	Spine on the second somite of abdomen.
l b.	Labrum.	δ.	Lateral spine of carapace.
o c.	Eye.	ϵ.	Mandibular palpus.
r.	Rostrum.	ζ.	Tendon of mandibular muscle.
r e.	Exopodite.	η.	Retinaculum.
r i.	Endopodite.		

1 – 4. *Carcinus mœnas* (continued from Pl. XIII.). From Faxon, *op. cit.*, Pl. 11.

1. First zoëa stage, immediately succeeding the stage figured on the preceding plate. VIII, IX, X, rudimentary third maxillipeds and first and second ambulatory appendages. The abdomen has six segments, the telson being not yet separated from the sixth somite.
2. Tail of the same stage. The Arabic numerals indicate the homology of the spines with those of the tail of the protozoëa (Pl. XIII. fig. 17).
3. First antenna of the same stage.
4. Second antenna of the same stage. *s p*, spinous process corresponding to the spine on the second antenna of larvæ of prawns (Pl. XI. fig. 11, &c.) and *Paguridæ* (Pl. XII. fig. 22). *r e*, squamiform process, homologous to the external branch of the antenna of larval *Macroura*, to the antennal scale of adult *Macroura*. Both of these parts become aborted in the adult. The flagellum (endopodite) of the second antenna of the adult is wanting in the youngest zoëa stages, or represented only by a small tubercle at the base of the squamiform process.

5 – 11. From Claus, Untersuchungen zur Erforschung der Genealogischen Grundlage des Crustaceen-Systems, Taf. X., XI., Wien, 1876.

5. Later zoëa stage of a Portunid from Chili. 4 mm. long. This is probably the last zoëa stage, preceding the megalopa. The first and second maxillipeds still serve as swimming organs. The five ambulatory legs (IX – XIII) are quite largely developed but still functionless. From the time of their first appearance they are simple appendages destitute of external swimming branches. The chela is already prominent on the first pair (IX). The second to the sixth abdominal somites are now provided with appendages. The last pair (XIX) do not anticipate the others, as in *Pagurus* (Pl. XII.) and most *Macroura* (e. g. *Penæus*, Pl. IX., *Lucifer*, Pl. X.).
6. First antenna of the same. *r e*, outer branch. The inner flagellum, wanting in the earlier zoëa stages, is developing as a sac-like process.
7. Second antenna of the same. The flagellum (*r i*, wanting in fig. 4) is now quite well developed and segmented.
8. Mandible of a younger zoëa stage of a Brachyuran (*Fissocarris*) showing the commencement of the growth of the mandibular palp (ϵ) which is wanting in the earliest zoëa stage.
9. Mandible of the late zoëa stage of the Portunid represented in figs. 5 – 7. ϵ, palpus.
10. First maxilla of young zoëa stage of *Thia polita*. 1, 2, basal joints (protopodite of Huxley). *r i*, endopodite in the form of a two-jointed palpus.
11. Second maxilla of the same. 1, 2, basal joints or protopodite, each joint presenting a bilobed blade. *r i*, endopodite, also bilobed. *r e*, exopodite or scaphognathite.

12 – 26. *Cancer* from Newport, R. I. From drawings by Faxon, July, 1879.

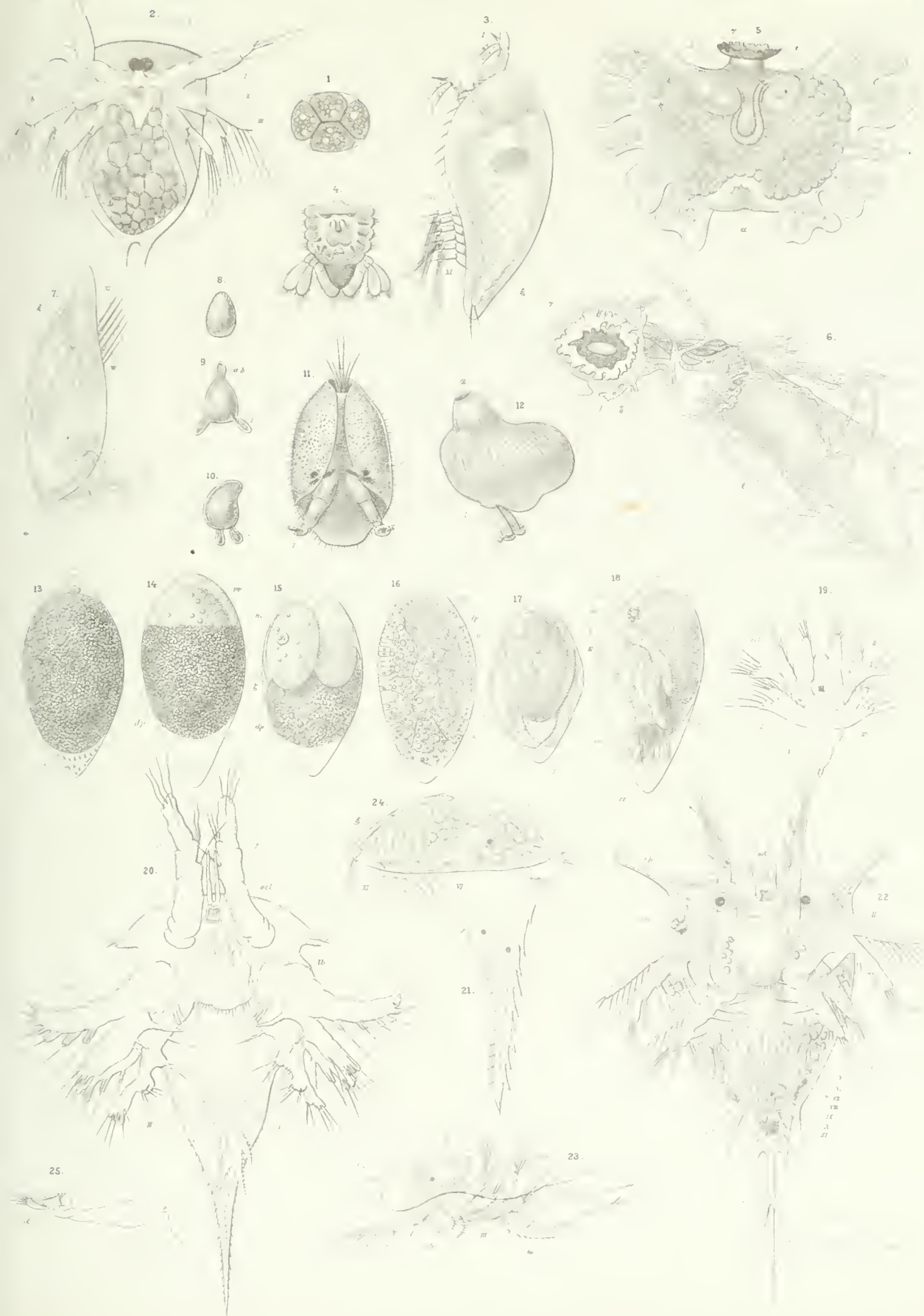
12. Megalopa stage. Among the *Brachyura* no schizopod stage is found, but the zoëa passes into the megalopa phase, in which most of the characters of the adult are seen. The abdomen, however, is largely developed, and provided with swimming-feet. The megalopa stage of the Brachyuran corresponds very closely with the adult Anomouran. The maxillipeds are now converted into mouth parts, and the five Decapodal legs have their full development. The caudal fork of the zoëa has become a telson plate similar to that of the adult. The crossed lines on the left of the figure indicate the natural size.
13. First antenna of the same.

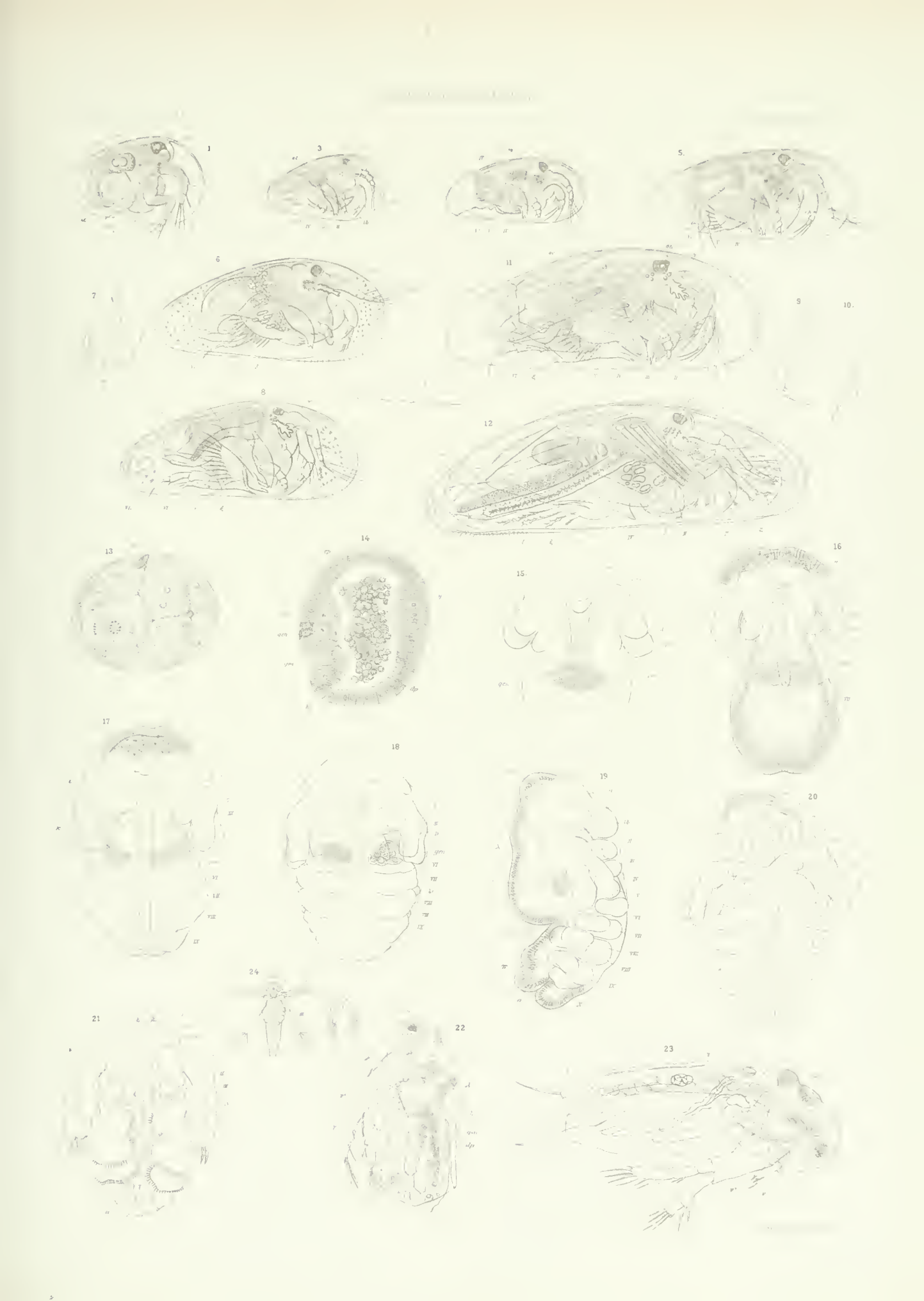
14. Mandible of the same. The palpus has been removed. ζ, tendon of the mandibular musele.
15. Mandibular palpus of the same.
16. Second maxilla of the same.
17. First maxilliped of the same, with endopodite ($r\ i$), exopodite ($r\ e$), and epipodite.
18. Second maxilliped of the same.
19. Third maxilliped of the same. $b\ r$, gills.
20. Proximal end of left cheliped of the same, furnished with a stout hook. Seen from ventral side.
21. Proximal end of left leg of the second pair, with two hooks, seen from ventral side. From the same stage.
22. One of the three long curved setæ on the terminal segment of the last pair of legs of the same (see fig. 12). The other two setæ are destitute of the teeth with which this one is furnished.
23. One of the abdominal limbs of the same. The endopodite is provided with hooked setæ (η), which serve to lock together the abdominal limbs of the two sides.
24. Posterior abdominal appendage. No endopodite.
25. The megalopa represented by fig. 12 passes by a single moult into the crab stage of the form represented in this figure, dorsal view. The eyes are much larger than in the adult, the antennæ longer, and the length of the carapace much greater in proportion to its breadth, and of very different outline. Breadth of carapace, 4 mm.
26. The same, ventral view. The form of the abdomen would seem to indicate that this specimen is a young male. The third, fourth, and fifth abdominal segments, which, in the adult male, are fused together, are still free.
27. Carapace of adult *Cancer borealis*, half natural size. The megalopa and young crab represented in figs. 12, 25, and 26 belong either to this species or to the closely allied *C. irroratus*. This figure is introduced to show the marked difference in proportions and outline between the young and adult stages. Drawn on stone, from nature, by A. Meisel.

28 – 30. Young stages of *Pinnixa* (*Sayana?*) from Newport, R. I. From Faxon, On some Young Stages in the Development of *Hippa*, *Porcellana*, and *Pinnixa*, Pl. IV., V. Bull. Mus. Comp. Zoöl., V., 1879.

28. Last zoëa stage, seen from above and in front. $a\ b$, penultimate abdominal segment, produced on each side into a rounded lobe. Through the transparent carapace are seen the rudimentary and as yet functionless ambulatory appendages. The cross denotes the natural size.
29. The third maxilliped and five ambulatory limbs removed from the body. VIII, endopodite of third maxilliped. VIII′, exopodite of third maxilliped. VIII″, epipodite of third maxilliped.
30. The zoëa (fig. 28) passes directly, at one moult, into the adult form shown in fig. 30. This abbreviation of the developmental history whereby the megalopa stage is eliminated is very unusual among the marine *Brachyura* which leave the egg in the zoëa form. S. I. Smith has shown that another species of *Pinnixa* passes through a megalopa stage. Some land-crabs, as has long been known, leave the egg in the adult form, like *Astacus* among the *Macroura*.


3
4
5
2
6
9
10
12.
11
13
14
20
15
8
7
19
18
16
17


1
2.
3.
4.
5
6.
7.
8.
9
10.
11.
12
13
14
15
16
17
18
19.
20.
21.
22
23.
24.
25.




1
2
3
4
5.
6
7
8
9
10
11
12
13
14
15
16
17
18


2
3
6
4.
7.
8
9.
5
1
10.
11
14
19.
17.
18
16
13.
15
12
25
26.
22
21.
20.
27
23.
28
30
29
24

Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. IX. No. 2.

SELECTIONS

FROM

EMBRYOLOGICAL MONOGRAPHS.

COMPILED BY

ALEXANDER AGASSIZ,
WALTER FAXON, and E. L. MARK.

II.—ECHINODERMATA.

By ALEXANDER AGASSIZ.

WITH FIFTEEN PLATES.

CAMBRIDGE:
Printed for the Museum.
July, 1883.


JOHN WILSON
& SON,
UNIVERSITY
PRESS.

NOTICE.

THE Bibliography of the Echinodermata, by A. Agassiz, to accompany the second part of the "Selections from Embryological Monographs," has been published as No. 2 of Vol. X. of the Bulletin of the Museum.

The Bibliography of the First Part, the Crustacea, by Walter Faxon, forms No. 6 of Vol. IX. of the Bulletin of the Museum. The Plates have been published as No. 1 of Vol. IX. of the Memoirs of the Museum.

Other Parts of the Bibliography and of the Plates are in preparation, — Protozoa, Acalephs, Polyps, Fishes, and Reptiles.

ALEXANDER AGASSIZ.

MUSEUM OF COMPARATIVE ZOÖLOGY,
Cambridge, Mass., U. S. A.

JULY, 1883.

TABLE OF CONTENTS.

PLATES I., II. *Development of* CRINOIDEA (*Comatula*). Figures from GEORGE J. ALLMAN, WILLIAM B. CARPENTER, A. GOETTE, HUBERT LUDWIG, and C. WYVILLE THOMSON.

PLATE I. —	1–9	*Comatula rosacea*	From WYVILLE THOMSON.
	10–26	*Comatula mediterranea* . . .	" A. GOETTE.
	27–35	*Comatula rosacea*	" WYVILLE THOMSON.
PLATE II. —	1–17	*Comatula rosacea* . . .	" WM. B. CARPENTER.
	17–21	*Comatula rosacea*	" GEO. J. ALLMAN
	22–23	*Antedon larva*	" H. LUDWIG.

PLATES III., IV. *Development of* OPHIUROIDEA. Figures from ALEXANDER AGASSIZ, N. C. APOSTOLIDÈS, AUGUST KROHN, HUBERT LUDWIG, ELIAS METSCHNIKOFF, JOHANNES MULLER, MAX SCHULTZE, and T. H. STEWART.

PLATE III. —	1–14	*Amphiura squamata* . . .	From E. METSCHNIKOFF.
	14–19	" " . . .	" H. LUDWIG.
	20	*Ophiopholis?*	" ALEXANDER AGASSIZ.
	21–23	*Amphiura?*	" " "
	24, 25	*Ophiocoma rosula*	" T. H. STEWART.
	26–31	*Amphiura squamata* . . .	" MAX SCHULTZE.
	32, 33	*Viviparous Ophiuran* . . .	" A. KROHN.
PLATE IV. —	1–13	*Ophiothrix versicolor* . . .	" N. C. APOSTOLIDÈS.
	14–26	*Ophiothrix fragilis*	" JOHANNES MÜLLER.
	27–34	*Pluteus bimaculatus* . . .	" " "

PLATES V.–VIII. *Development of* ASTEROIDEA. Figures from ALEXANDER AGASSIZ, LOUIS AGASSIZ, WILHELM BUSCH, J. KOREN and D. C. DANIELSSEN, S. LOVÉN, HUBERT LUDWIG, JOHANNES MÜLLER, MICHAEL SARS, and C. WYVILLE THOMSON.

PLATE V. —	1–4	*Echinaster sepositus* . . .	From W. BUSCH.
	5–49	*Asterina gibbosa* . . .	" H. LUDWIG.
PLATE VI. —	1–11	*Asterina gibbosa* (continued) . .	" "
	12–19	*Asteracanthion flaccida* . . .	" L. AGASSIZ.
	20–23	*Pteraster militaris*	" M. SARS.
	24–32	*Asteracanthion violaceus* . .	" WYVILLE THOMSON.
	33–42	*Echinaster sanguinolentus* . . .	" M. SARS.
	43–46	*Echinaster Sarsii* . . .	" JOHANNES MÜLLER.
	47, 48	*Wurmförmige Asterie* . . .	" " "
	49–51	*Pteraster militaris* . . .	" J. KOREN and D. C. DANIELSEN.
PLATE VII. —	1–28	*Asteracanthion berylinus* . . .	" ALEXANDER AGASSIZ.
	29–34	*Asteracanthion pallidus* . .	" " "
PLATE VIII. —	1–23	*Asteracanthion pallidus* (continued) .	" " "
	24	*Bipinnaria asterigera* . . .	" JOHANNES MÜLLER.
	25–26	*Asterias glacialis*	" S. LOVÉN.

PLATES IX.–XII. *Development of* ECHINOIDEA. Figures from ALEXANDER AGASSIZ, WILHELM BUSCH, J. W. FEWKES, H. GARMAN and B. P. COLTON, AUGUST KROHN, JOHANNES MÜLLER, and EMIL SELENKA.

PLATE IX. —	1–16	*Echinus miliaris*	From E. SELENKA.
	17–19	*Strongylocentrotus lividus*	" "
	20–23	*Arbacia pustulosa*	" "
	24–27	*Echinocardium cordatum*	" "
	28, 29	*Arbacia pustulosa*	" W. BUSCH.
	30–37	*Arbacia pustulosa*	" JOHANNES MÜLLER.
	38–40	*Arbacia punctulata*	" J. W. FEWKES.
	41	*Arbacia punctulata*	" ALEXANDER AGASSIZ.
	42, 43	*Arbacia punctulata*	" H. GARMAN and B. P. COLTON.
	44, 45	*Arbacia punctulata*	" ALEXANDER AGASSIZ.
PLATE X. —	1–44	*Strongylocentrotus Dröbachiensis*	" " "
PLATE XI. —	1, 3, 5	*Spatangus purpureus*	" A. KROHN.
	2, 4, 6–9	*Spatangus purpureus*	" JOHANNES MÜLLER.
	10	*Spatangoid Pluteus*	" " "
	11	*Echinoid Pluteus*	" " "
	12–18	*Echinus lividus*	" " "
	19–27	*Echinocyamus pusillus?*	" " "
	28	*Echinarachnius parma?*	" ALEXANDER AGASSIZ.
	29	*Echinus acutus*	" JOHANNES MÜLLER.
	30	*Echinus brevispinosus*	" " "
PLATE XII. — YOUNG STAGES OF ECHINI.			
	1–3	*Goniocidaris canaliculata*	From ALEXANDER AGASSIZ.
	4	*Dorocidaris papillata*	" " "
	5, 6	*Asthenosoma hystrix*	" " "
	7	*Diadema setosum*	" " "
	8–12	*Mellita sexforis*	" " "
	13, 14	*Mellita testudinata*	" " "
	15, 16	*Mellita longifissa*	" " "
	17–22	*Echinarachnius parma*	" " "
	23, 24	*Encope emarginata*	" " "
	26–29	*Conolampas Sigsbei*	" " "
	30	*Hemiaster cavernosus*	" WYVILLE THOMSON.
	31–35	*Hemiaster cavernosus*	" ALEXANDER AGASSIZ.
	36, 36′	*Spatangus purpureus*	" " "
	37–40	*Brissopsis lyrifera*	" " "

PLATES XIII.–XV. *Development of* HOLOTHUROIDEA. Figures from D. C. DANIELSSEN and J. KOREN, ELIAS METSCHNIKOFF, JOHANNES MÜLLER, and EMIL SELENKA.

PLATE XIII. —	1–11	*Synapta* — *Auricularia with calcareous wheels*	From JOHANNES MÜLLER.
	12–17	*Synapta* (continued)	" E. METSCHNIKOFF.
	18	*Auricularia with calcareous gland*	" JOHANNES MÜLLER.
	19	*Auricularia with eleven spheres*	" " "
	20–32	*Auricularia with elastic spheres*	" " "
	33–37	*Auricularia with dendritic anal gland*	" " "
PLATE XIV. —	1–12	*Holothuria tubulosa*	" E. SELENKA.
	13–27	*Holothuria tremula*	" D. C. DANIELSSEN and J. KOREN.
PLATE XV. —	1–13	*Cucumaria doliolum*	" E. SELENKA.
	14–27	*Homologies of* ECHINODERM LARVÆ	" JOHANNES MÜLLER.

REFERENCES TO THE PRINCIPAL FIGURES.

For a comparison of the earliest stages of development, see *the Segmentation of the Egg* on

Plate I. figs. 1–4, for Comatula.

Plate III. figs. 1, 26, Plate IV. figs. 1–7, for the Ophiuroidea (Amphiura and Ophiothrix).

Plate V. figs. 6–11, Plate VII. figs. 1–12, for the Asteroidea (Asterina and Asteracanthion).

Plate IX. figs. 1, 2, 17–20, Plate X. figs. 1–13, for the Echinoidea (Arbacia, Echinus, and Strongylocentrotus).

Plate XIV. figs. 1–3, Plate XV. figs. 1–3, for the Holothuroidea (Holothuria and Cucumaria).

For the *Formation of the Blastula and Gastrula*, see

Plate I. figs. 5, 11, 12, for Comatula.

Plate III. figs. 3–7, Plate IV. figs. 8–10, for the Ophiuroidea (Amphiura and Ophiothrix).

Plate V. figs. 12–25, Plate VII. figs. 12–20, for the Asteroidea (Asterina and Asteracanthion).

Plate IX. figs. 3–12, 19–27, Plate X. figs. 14–24, for the Echinoidea (Arbacia, Echinus, Spatangus, Echinocardium, and Strongylocentrotus).

Plate XIII. fig. 12, Plate XIV. figs. 3–5, Plate XV. figs. 3–6, for the Holothuroidea (Synapta, Holothuria, and Cucumaria).

For the *General Homologies of Echinoderm Larvæ*, see

Plate XV. figs. 14–27.

For the *Development of the different External Parts of the Pluteus or Larva*, see

Plate I. figs. 8, 9, 21, 27, 28, for Comatula.

Plate III. figs. 9–14, 29, 30, Plate IV. figs. 11–19, for the Ophiuroidea.

Plate V. figs. 1–3, 37–41, 44, 45, 47, 48, Plate VI. figs. 4, 12, 14, 16, 18, 24–31, 35–40, 44–46, Plate VII. figs. 19–34, for the Asteroidea (Asterina, Echinaster, and Asteracanthion).

Plate IX. figs. 13–16, 30–35, 38–41, Plate X. figs. 26–37, Plate XI. figs. 1–17, 19–24, 28–30, for the Echinoidea (Arbacia, Strongylocentrotus, Echinus, Echinocyamus ? and Echinarachnius ?).

Plate XIII. figs. 1–8, 13–16, 18–27, 33–35, Plate XIV. figs. 4, 8, 9, 15–20, Plate XV. figs. 8–11, for the Holothuroidea (Synapta, Holothuria, and Cucumaria).

For the *Development of the Water System of the Vasoperitoneal Sacs*, see

Plate I. figs. 12–20, 22–24, for Comatula.

Plate III. figs. 6–14, Plate IV. figs. 18–20, 27, 29, 31, for the Ophiuroidea (Amphiura and Ophiothrix).

Plate V. figs. 20–28, 32–34, 36, 38, 43, 46, 49, Plate VI. figs. 2, 3, 6–9, Plate VII. figs. 20–34, Plate VIII. figs. 4–9, 11, 13, 14, 17, 18, for the Asteroidea (Asterina and Asteracanthion).

Plate IX. figs. 5–13, 19, 21, 26, 27, Plate X. figs. 21–37, for the Echinoidea (Arbacia, Echinus, Spatangus, Echinocardium, and Strongylocentrotus).

Plate XIII. figs. 4–37, Plate XIV. figs. 5–12, 17, 18, 21–27, Plate XV. figs. 6, 7, 9, for the Holothuroidea (Synapta, Holothuria, and Cucumaria).

For the *Development of the Young Echinoderm*, see

Plate I. figs. 24, 25, 29–36, Plate II. figs. 1–23, for Comatula.

Plate III. figs. 14–20, 22–25, 29–33, Plate IV. figs. 20–34, for the Ophiuroidea (Amphiura and Ophiothrix).

Plate V. figs. 3, 4, 29–31, 35, 37–41, 45, 47–49, Plate VI. figs. 1, 4, 5, 9, 11, 13, 17, 19, 20–22, 29–32, 37–42, 47–51, Plate VIII. figs. 1–26, for the Asteroidea (Asterina, Echinaster, Pteraster, and Asteracanthion).

Plate IX. figs. 35–37, 42–45, Plate X. figs. 37, 40–43, Plate XI. figs. 8, 17, 18, 25–27, Plate XII. figs. 30–34, for the Echinoidea (Arbacia, Strongylocentrotus, Echinus, Echinocyamus ? and Hemiaster).

Plate XIII. figs. 6–11, 20–37, Plate XIV. figs. 17–27, Plate XV. figs. 8–11, for the Holothuroidea (Synapta, Holothuria, and Cucumaria).

For the *Young Stages of Echinoderms*, see

Plate I. figs. 31, 34, 35, 36, Plate II. figs. 1, 3–7, 18–20, for Comatula.

Plate III. figs. 14–20, 24, 25, 31, 32, Plate IV. figs. 24, 26, 32, 34, for the Ophiuroidea (Amphiura and Ophiothrix).

Plate V. fig. 4, Plate VI. figs. 4, 5, 9, 10, 13, 15, 17, 19, 20–22, 31, 32, 42, 47, 48, 50, 51, Plate VIII. figs. 8, 10–12, 15–18, 25–28, for the Asteroidea (Asterina, Echinaster, Asteracanthion, and Pteraster).

Plate IX. figs. 36, 37, 44, 45, Plate X. figs. 40–44, Plate XI. figs. 26, 27, Plate XII. figs. 1–40, for the Echinoidea (Arbacia, Strongylocentrotus, Echinus, Dorocidaris, Goniocidaris, Asthenosoma, Diadema, Mellita, Echinocyamus, Encope, Echinarachnius, Conolampas, Spatangus, and Hemiaster).

Plate XIII. figs. 9–11, 29–31, 35–37; Plate XIV. figs. 21–27, Plate XV. figs. 10, 11, for the Holothuroidea (Synapta, Holothuria, and Cucumaria).

EMBRYOLOGICAL MONOGRAPHS.

PLATE I.

Development of CRINOIDEA (*Comatula*). *Figures from* C. WYVILLE THOMSON *and* ALEXANDER GOETTE.

1 – 9. *Comatula rosacea.* From C. Wyville Thomson, On the Embryogeny of Antedon rosaceus Linck (Comatula rosacea of Lamark), 1863. Trans. R. S. London, CLV., 1865, Pls. XXIII.–XXVII.

10 – 26. *Comatula mediterranea.* From Alexander Goette, Vergleichende Entwickelungsgeschichte der Comatula mediterranea, 1876, Pls. XXXV., XXXVI. Archiv für Microskop. Anat., XII.

27 – 35. *Comatula rosacea.* From C. Wyville Thomson, On the Embryogeny of Antedon rosaceus, quoted above.

1 – 9. *Comatula rosacea.* From C. Wyville Thomson.

1. Egg shortly after impregnation.
2, 3, 4, 5. Different stages of segmentation.
6, 7. Development of the pseudembryo within the vitelline membrane.
8, 9. Dorsal and ventral aspects of the pseudembryo shortly before the disappearance of the ciliated bands.

10 – 26. *Comatula mediterranea.* From A. Goette.

a a. Gastrula axis.
a f. Anus.
b b. Longitudinal axis of the gastrula.
c. Gastrula mouth.
d. Intestine.
d'. Œsophagus.
f. Base of the stem of the Comatula larva.
f'. Plate of base of stem.
l p. Left peritoneal sac (oral body cavity).
l p'. Oral chamber.
m. Mouth.
m d. Mesoderm.
m t. Mesentery.
o b. Outer skin.
o b'. Yellow cells of the same.
o t. Oral funnel.
p. Perisome.
r. Circular canal.
r p. Right peritoneal sac (aboral body cavity.)
r p'. Continuation of the same into the stem.
s t. Stem of the young Comatula larva.
s t'. Skeleton of the stem.
t t. Contractile tentacle.
t t'. Non-contractile (rigid) tentacles.
v s. Visceral plate.
v s'. Its continuation between the intestine and the water-system.
w. Water-system.
w c. Stone canal.
w p. Cords of vibratile cilia.

10. Median section through a young larva (gastrula form).
11. Median section through a somewhat older larva.
12–15. Frontal sections of successively older larvæ, seen from the dorsal side.
16. Transverse section of a similar larva, anterior plane.
17, 18. Sagittal sections; the median section is indicated in outline.
19. Median sections of a somewhat older larva.
20. Frontal section, seen from the ventral side; the perisome begins to be intimately united with the outer skin and the parietal plate.

21. A larva at the time when the skeleton begins to form; the diagonally transverse dark stripe running across the digestive cavity indicates the position of the mesentery.
22, 23. Sagittal section of a young embryo with a stem.
24. Frontal section of a similar larva; the two layers of the rudimentary ring canal and tentacles begin to separate.
25. Median section of a much older embryo, with a comparatively longer stem. *z*, hood of the oral anterior chamber.
26. Transverse section of a larva perhaps slightly older, anterior plane.

27–35. *Comatula rosacea*. From C. Wyville Thomson.

27. Dorsal view of a pseudembryo about in the stage of fig. 9.
28. Lateral view of a pseudembryo somewhat older than the preceding figure; the ciliated bands are disappearing.
29. The pseudembryo is losing its special organs of assimilation and locomotion, and is passing into the Pentacrinoid stage.
30. The youngest Pentacrinoid stage.
31. Pentacrinoid larva immediately after the complete separation of the oral valves, expanded.
32. A portion of the oral disk of the same stage seen from above, in a state of complete expansion; *a*, patent oral aperture bounded by a ring of contractile tissue, and showing yellow, richly ciliated granular folds, arranged somewhat spirally on the walls of the digestive cavity; *b*, central ring of the radial vascular system; *c*, rigid non-extensile tentacles in immediate connection with the vascular ring, ten in number, and laid up in a state of complete expansion in pairs against the inner surface of the oral valves, *f*; *d*, the first pair of extensile radial tentacles; *e*, azygous radial extensile tentacle leading out of the growing arm to its bifurcation, and giving off pairs of tentacles of the same series from its base.
33. Pentacrinoid in the same stage as fig. 31, the cup closed.
34. Pentacrinoid larva immediately before the expansion of the ventral disk; *a*, centrodorsal plate; *b*, series of basal plates; *c*, first radial plates; *d*, second radial joint; *e*, third radial; *f*, first brachial joint; *g*, anal plate; *h*, stem joint; *k*, cribriform plate supporting the disk of attachment; *l*, granular visceral mass; *m*, cœcal process passing from the stomach towards the papilla which indicates the position subsequently occupied by the anal tube; *n*, oral valve and plate.
35. Another Pentacrinoid larva in a somewhat earlier stage than the preceding, expanded, and showing the arrangement of the non-extensile tentacles in connection with the oral vascular ring.

PLATE II.

Development of CRINOIDEA (*Comatula*), *continued. Figures from* WILLIAM B. CARPENTER, GEORGE J. ALLMAN, *and* HUBERT LUDWIG.

1–17. *Comatula rosacea*, continued. From William B. Carpenter, Researches on the Structure, Physiology, and Development of Antedon (Comatula Lamk.) rosaceus, Part 1., 1866. Trans. R. S. London, CLVI., 1866, Pls. XXXIX.–XLII.

a.	Anal plate.	*c d.*	Centrodorsal plate.
b b.	Basals.	*o o.*	Oral plates.
b r.	Brachials.	r^1, r^2, r^3.	First, second, and third radials.
c.	Cirri.	*v.*	Vent.
c′.	Central pore.		

1. Greatly enlarged view of a Pentacrinoid larva, in a stage nearly corresponding with that of fig. 7, the nearest ray having been removed so as to bring into view the oral apparatus: *c d*, centrodorsal plate bearing two cirri, one rudimentary, the other, *c*, in an advanced stage of development; r^1, r^2, r^3, first, second, and third radials; *o o*, orals, now completely separated from the radials by the intervention of a membranous perisome.
2. Calyx of the same specimen, seen from the other side, showing the centrodorsal plate bearing two cirri, one rudimentary, the other, *c*, still retaining its rudimentary form; the first, second, and third radials, r^1 r^1, r^2 r^2, r^3 r^3, and the anal plate, *a*, are now lifted out from between the first radials by the development of the prominent vent, *v*, to which it is attached.

3, 4, 5, 6, 7. Pentacrinoidal larvæ in different stages. Figs. 4–7 are the successive stages preceding the fully developed Pentacrinoid stage, fig. 3.

3. Shows the Pentacrinoid ready to assume its free condition, two rows of dorsal cirri being now completed, the arms being considerably elongated by the addition of new segments, and several pairs of pinnules being formed at their extremities.
4. Shows the basal, *b b*, the circlet of first radials, r^1 r^1, already complete, the rudimentary second and third radials supported by this and the circlet of orals, *o o*, alternating with these and resting on the first radials.
5. Shows the incipient development of the arms from the extremities of the third radials, the relative position of the other parts being but little changed, and the dorsal cirri not having yet made their appearance. See fig. 10 for a representation of the skeleton in this stage on a larger scale.
6. Showing the further development of the arms, the incipient opening out of the calyx occasioned by the increased development of the first radials, and the first appearance of the dorsal cirri.
7. Showing the first appearance of the pinnules at the extremities of the arms, the further opening out of the calyx, bringing the vent to view, and the formation of the first whorl of dorsal cirri.
8. Skeleton of an early Pentacrinoid larva, from a dried specimen, showing the mode in which the calyx can be (in that stage) completely closed in by the folding together of the orals, *o o*.
9. Skeleton of the Pentacrinoid larva of fig. 3, showing two rudimentary segments of the stem, the incipient development of the dorsal cirri, the basals, *b b*, the first, second, and third radials, and the anal, *a*, now being lifted up from between the first radials.
10. Skeleton of Pentacrinoid at the time of the first development of the arms, and before the first appearance of the dorsal cirri; *b b*, basals; r^1 r^1, first radials; *a*, anal; r^2 r^2, second radials; *o o*, orals; r^3 r^3, third radials.
11. Skeleton of the calyx of a Pentacrinoid nearly ripe for detachment, as seen from its internal or ventral aspect, the centrodorsal plate having been removed; *b b*, basals; r^1 r^1, first radials.
12. The same as seen from its external or dorsal aspect; *c*, central pore for the passage of the sarcodic axis through the centrodorsal plate; *b b*, basals; r^1 r^1, first radials; r^2, second radials; r^3, third or axillary radials; *b r*, brachials; *a*, anal.

13. Incipient rosette formed by the coalescence of the five altered basals in a young Antedon.
14. Skeleton of base of calyx of young Antedon, seen from its internal or ventral side ; showing the five basals (*b*) altered by endogenous growth in preparation for the formation of the rosette.
15. Skeleton of base of calyx of young Antedon seen from its dorsal aspect, the centrodorsal plate having been removed ; showing that the central space round *b*, on the under side, has been enlarged by the resorption of a part of the original basals, though it is still contracted, near the cavity of the calyx, by the secondary endogenous growth, with the same system of axial canals as are figured in the subsequent figure (fig. 16).
16. The same as fig. 15, seen from the ventral aspect ; showing the five basals grouped around *b*, and traversed by canals for the radiating cords of the sarcodic axis, of which a trunk enters each basal from the central space, and then subdivides into two branches, that pass into the two radials between which the salient angle of the basal projects ; thus each first radial receives cords from two basals, and these are lodged in two canals which coalesce into one towards its distal border, each of them having first become connected by a lateral branch with the like canal in its contiguous first radial ; <—*a*—> shows the position of the anal.
17. Calyx of young Antedon just detached, seen from its dorsal side, showing five cirri of the mature type and five of the rudimentary type, the radial and brachial plates, and the extension of the visceral disk as far as the third radial.

18–21. *Comatula rosacea*, continued. From George J. Allman, On a Prebrachial Stage in the Development of Comatula and its Importance in Relation to certain Aberrant Forms of Extinct Crinoids (1863), Pl. 13. Trans. R. S. Edinburgh, XXIII. Part II., 1864.

18. The animal with its roof-plates fully expanded and the cirri extended from between their edges.
19. The same in the act of expansion.
20. The same with the cirri entirely withdrawn, and the roof-plates closed.
21. Outline of the body looking down upon it from the vertex.

22, 23. *Antedon Larva.* From H. Ludwig, Ueber den primären Steinkanal der Crinoiden, nebst vergleichenden anatomischen Bemerkungen über die Echinodermen überhaupt, 1880, Pl. XII. Zeits. f. Wiss. Zool., XXXIV. Morphol. Studien an Echinodermen, II. Heft 1.

22. Optical longitudinal section of an Antedon larva. M, mouth ; D′, œsophagus ; D″, stomach ; L L′, body cavity ; H, position of the so-called heart ; W, water-system ring ; S T, stone canal ; T, tentacle ; K, reddish-brown body ; F, axial cord of the stem.
23. Diagrammatic sketch of an Antedon larva. D‴, intestine ; A, anus ; P, pore in calyx ; T, T′, T″, tentacles ; other letters as in fig. 22.

PLATE III.

Development of Ophiuroidea. *Figures from* Elias Metschnikoff, Hubert Ludwig, Alexander Agassiz, T. H. Stewart, Max Schultze, *and* August Krohn.

(1–20, 26–33, *Viviparous Ophiurans.*)

1–14. *Amphiura squamata.* From E. Metschnikoff, Studien über die Entwickelung der Echinodermen und Nemertinen. Mém. de l'Acad. Imp. des Scien. de St. Pétersbourg, VII^e^ Série, XIV. No. 8, Pls. III. B, IV., 1869.

b l.	Blastoderm.	*o.*	Mouth.
c.	Cutis.	*o c.*	Œsophagus.
c c.	Provisional limestone rods: probably the homologue of the Pluteus rods.	*p a.*	Dorsal pore of the water-system (madreporite).
		p l.	Remnant of rudimentary Pluteus.
c p l.	The bilateral embryonic skeleton.	*t.*	Tentacles.
c s.	Segmental cavity.	*v.*	Rudimentary water-system.
d^1.	Left lateral disk.	*v a.*	Water-system.
d^2.	Right lateral disk.	*v t.*	First trace of digestive cavity.
e p.	Epidermis.	*v v.*	Lobed water-system.
m e.	Thin outer membrane surrounding blastoderm.	*v p, v r.*	Circular canal.
m v.	Thick inner membrane of same.		

1. Egg, surrounded by its two membranes (*m e*, *m v*) with the blastoderm (*b l*).
2. The same in profile: the outer egg membrane is not figured.
3. Somewhat more advanced stage, showing, in addition to the blastoderm, the first indication of the digestive cavity (*v t*) and of the large cells of the cutis (*c*).
4. Elongated embryo still protected by the inner egg membrane (*m v*). The deposition of the provisional limestone rods has commenced (*c c*). On each side of the future œsophagus are placed the rudiments of the water-system (*v*).
5. Somewhat older embryo, with longer limestone rods (*c p l*), seen in profile.
6. Still older embryo, seen from the dorsal side, showing the greatly enlarged water-system (*v a*) and its two lateral disks (d^1, d^2).
7. Somewhat older embryo, also seen from the dorsal side, showing the five lobes of the water-system (*v a*).
8. Older stage, remarkable for the great development of the lateral disks (d^1, d^2), the change in the position of the digestive cavity and œsophagus, the great increase in the size of the lobes of the water-system (*v v*), and the formation of a dorsal pore (*p a*), the future madreporic body.
9. Somewhat older embryo, showing the horseshoe-shaped water-system, each primary fold of which (*v v*) has subdivided into four secondary lobes.
10. Embryo seen in profile. The œsophagus is already surrounded by the water-system; each fold of the water-system has subdivided into five smaller ones. The stone canal is most distinct.
11. An embryo about in the stage of fig. 10, seen from the dorsal side: the provisional limestone skeleton is already disappearing.
12. The water-system of the same embryo: *v v*, the blind sacs (tentacles) of the water-system; *v r*, the circular canal; *p a*, the madreporite.
13. The embryo in a stage immediately after passing from the bilateral to the pentagonal form, seen from the actinal side: the peculiar arrangement of the tentacles (*t*) and the formation of the mouth skeleton are specially to be noticed in this stage.
14. Somewhat more advanced than the preceding stage, seen from the dorsal side, showing the six reticulated plates of the abactinal surface, as well as the stem (*p l*), first described by Krohn and Schultze, forming a temporary connection with the ovary. This becomes atrophied in still older stages.

14′–19. *Amphiura squamata.* From Hubert Ludwig, Zur Entwickelungsgeschichte des Ophiurenskelettes, 1882 (Morphol. Studien, II., Heft 2). Zeits. f. Wiss. Zool., XXXVI., Pl. XI.

A_1, A_2. First and second ambulacral plates.
$A\,d_1$, $A\,d_2$, $A\,d_3$, etc. First, second, third, etc. adambulacral plates.
C. Dorsocentral plate.
m. Madreporic plate.
O. Oral plates (mouth shields).
R. Primary radials.
R a. Radials of the young ophiuran.
T. Terminal plates.
T o. Torus angularis.
t. Teeth.
V V′. Ventral plates.
x. Remnant of embryonic skeleton.

14′. Young Amphiura, seen from the dorsal side. The composition of the plates, of *y*-shaped rods, is still plainly visible.

15. Somewhat older stage, seen from the actinal side. *V*, oldest ventral plate; *V′*, very young ventral plate; *t*, rudimentary teeth.

16. Somewhat older than fig. 14′, but younger than fig. 15, seen from the dorsal side.

17. Somewhat older than the stage corresponding to fig. 19, seen from the dorsal side, showing the arrangement of the intermediate plates formed between the central and the primary radials.

18. Somewhat older than the stage of fig. 17, seen from the dorsal side; the intermediate plates have greatly increased in size and number.

18′. Shows the arrangement of the plates of the actinal side in a stage slightly older than fig. 17.

19. Stage corresponding to fig. 15, seen from the dorsal side; intermediate plates begin to appear between the central plates and the primary radials.

20–23. *Ophiopholis* (?) and *Amphiura* (?). From Alexander Agassiz, On the Embryology of Echinoderms. Mem. Am. Acad., IX., figs. 29, 31–33, 1864.

20. *Ophiopholis bellis?* From a drawing made under the direction of L. Agassiz in 1849. Abactinal view of a young Ophiopholis to show the arrangement of the plates of the disk.

21–23. *Amphiura?*

21. A full-grown Pluteus, in which the water-tubes, *w*, *w′*, are plainly seen. *d*, digestive cavity; *m*, mouth; *a*, anus; *t*, rudimentary tentacular lobes of the water-system; *v′*, anal, and *v*, oral vibratile cord; c'–c^4, arms of the Pluteus.

22. Older stage, seen from the abactinal side, in which the arms of the Pluteus (c''–c^4) are almost entirely resorbed; the two long arms c' are still intact, they are omitted for want of space. *r*, abactinal region; *y*, rudimentary terminal plate; *y′*, adambulacral plate; r^4, junction of limestone rods of the long arms c'.

23. The same, seen from the actinal side; lettering as above: *s*, actinal region; *t*, *t′*, tentacular loops.

24, 25. *Ophiocoma rosula.* From T. H. Stewart, On the Young State of Ophiocoma rosula, and on the Form and Development of the Spines of this Species. Ann. & Mag. Nat. Hist., XVIII., 1856, Pl. XV.

24. Young Ophiocoma seen from the abactinal side.

25. Actinal view of central portion of the disk.

26–31. *Amphiura squamata.* From Max Schultze, Ueber die Entwickelung von Ophiolepis squamata, einer lebendiggebährenden Ophiure. Archiv. f. Anat. Phys. u. Wiss. Med., 1852, Pl. I.

26. Ovarian eggs of *Amphiura squamata.*

27. Young embryo with rudimentary provisional limestone rods.

28. Somewhat older than fig. 27, the embryonic limestone rods are arranged symmetrically.

29. Older embryo. In addition to the provisional limestone rods, *a*, we have also the radials, *b*, developed; and the first trace of the terminal plates, *c*.

30. The embryo has assumed a pentagonal outline; of the provisional limestone rods we find only the remnants at *a*; lettering as before; the plates of the abactinal side are seen through from the ventral side under the rudimentary actinal plates.

31. Portion of a young Amphiura measuring $\frac{1}{4}$‴ in diameter, seen from the actinal side: *a*, interbrachial dorsal plates; *b c*, actinal plates adjoining actinostome; *d d*, interbrachial plates of the actinal side; *e e*, spoon-shaped brachial plates; *f*, terminal plates; *g*, *g*, tentacles; *h*, teeth.

32, 33. *Viviparous Ophiuran.* From August Krohn, Ueber einen neuen Entwickelungsmodus der Ophiuren. Archiv. f. Anat. Phys. u. Wiss. Med., 1857, Pl. XIV. B.

32. Actinal view of ophiuran embryo; *a*, pentagonal disk of young ophiuran; *b*, central cavity, the future mouth; *c*, tentacles; *d*, tentacles of actinostome; *e*, remnant of rudimentary Pluteus.

33. Young ophiuran of same embryo; *a*, dorsal plates; *b*, arm plates; *c*, terminal plate; *d*, spines of the actinal side projecting beyond the disk.

PLATE IV.

Development of Ophiuroidea, *continued. Figures from* Nicolas Christo Apostolidès *and* Johannes Müller.

1–13. *Ophiothrix versicolor.* From N. C. Apostolidès, Anatomie et Développement des Ophiures. Archives de Zool. Exp et Gén., X., Pl. XI., 1881.

1. Egg. *m*, outer envelope : *y*, yolk ; *v*, germinative vesicle ; *n*, nucleus.
2, 3, 4, 5. Different stages of segmentation.
6. Blastosphere.
7. Blastosphere. *e*, ectoderm cells.
8. Older than fig. 7. *e*, ectoderm; *y*, yolk cells.
9. Older stage ; lettering as before. First appearance of the limestone rods of the Pluteus.
10. Still older stage ; *r*, the limestone rods of the Pluteus have increased in size.
11. Slightly older ; the digestive cavity, *d*, is outlined.
12. The embryo assumes somewhat the Pluteus outline.
13. Young Pluteus seen from the dorsal side. *p*, general cavity ; *f*, limestone rods ; *a*, anal region of the digestive cavity.

14–26. *Ophiothrix fragilis.* From J. Müller, Ueber die Ophiurenlarven des Adriatischen Meeres, Berlin (Pt. 5), (1851,) Pls. VI., VII., VIII. Abhand. d. K. Akad. d. Wiss., Berlin, 1852.

14–17. Younger stages of the Plutens. *m*, mouth ; *d*, digestive cavity.
18. Pluteus at a stage in which all the arms are developed, although the two long arms have by no means reached their full length (see fig. 19). *m*, mouth ; *o*, œsophagus; *d*, digestive cavity ; *i*, intestine ; *w*, *w'*, lateral disks of water-tubes ; *t*. lobed water-system.
19. Pluteus of same, in which the two long arms have reached their full length ; lettering as in fig. 18.
20. The long arms of the Plutens alone remain (extremities omitted) ; the others have been mostly resorbed : the young ophiuran has assumed a pentagonal outline ; the plates of the abactinal system, the terminal arm plates, and the interbrachial plates, are represented by *y*-shaped rods. *t'*, terminal lobes (tentacles) ; t^1, actinal lobes ; t^2, second pair of lobes.
21. Pentagonal Ophiothrix, seen from the dorsal side : the teeth are seen through the disk.
22. The same as fig. 21, seen from the actinal side, the arms folded towards the actinal opening, showing also the hooks, the teeth, and the true mouth in the depth of the central star-shaped mouth.
23. Slightly older, seen in profile : the long arms of figs. 20–23 are still of full length.
24. A young Ophiothrix after the loss of the two long arms, seen from the dorsal side.
25. Somewhat older than stage of fig. 23, seen from the actinal side. *t'*, t^1, t^2, t^3, terminal, actinal, and second and third pairs of tentacles.
26. Young Ophiothrix, seen from the abactinal side, with two arm-joints. All traces of the Pluteus have disappeared.

27–34. *Pluteus bimaculatus.* From J. Müller, Ueber die Ophiurenlarven des Adriatischen Meeres, Pls. IV., V., quoted above.

27. Shows the young ophiuran at the time when the arms of the Pluteus begin to be resorbed and the tentacular lobes are arranged in a horseshoe shape round the actinostome ; lettering as in fig. 25.
28. Somewhat older stage, seen from the actinal side ; the young ophiuran has assumed a pentagonal outline; the terminal arm plates and the interbrachial plates are well developed ; the actinal tentacles are bent in towards the centre of the actinostome.
29. Still older stage, also seen from the actinal side, with three pairs of tentacles.
30. Somewhat older stage, seen from the abactinal side ; the plates of the disk, the centrodorsal, radials, and intermediates, are well developed.

31. Older ophiuran seen from the actinal side; t', t^1, t^2, t^3, terminal, and first, second, and third pairs of tentacles.

32. Free ophiuran without Plutean appendages, fished up from the surface. $\frac{6}{10}'''$ in diameter. Seen from the dorsal side.

The stages 27–31 all have the two long arms intact; the other shorter arms are in different stages of resorption; see figs. 27, 28, 30. The long arms are not figured for want of space.

33. A single arm of fig. 32, from the abactinal side.

34. The central part of the disk with a portion of the arm of the same from the actinal side, showing the teeth and the mouth papillæ. Neither Müller nor Metschnikoff was able to determine the ophiuran which is developed from *Pluteus bimaculatus*. Müller considered it at first to be *Ophiolepis squamata*.

PLATE V.

Development of Asteroidea. *Figures from* Wilhelm Busch *and* Hubert Ludwig.

1 – 4. *Echinaster sepositus.* From W. Busch, Beobachtungen über Anatomie und Entwickelung einiger Wirbellosen Seethiere. Berlin, 1851, Pl. XII.

1. Young pelagic embryo : *a*, body ; *b b*, so-called brachiolarian appendages.
2. The same embryo somewhat more advanced : *a*, the body where the future Starfish is developed ; *b b*, so-called brachiolarian appendages ; *c*, commencement of a third pair.
3. The young starfish has assumed a pentagonal outline ; the tentacles (*b*) of the disk are clearly indicated, and the brachiolarian appendages have taken their maximum development on each side of the axis *a*.
4. The most advanced stage of the young Echinaster observed by Krohn. The brachiolarian appendages are reduced by resorption to mere rudiments, *a* ; *b*, older pair of tentacles ; *d*, odd terminal tentacles ; *e*, youngest pairs of tentacles ; *f*, actinal ambulacral furrow.

5 – 49. *Asterina gibbosa.* From H. Ludwig, Morphologische Studien an Echinodermen, II., 2 Heft, 1882. Zeits. f. Wiss. Zool., XXXVII., Pls. I. – VI.

A_1. First ambulacral plate.
A_2. Second ambulacral plate.
Bl. Blood system.
C. Dorsocentral plate.
D. Digestive cavity.
E C. Enterocœlum.
Ect. Ectoderm.
E h. Egg membrane.
Ent. Entoderm.
G m. Gastrula mouth.
H C. Hydrocœlum.
JR_1, JR_2, JR_3, JR_4, JR_5. First to fifth interradial.
l El. Left enterocœlum pouch.
L m. Larval mouth.
L s. Larval œsophagus.
M. Mesentery.
M s. Mesoderm.
P. Dorsal pore.
r El. Right enterocœlum pouch.
T_1, T_2, T_3, T_4, T_5. First to fifth terminal plates.
1, 2, 3, 4, 5, denote the Hydrocœlum lobes and ambulacral arm lobes.
I, II, III, IV, V, denote the antiambulacral arm lobes; *O* denotes the upper side of the embryo or larva ; *U*, the lower ; *H*, the posterior, and *V*, the anterior extremity ; *L*, left ; *R*, right; *V L*, in front to the left ; *H U*, behind and below.

5 – 10. Stages of segmentation of the first day.
5. Three spheres of segmentation are shown. I, I, are formed from the division of the upper of the two spheres ; II, the lower sphere ; this is originally somewhat larger than the upper sphere.
6. The lower sphere, II, is now also divided into two, II_1 . . . .
7. The same as fig. 6, so turned as to show the two spheres I_1 . . . .
8. The stage with four spheres somewhat older than the preceding figures.
9. A stage with eight spheres ; I_2 and II_2, the two spheres resulting from the division of the spheres I and II of the stage of fig. 8.
10. Stage with sixteen spheres, which have resulted from the subdivision of the cells I_2 into I_3, and of the cells II_2 into II_3.
11. Section through a blastula composed of 32 spheres.
12. Longitudinal section of a gastrula on the second day. *G m*, the gastrula mouth.
13. The same stage, looking into the gastrula mouth.
14. Longitudinal section of an older gastrula, with a decidedly narrower opening, *G m*.
15, 16, 17. Posterior, anterior, and right view of an embryo just escaped from the egg, fourth day.
18. Longitudinal section of a gastrula somewhat older than fig. 14 ; the gastrula mouth is approaching the lower pole : *a*, the point at which the diverticula of the gastrula digestive cavity begin to be formed.

19. Gastrula three days old. The diverticulum of the gastrula cavity begins to be formed on the left and right sides. *a* shows the left diverticulum.
20. Longitudinal section of a gastrula soon after its escape from the egg ; the left and right enterocœlum pouches are indicated.
21. The same stage as fig. 20, seen from the left side : *L m*, the invagination of the ectoderm which eventually forms the larval mouth.
22. The same stage as fig. 20, seen from the right side.
23. Embryo at the beginning of the fifth day, seen from the left. *a*, point of separation of the gastrula cavity and the enterocœlum ; *b* indicates the position of the gastrula mouth, *Gm*, which has now disappeared.
24. Transverse section of an embryo in the stage of fig. 23.
25. Longitudinal section of an embryo at the end of the fourth day ; in which the gastrula cavity *a* is still in communication with the enterocœlum.
26. Longitudinal section of an embryo at the end of the fifth day; the communication between the gastrula cavity and the enterocœlum has become completely shut off at *a*.
27. Larva of the seventh day, seen from the left side ; the intestine, of which the position is merely indicated, has been removed, to show the mesentery, *M*, placed behind it. The arrow indicates the communication between the enterocœlum of the larval organ and the enterocœlum surrounding the intestine.
28. Larva in the same stage as fig. 27, from the anterior side : the position of the intestine is only indicated.
29, 30, 31. Different views of a larva on the sixth day.
29. Seen from the left side : *a*, the larval organ (the brachiolarian appendages) ; *b*, its anterior, *c*, its posterior lobe ; *d*, the button-like projection on the creeping surface of the larval organ.
30. The same as fig. 29, seen from the anterior and left side.
31. The same, seen facing the creeping surface of the larval organ.
32. Larva of the sixth day, seen from the left. The hydrocœlum has become five-lobed, 1, 2, 3, 4, 5, its five lobes ; the position of the mesentery on the other side of the digestive cavity is indicated as if seen through it. The arrows indicate the communication between the larval enterocœlum, the hydrocœlum, and the enterocœlum surrounding the digestive cavity.
33. Larva of the seventh day. The hydrocœlum is apparently shut off at *a* from the larval organ ; communication between it and the larval organ, however, is still clearly to be made out, and is indicated by the arrow ; *b*, formation of an ambulacral lobe (1) in the mesoderm below the hydrocœlum ; *c*, a band of connective tissue, not always found in this position.
34. Larva of the seventh day, from the posterior side. *L s*, the larval œsophagus ; *S s*, pouch of the digestive cavity extending towards the hydrocœlum, which later trends towards the œsophagus of the young Starfish. The madreporic canal is abnormally early developed.
35. Exterior view of the same larva, showing on an upper plane the dorsocentral plate, *C*, with interradials JR_1, JR_2, JR_3, JR_4, JR_5, and one of the terminal plates, T_3 ; on the next somewhat lower plane are the terminal plates T_1, T_3, T_4, and on a still lower plane, T_2.
36. Longitudinal section through the same larva, seen from the anterior side ; *a* shows the broad open communication between the enterocœlum of the larval organ and the hydrocœlum, as well as the communication between the dorsal pore and the enterocœlum of the larval organ.
37. View of a whole embryo, seen from the right and lower side.
38. View of a larva partly cut open, seen from the right side. *Bl''*, central blood system. *a*, mesoderm plate covered by the entoderm of the enterocœlum ; this has taken the place of the larval œsophagus, which has now disappeared.
39. A larva of the eighth day, seen from the left side.
40. A similar larva, creeping. *a* and *b* in both these figures denote the anterior and posterior larval lobes.
41. The surface of the larval organ of an embryo somewhat more advanced than figs. 39, 40.
42. Larva in about the same stage as fig. 41, seen from the right side.
43. Larva on the eighth day, seen from the right side, showing the position of the blood cavity, *Bl*, in the mesentery adjoining the fifth interradial, JR_5, in the position where the madreporic plate will eventually be formed.
44. Larva at the beginning of the ninth day, seen from the left.
45. Larva at the end of the eighth day, seen from the anterior side.
46. Larva of the ninth day, cut open close to the surface on the left, to show the shape of the hydrocœlum lobes, their unequal development, and the formation of the first and second ambulacral plates.
47. Larva of the tenth day, seen from the anterior side.
48. The same, from the anterior and left side.
49. Larva of the tenth day. This larva still retains a large larval organ : seen from the left, the section is so made as to show the relation of the five lobes of the ambulacral and antiambulacral areas.

PLATE VI.

Development of Asteroidea, *continued. Figures from* Hubert Ludwig, Louis Agassiz, Michael Sars, C. Wyville Thomson, Johannes Müller, *and* J. Koren *and* D. C. Danielssen.

1–11. *Asterina gibbosa*, continued. From H. Ludwig, Morphologische Studien an Echinodermen II., 2 Heft, 1882. Zeits. f. Wiss. Zool., XXXVII., Pls. VII., VIII.

A_1. First ambulacral plate.
A_2. Second ambulacral plate.
$A\,d_1$. First adambulacral plate.
$A\,d_2$. Second adambulacral plate.
$A\,f$. Anal opening.
$B\,l$. Blood system.
C. Centrodorsal plate.
D. Digestive cavity.
Ec. Enterocœlum.
F. Terminal tentacle.
F_1. First pair of tentacles.
F_2. Second pair of tentacles.
$H\,c$. Hydrocœlum.
$J\,a$. Interambulacral plates.
$J\,m$. Intermediate plates.
$J\,R_1$, $J\,R_2$, $J\,R_3$, $J\,R_4$, $J\,R_5$. First to fifth interradial plates.
$\downarrow l$. Interradial space of the larval organ.
$\downarrow m$. Interradial space of the madreporic plate.
M. Mesentery.
Ms. Mesoderm.
P. Dorsal pore.
$S\,s$. Œsophagus of Starfish.
$S\,t$. Stone canal.
T_1, T_2, T_3, T_4, T_5. First to fifth terminal plates.
1, 2, 3, 4, 5, denote the hydrocœlum and ambulacral lobes.
I, *II*, *III*, *IV*, *V*, denote the antiambulacral arm-lobes. *O* denotes the upper extremity ; *U*, the lower ; *V*, the anterior ; *H*, the posterior ; *L*, left ; *R*, right.

1. Larva at the end of the ninth day, seen from the dorsal side of a young Starfish. The abactinal region is represented as transparent, to show the five lobes of the digestive cavity, the centrodorsal plate C, the five interradials $J\,R_1 - J\,R_5$, and the five terminal plates $T_1 - T_5$. The remnant of the larval organ (the brachiolarian arms) is represented by a.
2. Larva of the tenth day, seen from the anterior extremity ; the optical section passes through the lobes 1 and 3 of the hydrocœlum ; $a\,b$, remnants of the larval organ.
3. Transverse section of a larva in the stage of fig. 2. The ambulacral arm lobes 2 and 3 have been cut longitudinally.
4. A young Starfish at the end of the tenth day, after the reduction of the larval organ a ; the mouth of the Starfish is not yet formed.
5. Young Starfish of the tenth day, seen from the abactinal side ; a, larval organ ; $\downarrow l$, interradial space of the larval organ ; $\downarrow m$, interradial space of the madreporic body.
6. Section across a young Starfish of the eleventh day, close to the actinal side. The water-ring is not yet closed ; at a are the two diverticula of the water system, which unite in a subsequent stage ; the section passes through the three-lobed digestive cavity, $S\,s$; this does not yet open externally.
7. Exterior view of the soft parts of an arm of a young Starfish, in the thirteenth day. N, rudimentary nervous ring ; B, swelling at the base of the terminal tentacle, where later an eye develops.
8. The same as fig. 7, to show the course of the ambulacral canal, the tentacles, and their position with respect to the terminal, the ambulacral, and the interradial plates.
9. Starfish of the sixteenth day, seen from the actinal side, to show the general arrangement of the hard parts.
10. A young Starfish of the sixteenth day, seen from the abactinal side, about in the same stage as fig. 9. Showing the arrangement of the plates of the abactinal side, the anal opening $A\,f$, the odd terminal tentacle F, extending beyond the edge of the disk ; S, the young spines.
11. Taken from a young Starfish forty-two days old. The abactinal surface is removed, showing the five blind pouches of the alimentary canal, which begin to fork at the extremity to form the five pair of digestive cœca of the old Starfish ; M, rest of the larval mesentery ; Sp, the five interbrachial septa ; Bs, the interradial cœcum of the end of the alimentary canal.

12–19. *Asteracanthion flaccida.* From drawings made under the supervision of L. Agassiz, in 1848.

d. Abactinal side of the young Starfish.
p. Larval organ (brachiolarian appendages).
t. Terminal tentacles.
t', t'', t^3, t^4. First, second, third, and fourth pair of tentacles, counting from the terminal tentacle.

12. Profile view of larva, with only the terminal tentacles developed.
13. The same as fig. 12, seen from the actinal side of the young Starfish.
14. Somewhat older stage than fig. 12; besides the terminal tentacles, *t*, an additional pair of tentacles, t', has been developed.
15. The same as fig. 14, seen from the actinal side.
16. Still older stage, with a second pair of tentacles, t', developed in addition to the *t* and t''.
17. The same as figure 16, seen from the actinal side.
18. Still older stage; the larval organ, *p*, is nearly resorbed, and there are now in each arm four pairs of tentacles, t'–t^4, in addition to the terminal tentacle, *t*. In figs. 14–19, t' always denotes the last-formed tentacle, t'' the last but one; the outline of the young Starfish becomes more and more pentagonal as it passes through the stages of figs. 13 to 15, and 17.
19. The young Starfish has five well-formed arms, four pairs of tentacles, t'–t^4, a distinct and closed circular water-ring. The actinostome of the Starfish is not yet formed, and the larval organ has not been completely resorbed.

20–23. *Pteraster militaris.* From M. Sars, Oversigt af Norges Echinodermer, 1861, Pl. VI.

a. The five perianal plates.
b. Terminal arm-plates.
c. Second arm-plates.
d. Remnant of the larval organ.
e. Circular water-ring.
g. Terminal tentacle.
t', t'', t'''. Third, second, and first pair of ambulacral tentacles.

20. Young Starfish, seen from the dorsal side; *a*, the five perianal plates; *b*, the ten arm-plates.
21. One of the arms, seen from the actinal side; *b*, oldest arm-plates; *c*, younger arm-plates; *d*, remnant of larval organ; *e*, circular water-canal; *f*, ambulacral canal; *g*, terminal tentacle; t', t'', t''', third, second, and first pairs of ambulacral tentacles. The tentacles are contracted.
22. One of the arms, of a stage somewhat older than fig. 21, seen from the actinal side, with the tentacles extended.
23. Fig. 21, seen in profile.

24–32. *Asteracanthion violaceus.* From C. Wyville Thomson, On the Embryology of Asteracanthion violaceus, L. Quart. Journ. Microsc. Scien., I., 1861, Pl. VII.

24. Embryo about four hours after complete segmentation.
25. Embryo four hours later; first formation of the larval organ, the so-called peduncle, or brachiolarian arms.
26. Embryo about nine hours later, with three brachiolarian appendages.
27. Embryo about twenty-four hours old.
28. Peduncle and appendages, which have become separated by a natural process of fission from an embryo about a week old.
29. The embryo has become distinctly pentagonal; the brachiolarian appendages are fully developed. Thirty-six hours after segmentation.
30. Embryo in which the pentagonal outline of the young Starfish is well defined, with five tentacles; the brachiolarian appendages are beginning to be resorbed, and are no longer very efficient in assisting locomotion, as in the earlier stages. About eight days after segmentation.
31. Embryo five weeks after segmentation; shows the remains of brachiolar appendages, much atrophied; the actinostome of the young Starfish is indicated, and there are three pairs of tentacles in addition to the odd terminal one.
31′. Abactinal view of a young Starfish, about twelve days old, showing the arrangement of the limestone plates of that side.
32. View of the actinal surface to show the arrangement of the ambulacral plates.

33–42. *Echinaster sanguinolentus.* From M. Sars, Ueber die Entwickelung der Seesterne. Fragment aus meinen Beiträge zur Fauna von Norvegen. Archiv für Naturg., 1844, I., Pl. VI.

a. Brachiolar appendages.
b. Tubercular brachiolar appendage.
c. Ambulacral tentacles.

33. Egg just laid, greatly magnified. Chorion colorless; yolk, brilliant orange-red.
34. Egg three days old, in which the blastosphere has been formed.
35. Embryo just after being hatched.

36. Embryo in which the larval organs, *a a*, are forming.
37. Somewhat older embryo.
38. The young Starfish is well advanced: *c*, ambulacral tentacles; the brachiolarian appendages, *a a*, are fully developed, and a small tubercle, *b*, has formed on the upper surface of the larval organ. Seen from the actinal side.
39. The same as fig. 38, seen from the abactinal side.
40. Somewhat older stage, seen from the actinal side: the young Starfish has now assumed a well-defined pentagonal outline.
41. The same embryo as fig. 40, seen from the abactinal side.
42. The same embryo, about two months old, seen from the abactinal side after the resorption of the larval organs.

43–46. *Echinaster Sarsii*. From J. Müller, Ueber den Allgemeinen Plan in der Entwickelung der Echinodermen (Pt. 6), 1852, Pl. 1. Abhandl. der K. Akad. der Wiss. Berlin, 1853.

a. Larval organ, odd brachiolarian arm.
b. Larval organ, paired brachiolarian arms.
c. Tubercle between the brachiolarian arms.
d. Cortical layer.
e. Inner layer.
f. Interior cavity.
f'. Cavity leading to the brachiolar appendages.
g. Digestive cavity.
h. Interior of the digestive cavity.
i. Tentacles of the Starfish.

43. Longitudinal section through an embryo.
44. Transversely longitudinal section across the brachiolarian arms.
45. Longitudinal sections of an older embryo in which the body cavity is divided into two, one of which contains the digestive cavity, and the other communicates with the larval organs.
46. A similar section through an embryo somewhat older than fig. 45.

47, 48. *Wurmförmige Asterie*. From J. Müller, Ueber den Allgemeinen Plan in der Entwickelung der Echinodermen (Pt. 6), 1852, Pl. I. Quoted above.

a. Lateral ambulacral tentacles. *b*. Odd terminal tentacle. *c*. Spines of the actinal surface.

47. *Wurmförmige Asterie*, seen from the abactinal side.
48. The same, seen from the actinal side.

49–51. *Pteraster militaris*. From J. Koren and D. C. Danielssen, Observations sur le Développement des Astéries, in Fauna littoralis Norvegiæ, Seconde Livraison, 1856, Pl. VIII.

a. Anal opening.
b. Intestinal canal.
c. Extremity of the intestinal canal.
d. Circular water canal.
e. Madreporic canal.

49. Young embryo.
50. Young embryo which has assumed a pentagonal outline.
51. A young Starfish seen from the actinal side; *b*, ambulacral plates; *c*, tentacles.

Figs. 49, 50 are much younger than the stages figured by Sars; see this Plate, figs. 20–23. Fig. 51 is about in the stage of fig. 22.

PLATE VII.

Development of Asteroidea, *continued. Figures from* Alexander Agassiz.

a. Anus.
b. Dorsal or water pore, madreporic opening.
c. Alimentary canal.
d. Digestive cavity.
c'. Median anal arms of Brachiolaria.
c''. Dorsal anal arms of Brachiolaria.
c'''. Ventral anal arms of Brachiolaria.
c''''. Dorsal oral arms of Brachiolaria.
c^5. Ventral oral arms of Brachiolaria.
c^6. Odd terminal oral arm of Brachiolaria.
f. Brachiolar arms.
f'. Branch of water-tube (w w') leading into *f*.
f''. Odd brachiolar arm.
f'''. Surface warts at the base of the odd brachiolar arm (f'').
m. Mouth.
m'. Pistol-shaped oral pouch of œsophagus.
m''. Anal pouch of œsophagus.
o. Œsophagus.
v. Vibratile cord, anal part.
v'. Vibratile cord, oral part.
w. Water-tube, developing the abactinal area.
w'. Water-tube of Brachiolaria leading to madreporic opening (*b*), and developing the actinal area.
$w\,w'$. Portion of the water-tube of Brachiolaria formed by the junction of w and w'.

1–28. *Asteracanthion berylinus*. From Alexander Agassiz, Embryology of the Starfish, 1864 (Advance Part of Agass. Cont. Nat. Hist. U. S., V.), Pls. I., II. Memoirs Mus. Comp. Zoöl., V., No. 1, North American Starfishes, 1877, Pls. I., II.

Figs. 13–18. Scyphistoma stages.
Figs. 19–25. Tornaria stages.
Figs. 26–30. Brachina stages.
Figs. 31–34. Brachiolaria stages.

1. A mature egg, surrounded by spermatic particles, soon after artificial fecundation. The egg has assumed a spherical shape, and contains the germinative vesicle and dot. There is no trace of any interval between the yolk and outer envelope.
2. The germinative vesicle has disappeared, but the nucleolus remains.
3. The germinative dot is no longer visible; the yolk has contracted, and is separated by a slight space from the outer envelope. The egg at this early stage has all the appearance of having already gone through its segmentation, the whole yolk being made up of small spherical cells resembling very minute spheres of segmentation, although the segmentation has not yet commenced. Two hours after fecundation.
4. Shows the first trace of segmentation, consisting in a slight depression on one side of the yolk.
5. The yolk has become flattened on opposite poles; the "Richtungsbläschen" are visible on one side of the yolk.
6. Shows the yolk divided into united ellipsoids: the whole yolk rotates slowly, always in one direction, from right to left. The "Richtungsbläschen" are at one pole of the axis of segmentation.
7. The two segments of the yolk have entirely separated. The "Richtungsbläschen" are likewise isolated at one pole of the axis of segmentation.
8. The yolk segments are about to separate into four.
9. The yolk, about to divide into eight spheres.
10. The yolk is divided into sixteen spheres.
11. The spheres of the yolk have undergone two additional subdivisions since the preceding stage.
12. The segmentation has been carried on still further; the spheres of segmentation have become somewhat polygonal, and form an embryo with a spherical shell consisting of comparatively large cells.
13. An embryo after its escape from the egg; the wall is no longer of the same thickness throughout, but has become very much thickened at one pole (*a*), and the spheres of segmentation have become somewhat indistinct.
14. The thickened wall of the flattened pole (*a*) has formed a slight invagination.
15. The invagination (*a*) has increased in depth, the spheres of segmentation have entirely disappeared, the invagination (*a*) assumes somewhat the aspect of a rudimentary digestive cavity. Twelve hours after fecundation.

16. Twenty-two hours after fecundation; the embryo has become greatly lengthened, and is cylindrical. The cavity (*d*) has slightly expanded at the closed extremity, and the walls of the embryo are somewhat reduced in thickness except at the perforated region; the body is somewhat translucent, slightly tinged with ochre-color. The opening (*a*) still serves as a mouth, although in more advanced stages a second opening is formed which becomes the true mouth of the embryo, at which time the present mouth then becomes the anus.
17. Slightly older embryo than fig. 16, seen from the side; the digestive cavity (*d*) is no longer in the axis, but is bent to one side (the lower side).
18. Older embryo, seen in profile; the pouch formed at the end of the closed extremity of the bent digestive cavity (*d*) is nearer the lower side than in fig. 17, and is moving towards the slight depression (*m*, the future mouth) placed in the middle of the larva.
19. A larva somewhat more advanced, seen in profile, in which the terminal pouch of the digestive cavity has actually come into contact with the wall of the lower side at *m*. The dorsal region of the perforated extremity projects slightly beyond the depression in which *m* is placed. The digestive cavity is not yet divided into distinct regions.
20. A larva somewhat more advanced (end of the second day), seen in profile. The digestive cavity is no longer a simple bent tube, as in fig. 18; it is strongly contracted near the extremities; at the distal extremity two diverticula have formed, projecting upwards (*w*); a second opening (*m*) has been formed at the point of contact of the former closed extremity of the digestive cavity with the lower side; this connects the œsophagus, by a short tube, with the main pouch of the digestive cavity. This second formed opening (*m*) is the true larval mouth, while the first formed opening (*a*) now becomes the anus, after having, up to this stage, performed the functions of both mouth and anus.
21. Isolated digestive cavity seen from below, showing the position of the mouth and anus on the same side of the larva. The anal extremity of the larva bending over as in fig. 24 at about this stage, thus bringing the anal opening from the extremity of the larva to the lower side. The two diverticula (*w w'*) of the digestive cavity (the future water-tubes) are so far differentiated as to be quite distinct from the digestive cavity. The walls of these diverticula are excessively attenuated, and are scarcely connected with the digestive cavity.
22. Larva somewhat older than stage of fig. 21, seen from above, in which the two small bodies, *w*, *w'*, the diverticula of younger stages formed from the pouch of the digestive cavity at its closed extremity (the problematic bodies of Müller), have entirely separated from the digestive cavity from which they were formed; the three divisions of the original cavity into intestine, stomach, and œsophagus are plainly marked out.
23. Older larva, seen from below at the end of the third day after fecundation, showing the triangular shape of the mouth (*m*), the greater size of the problematic bodies *w*, *w'* (the water-tubes), which increase independently and at an unequal rate; the tube *w'* communicates with the madreporic opening (*b*); it also shows the position of the rudimentary oral and anal vibratile crescent cords.
24. The same as fig. 23, seen in profile, to show the position of the mouth in a strongly marked depression, the great increase in size of the oral part of the œsophagus, the swelling of the stomach, and the bending of the extremity of the intestine back and downward toward the mouth, so as to make a small angle with the trend of the stomach.
25. Slightly older larva, seen from above. The principal difference between this stage and the preceding one consists in the greater increase in size of the vibratile crescents, which now form two small plastrons, and the greater size of the water-tubes. The intestine also bends so as to make, when seen in profile, almost a right angle with the stomach, which is pushed out farther toward the anal extremity.
26. More advanced larva, seen from the left profile, in which the oral pouch has assumed its characteristic pistol-shape. The stomach and intestine make a sharp angle with each other, the latter being much longer than the stomach proper. In its present aspect it closely resembles a retort, the stomach being the receiver, the intestine the tube. The anal and oral vibratile crescents are greatly extended towards the extremity of the body, the one on the oral, the other on the dorsal side.
27. A larva six days after fecundation, seen from the right profile; the water-tubes extend beyond the opening of the mouth, the tube leading from the dorsal water-pore (madreporic body) to the water-tube (*w'*) is quite distinctly seen.
28. The same larva as fig. 27, seen from below, showing the intestine thrown to one side of the axis of the larva, the water-tubes extending along the sides of the stomach toward the anal extremity.

29–34. *Asteracanthion pallidus*. From Alexander Agassiz, Embryology of the Starfish, 1864 (Agass. Cont. Nat. Hist. U. S., V.), Pls. III., IV., VII. Memoirs Mus. Comp. Zoöl., 1877, V., No. 1, North American Starfishes, Pls. III., IV., VII.

29. Larva seen from the right profile, somewhat more advanced than any larva of *A. berylinus* raised by artificial fecundation.
30. The same larva seen from the oral side. The water-tubes have greatly increased in diameter; they have united beyond the mouth, and also extend along the sides of the stomach so as to meet, but without unit-

ing. The slight lobes along the course of the vibratile cord indicate plainly the position of the median arms (c'), of the dorsal anal (c''), the ventral anal (c'''), and the dorsal oral arms (c''''). The greatest thickening of the vibratile cord is found at the rudimentary median arms. Beyond the mouth is shown the great development which the oral portion of the water-tube has taken. This and the preceding figure also show the mode of formation of the oral pair of ventral arms (c^6), as well as the first sign of the odd brachiolar appendage (f'').

31. Older larva, seen from the mouth side. Thus far the arms have altered but little the character of the outline of the larva. In this figure, however, some of them are sufficiently developed to be capable of considerable motion. The median arms (c') especially are far in advance of the others. The anal arms all develop so as to become more slender at first, and assume their true character earlier than the oral arms, which during the early stages are always more lobe-like, and take their final shape later than the anal arms. At the angle where the oral ventral arms and the odd arm come together, at the base of the oral arms, slight swellings are formed (f), which are the first indication of the pair of brachiolar arms (ff); the odd brachiolar arm (f'') can only be seen in a profile view (see figs. 29, 32, 33), though in this figure it can be traced as a double outline of the odd arm c^6 (f''). We can already see a constriction of the water-tube as it passes into the odd arm, and from this (nearer the mouth) are sent off two small ponches (f' f'), (see also figs. 32, 33,) which enter into the brachiolar pair of arms (f). The first trace of the actinal area of the future Starfish is also plainly visible (t) on the water-tube (w') on the left side of this figure.

32. Fig. 31 seen in profile.

33. An adult larva seen from the right actinal profile; the arms are in the position which they take when the larva is moving rapidly, arched towards the median arms, the brachiolarian arms alone being curved in the opposite direction from the others. In this figure the crescent-shaped ambulacral pentagon, as well as the lobed pentagonal outline of the abactinal area, is plainly seen.

34. A greatly magnified figure of a full-grown Brachiolaria, at rest, in its natural attitude, with the Starfish almost ready to resorb the larva; the obliquity of the planes in which the actinal and abactinal pentagons are situated is especially well seen in the pointed anal extremity of this Brachiolaria. No letters have been added to this figure, as the different parts can be readily distinguished by comparing it with figs. 31–33.

PLATE VIII.

Development of Asteroidea, *continued.* *Figures from* Alexander Agassiz, Johannes Müller, *and* S. Lovén.

a. Anus.
b. Dorsal or water pore, madreporic opening.
c. Alimentary canal.
d. Digestive cavity.
d'. Abactinal water-tubes in the angle of the rays of the young Starfish.
e. Eye of Starfish at the base of the odd tentacle (*t'*).
l. Dorsocentral plate.
l'. Interradial plate.
l^2. brachial terminal plate.
m. Mouth.
n. Opening for passage of ambulacral sucker.
o. Œsophagus.
p. Spines on edge of ray of young Starfish.
p^1. Spines of exterior rows along the abactinal surface of the rays.
p^2. Spines of middle row, on the abactinal surface of the rays.
p^3. Central spine of the abactinal surface of the young Starfish, with centrodorsal plate (*l*).
p' p''. Different forms of pedicellariæ.
p c. Plate at the junction of adjacent rays (ovarian plate).
r. Abactinal surface.
r'. First set of five limestone *y* rods which appear on the abactinal surface, and eventually become the terminal brachial plates (*l*^{2}).
r''. Second set of five *y* rods to appear on the abactinal surface, and which eventually become the interradial plates (*l'*).
r^1–*r*^{5}. The first to fifth arm-lobes of the young Starfish, *r*^{1} being the ray nearest the madreporic opening.
s. Actinal surface.
t t t. Tentacles or water-system lobes of the young Starfish.
t'. Odd terminal tentacle.
t''. Ambulacral tube.
t^1–*t*^{5}. First to fifth lobes of the water system, corresponding to the first to fifth arm-lobes of the young Starfish (*r*^{1}–*r*^{5}).
u. Lateral ambulacral plates, surmounted by spines.
u'. Median ambulacral plates, carrying very small spines.
w. Water-tube upon which the abactinal area develops.
w'. Water-tube communicating with the madreporic opening, upon which the actinal area is developed.

1–23. *Asteracanthion pallidus*, continued. From Alexander Agassiz, Embryology of the Starfish, 1864 (Agass. Cont. Nat. Hist. U. S., V.), Pls. V., VI., VII., VIII. Mem. Mus. Comp. Zoöl., Vol. V., No. 1, North American Starfishes, 1877, Pls. V., VI., VII., VIII.

As the figs. 1–7 are intended to illustrate the development of the Starfish proper, the anal part alone of the Brachiolaria is represented; figs. 2 4 correspond to a Brachiolaria which has reached a stage about as advanced as that of Pl. VII. fig. 31; figs. 5–7 are stages of development of the young Starfish which are only found on fully grown Brachiolariæ, and in which, excepting these changes of the Starfish itself, but slight modifications take place.

1, 2, 6. Represent that profile of the anal part of the Brachiolaria, in successively more advanced stages, which shows the water-tube upon which is developed the actinal area.

3. Represents the opposite profile of the anal extremity of the Brachiolaria, showing the water-tube upon which is developed the abactinal area.

4, 7. Represent the ventral side of the anal extremity of the Brachiolaria, showing the extremities of the actinal and abactinal areas of the Starfish.

5. Represents the dorsal side of the anal extremity of the Brachiolaria, showing the opposite extremities of the actinal and abactinal areas of the Starfish. Owing to the transparency of the Brachiolaria, either the actinal or the abactinal area is always projected upon the other, when the larva is seen in profile. In the dorsal or ventral views, the angle made by the actinal and abactinal areas becomes visible.

1. Actinal profile of the anal part of the water-tube (w') of the Brachiolaria, previous to the appearance of the pentagon of lobes. In stage of Pl. VII. fig. 27.
2. Somewhat more advanced actinal profile, showing the ambulacral pentagon, as well as the position of the ten limestone rods r'–r' and r''–r'' (the terminal and interradial plates), which are seen through the thickness of the larva on the surface of the other water-tube (w). In a stage intermediate between those of Pl. VII. figs. 30 and 31.
3. A larva in the same stage as the preceding figure, seen from the opposite profile, to show the abactinal area.
4. The same larva seen from the ventral side of the Brachiolaria, to show the relative position of the pentagons of the two areas; only two of the rods of the abactinal side are seen, while the edges of three of the actinal folds (t) can be perceived, one above the other, on the footlike projection formed by the folding of the water-tube w'.
5. A dorsal view of the Brachiolaria, showing a well-advanced embryo; the arm-lobes have become indented, the arms themselves are separated by a deep cut, the y rods have extended so as to form almost a continuous network over the whole abactinal area. The actinal pentagon has assumed the shape of prominent loops projecting beyond the footlike oblique fold of the water-tube.
6. The same embryo seen from the actinal profile; the inner tentacular folds have become tipped with a triangular point. The thickness of the abactinal surface prevents the network of cells on the edge of the arms from being seen.
7. The same, from the ventral side of the Brachiolaria. This figure shows, perhaps better than any other, the relative position of the extremity of the two pentagonal warped surfaces. The rough outline of the Starfish is due to the manner in which the tubercles of the abactinal surface project above it. The Starfish in this condition is at the point of resorbing the larva. The manner in which this resorption takes place is shown on fig. 23 of this Plate.
8. Quite an advanced embryo Starfish, in which all traces of the appendages of the Brachiolaria have entirely disappeared. Each side of the pentagon of suckers is a rosette made up of seven loops; the limestone particles are deposited so as to project at the angle of the arms between the tentacular loops. The mouth is movable, the pentagon is not closed, and the Starfish is not yet symmetrical; the shape of the different rays is not identical.
9. Magnified view of one of the ambulacral tubes of the preceding figure, with its rudimentary tentacles.
10. The young Starfish in which the two pentagons have almost closed, and been brought into parallel planes. There has been a great increase in the size of the cut between adjoining rays; the spines also have grown longer and more pointed: the limestone points of the angle of the the rays have advanced nearer the centre. The Starfish is not quite symmetrical, nor are all the arms exactly alike.
11. The same young Starfish, from the actinal side, showing the great increase in size of the ambulacral system. The tentacles are now long pouches on each side of the main tube. The basal tentacles of one of the arms are much farther apart than all the others, and this is the last indication that the ambulacral pentagon is not closed.
12. An abactinal view of one ray, and of the centre of a young Starfish, in which the spines project far beyond the edge of the disk. The arm-plates and the interradial plates have become connected by a narrow bridge. The original limestone rods are so much thickened by additional deposits that they form elliptical cells, which have entirely lost the polygonal character of the younger stages.
13. One arm and portion of the centre of the most advanced of the young Starfishes which have been raised from the Brachiolariæ, from the actinal side. The three pairs of tentacles have suckers; the deposit of limestone of the actinal area has a cellular structure. In this stage the madreporic body is still placed on the lower side, on the very edge of the disk. There is a prominent eye-spot at the base of the odd terminal tentacle. The young Starfish represented in figs. 13 and 14 is about four months old.
14. The same young Starfish as fig. 13, seen from the abactinal side: the spines are very prominent, long, somewhat spreading, becoming sometimes even fan-shaped at the extremity. The limestone cells are gradually assuming the character of those of the adult, small cells within larger ones; the cut between the rays is very deep.
15. The same young Starfish, seen in profile, to show the great development of the abactinal area, and the Echinus-like arrangement of the spines in the young Starfish. The odd tentacle, with the eye at its base, is seen turned up between two of the spines.
16. Two rays and the centre of a young Starfish, about in the stage of fig. 12, seen from the actinal side, in which the ambulacral tube is concealed by the limestone deposit: the pair of terminal tentacles has as yet increased but little in size in comparison with the other pairs, which have become so long that they extend beyond the edges of the arms. The eye, a brilliant carmine spot, makes its appearance at about this stage. The mouth is a well-defined pentagonal opening, limited by the actinal limestone deposit.
17. One of the rays and centre of a young Asteracanthion, about one year old, seen from the abactinal side.
18. Actinal view of an arm of a young Asteracanthion, probably in its third year.
19, 20, 21. Magnified views of spines (p), and of rudimentary pedicellariæ (p', p'').

22. Odd terminal tentacle, with the eye-speck (*e*) of a young Asteracanthion about in the stage of fig. 18.

23. Shows the process of resorption of the Brachiolaria into the young Starfish; it commences at the anal extremity, and in this case has gone on sufficiently far to leave the young Starfish riding upon the oral extremity of the Brachiolaria, which alone, with its brachiolarian and terminal arms, has retained its original shape and proportion.

24. *Bipinnaria asterigera*. From Johannes Müller, Ueber die Larven und die Metamorphose der Echinodermen, Zweite Abhandlung, (1848,) Pl. II. Abhandl. d. K. Akad. der Wiss. Berlin, 1849.

24. A Bipinnaria, 1″ in size, seen from the ventral side: *1*, upper arm (anal); *7*, ventral arm (oral); *2*, *3*, *4*, *5*, *6*, dorsal arms; *a*, mouth; *b*, anus; *d*, dorsal vibratile cord; *d′*, ventral vibratile cord; *c*, *a′*, furrow between the vibratile cords of the arms.

25–28. *Asterias glacialis*. From S. Lovén, Études sur les Échinoïdées, 1874, Pl. LIII. Kongl. Svenska Vetens. Akad. Handl., XI., No. 7.

25. Young Asterias, 1.3 mm., seen from the ventral side: *a*, *b*, ambulacral plates.

26. The same, seen from the abactinal side. In this stage the skeleton is almost exclusively made up of the apical and of the ambulacral system: *a*, dorsocentral plate (basal); *b*, interradial plates (genital); *c*, the terminal plates (ocular). The small plates (*p*) between the terminal and the angle of the interradial plates are the first dorsal arm-plates.

27. Older specimen, 2 mm., seen from the abactinal side; the single plate (*p*) of the preceding figure is replaced by a set of three plates. Lettering as before.

28. Another individual, 4.5 mm., seen from the dorsal side; one of the genital plates has been pierced by the madreporite (*r*); in each ray a pair of dorsal water-tubes (*t r*) have made their appearance. Lettering as for fig. 26.

PLATE IX.

Development of the Echinoidea. *Figures from* Emil Selenka, Wilhelm Busch, Johannes Müller, J. W. Fewkes, H. Garman *and* B. P. Colton, *and* Alexander Agassiz.

1–16. *Echinus miliaris.* From E. Selenka, Keimblätter und Organanlage der Echiniden, 1880, Pl. V. Zeits. f. Wiss. Zool., XXXIII.

1. Free swimming blastula, optical section ; *a*, position of the future anus ; *b*, funnel-shaped depression ; *f*, segmental cavity. 16 hours after artificial fecundation.
2. Blastula with the two clusters of mesoderm cells, *m*, *m'*, which have separated from the thickened part of the ectoderm ; *a*, position of the future anus. 18 hours.
3. Commencement of the invagination. 22 hours.
4. Young gastrula, optical section ; *a*, gastrula mouth (later anus). 27 hours.
5. Gastrula, optical section ; small limestone rods have made their appearance : *u*, digestive cavity ; *m*, *m'*, accumulation of cells from which the *y*-shaped rods take their origin ; *c*, expansion of the closed extremity of the digestive cavity, from which are developed the diverticula forming the water-tubes. 43 hours.
6. Gastrula, dark mesoderm cells at the upper extremity of the larva ; the diverticulum (water-system) of the digestive cavity forms a T across its closed extremity ; the limestone rods have greatly increased in length and are surrounded by the nomadic skeleton cells. 48 hours.
7. Gastrula, after 54 hours. Optical section, showing the position of the limestone rods. The digestive cavity, D, is becoming differentiated into an œsophagus, stomach, and intestine. The water-system, *v p*, has completely separated from the digestive cavity. Lettering as before.
8, 9, 10, 11, 12. Successive stages of the digestive cavity and its diverticulum, showing the manner in which the water-system is formed as a diverticulum at the blind extremity of the digestive cavity, and how it becomes separated from it. This process takes place, according to Selenka, in less than three quarters of an hour.
13. Pluteus, after 60 hours. It has lost its cylindrical outline, the rudiments of the arms appear, and the oral and anal planes of the larva are developing in opposite directions.
14. Diagram of the same Pluteus as fig. 13, seen in profile ; α, œsophagus ; β, stomach ; γ, intestine. The skeleton is not indicated.
15. Pluteus 94 hours after fecundation : *o*, mouth ; *a*, anus (gastrula mouth) ; α, œsophagus ; β, stomach ; γ, intestine ; *v p*, right water-tube ; *p*, left water-tube, which subsequently becomes the water system of the young Echinus and the left peritoneal sac. The œsophagus, α, is capable of a considerable contraction and expansion ; the narrow passages *h* and *i*, leading from the œsophagus and intestine into the stomach, are well seen in the profile figure of the same Pluteus (fig. 16).
16. The same Pluteus as fig. 15, seen in profile. The cilia which still cover the whole Pluteus are not represented in this figure, nor in figs. 13, 14.

17–19. *Strongylocentrotus lividus.* From E. Selenka, Keimblätter und Organanlage der Echiniden, 1880, Pl. VII. Zeits. f. Wiss. Zool., XXXIII.

17. Blastula making its escape from the egg ; *d*, outer membrane.
18. The same blastula, free, optical section ; *e a*, thickened wall of the blastula at the pole where the invagination will take place.
19. Gastrula 43 hours old. The vasoperitoneal vesicle has separated from the digestive cavity. Optical section, the two first *y*-shaped limestone rods of the skeleton have appeared.

20–23. *Arbacia pustulosa.* From E. Selenka, Keimblätter und Organanlage der Echiniden, 1880, Pl. VII. Zeits. f. Wiss. Zool., XXXIII.

20. Blastula 30 hours after artificial fecundation ; *e a*, thickened wall of the blastula, where the invagination will take place ; *f*, segmental cavity ; *g*, anal pole.

21. Gastrula, optical section ; *a*, digestive cavity. 48 hours.
22. Gastrula, 68 hours old.
23. Embryo 72 hours old ; the vasoperitoneal vesicle has separated from the digestive cavity.

24–27. *Echinocardium cordatum*. From E. Selenka, Keimblätter und Organanlage der Echiniden, 1880, Pl. VII. Zeits. f. Wiss. Zool., XXXIII.

24. Blastula, 30 hours ; *a*, position of the future anus ; *f*, segmental cavity ; *g*, funnel-shaped depression in the ectodermal cells at the anal pole.
24′. Blastula showing the commencement of the invagination ; *m*, *m′*, clusters of cells of the mesoderm which have become separated from the ectoderm at the anal pole.
25. Gastrula 40 hours hold.
26. Longitudinal optical section of the same.
27. Young larva 50 hours old, optical section ; the vasoperitoneal sac has become separated from the digestive cavity ; this is now differentiated into the α, œsophagus ; β, stomach ; and γ, the intestine.

Figs. 1–27 are grouped together to show, in the earlier stages of the Pluteus of several Echini types, the formation of the mesoderm cells, the invaginations of the gastrula, the development of the vasoperitoneal sacs, and the differentiation of the original digestive cavity of the gastrula. See also Pl. X. figs. 14–33.

Figs. 28–45 are devoted mainly to showing the formation of the arms of the Pluteus and the development of the young Arbacia. See also Pl. X. figs. 32–44.

28–37. *Arbacia pustulosa*.

28, 29. *Arbacia pustulosa*. From W. Busch, Beobachtungen über Anatomie und Entwickelung einiger Wirbellosen Seethiere, 1851, Pl. XIII.

28. Young Pluteus, seen from the mouth side ; the oral extremity does not yet project beyond the level of the fold connecting the dorsal anal arms.
29. Somewhat more advanced than the preceding stage, seen from the dorsal side ; the oral extremity projects nearly as much as the dorsal arms.

30–37. *Arbacia pustulosa*. From Johannes Müller, Ueber die Gattungen der Seeigellarven, Siebente Abhandlung, (1853,) Pls. II., III., IV. Abhandl. der K. Akad. der Wiss. Berlin, 1855.

a. Anus.
d. Digestive cavity (stomach).
om. Mouth.
o. Œsophagus.
t. Tentacular lobes of water-system.

30. Young Pluteus seen from the ventral side ; somewhat older than the oldest stage copied from Busch (fig. 29).
31. The same as fig. 30, seen in profile.
32. Still older Pluteus, seen from the ventral (mouth) side ; the oral arms, mere knobs in the preceding stages (figs. 30, 31), have greatly increased in length ; first trace of the posterior anal pair of arms.
33. Still older Pluteus, seen from the dorsal side. The posterior pair of anal arms projects well beyond the general outline of the anal extremity ; the auricles are beginning to form as folds of the vibratile cord, between the dorsal and oral arms, and the second pair of oral arms is present as mere knobs at the base of the oral arms.
34. Still older Pluteus, seen from the mouth side ; the dark pigment-spots of the abactinal region of the young Arbacia are seen through the Pluteus membranes of the anal extremity ; the posterior pair of anal dorsal arms has grown rapidly since the last stage (fig. 33), exceeding in length the oral arms ; the second pair of dorsal arms is also present, equalling in length the oral arms ; the auricles are also well developed.
35. Fully developed Pluteus, with two pairs of oral arms and a smaller pair of dorsal oral arms, with large auricular arms, and the long median dorsal arms of equal length ; the tentacular lobes of the water system, *t*, are well developed, and pedicellariæ even have made their appearance on the surface of the young Arbacia. In this stage the young Arbacia is about to resorb the Pluteus.
36, 37. Young stages of Arbacia ; 36 seen from above, 37 somewhat in profile. The club-shaped spines are the young spines of the edge of the test of the young Arbacia ; the straight spines are the remnants of the Pluteus rods in process of atrophy and resorption. In the stage 37, young pedicellariæ are seen.

38–45. *Arbacia punctulata*.

38–40. *Arbacia punctulata*. From J. W. Fewkes, On the Development of the Pluteus of Arbacia, 1881, Pl. I. Memoirs Peabody Academy of Science, Sixth Memoir.

38–40. Young Plutei, showing the development of the calcareous rods : *m*, mouth ; *d*, digestive cavity. Somewhat younger than the stages of Arbacia figured by Busch (figs. 28, 29), and somewhat older than those given by Selenka (figs. 22, 23).

41. *Arbacia punctulata.* From Alexander Agassiz, Revision of the Echini, Part IV., 1874, p. 729, fig. 66. Illust. Cat. Mus. Comp. Zool., No. VII., Pt. IV.

41. Adult Pluteus of *Arbacia punctulata; m*, mouth. The dark spots of the anal extremity are the pigment spots of the young Arbacia.

42–43. *Arbacia punctulata.* From H. Garman and B. P. Colton, Some Notes on the Development of Arbacia punctulata, Lam., 1882. Johns Hopkins University, Baltimore, Studies from the Biological Laboratory, II., No. 2, Pl. XVIII.

42. Young Arbacia which has begun the resorption of the Pluteus; the oral part of the Pluteus is greatly shrunken (*o l*).

43. The process of resorption is more advanced, only a trace of the oral part of the Pluteus is left (*o l*), and the limestone rods of the anal arms appear like tall spines on the abactinal side of the young Arbacia. The odd tentacular suckers are very prominent.

44, 45. *Arbacia punctulata.* From Alexander Agassiz, Revision of the Echini, Pt. IV., 1874, p. 734, figs. 68, 69. Illust. Cat. Mus. Comp. Zoöl., No. VII. Pt. IV.

44. Young *Arbacia punctulata*, 1.5 mm. in diameter, including the spines, seen from the abactinal side, showing the anal system with its four plates. The apical system covers nearly the whole abactinal area, and is covered by embryonic sessile tubercles: a few pedicellariæ have made their appearance. The edge of the test carries huge flattened spines triangular in section, nearly equalling in length the diameter of the test. The ambulacral suckers are slender, some of them longer than the diameter of the test, and provided with somewhat pointed sucking disks. The whole test and the spines are thickly covered with dark violet pigment spots and patches.

45. The same as fig. 44, seen from the actinal side, showing the connected limestone deposit of the actinal surface covering the ambulacral tubes; the longest tentacles are those nearest the odd terminal tentacle; the odd tentacle is a small, short, slender tube without a sucking disk.

PLATE X.

Development of the Echinoidea, *continued. Figures from* Alexander Agassiz.

a. Anus.
b. Madreporic body.
c. Alimentary canal (intestine).
d. Digestive cavity (stomach).
e′, *e″*, *e‴*, *e*IV. Arms of the Pluteus.
f. Brachiolar arms?
k. Teeth of young Echinus.
m. Mouth.
m s. Mesoderm cells.
n Interambulacral tubercles of young Echinus.
n′. Ambulacral tubercles of young Echinus.
o. Œsophagus.
p. Pedicellariæ.
r′. First *y* rod of the Pluteus.
s′. Pigment spots of the long Pluteus arms.
s″. Interambulacral spines of young Echinus.
s‴. Young spines of embryo Echinus.
t. Tentacles.
t′. Odd terminal tentacle.
t^1, t^2. First and second pairs of lateral ambulacral tentacles.
v. Anal part of vibratile cord.
v′. Oral part of vibratile cord.
v″. Vibratile epaulettes.
w. Water-tube.
w′. Water-tube communicating with the madreporic body.

1–17. *Strongylocentrotus Dröbachiensis.* From Alexander Agassiz, Revision of the Echini, Pt. IV., 1874. Illust. Cat. Mus. Comp. Zoöl., No. VII., pp. 709, 710.

18–44. *Strongylocentrotus Dröbachiensis*, continued. From Alexander Agassiz, On the Embryology of Echinoderms. Mem. Am. Acad., IX., 1864, selection from figs. 1–25.

1. Mature egg.
2. Egg in which the germinative vesicle has disappeared after fecundation.
3. The germinative dot has also disappeared. The yolk has separated from the outer membrane, leaving an interval between it and the envelope.
4. The yolk has become depressed at one pole.
5. The same depression takes place at the two poles.
6–12. Different stages of segmentation.
6. The first trace of segmentation is a slit at one pole.
7. The yolk is divided into two large ellipsoidal masses.
8. The masses subdivided again.
9. The four spheres show a tendency to a further subdivision.
10. There are now eight spheres of segmentation.
11. There are thirty-two spheres, and they already show a tendency to form an envelope.
12. There are sixty-four spheres, and the walls of the embryo are already indicated.
13. The segmentation has gone on until the spheres are quite small, and the wall of the embryo very distinct.
14. The embryo has just escaped from the egg; the wall is thickened at one pole.
15. A slight invagination forms at the thickened pole.
16. The invagination has become somewhat deeper.
17. Older embryo more elongated, with thin walls at the upper extremity; the invagination now performs the function of a rudimentary digestive cavity.
18. Still older embryo, seen in profile; the digestive cavity is no longer in the axis of the Pluteus.
19. The same as fig. 18, seen from above.
20. Profile view of a Pluteus, somewhat more advanced than fig. 18; the digestive cavity is bent towards the ventral side of the larva.
21. Somewhat older Pluteus, at the end of the fourth day, seen from above. At the closed extremity of the digestive cavity two small diverticula have formed (*v*, *w′*), the first appearance of the water-tubes.

The digestive cavity itself shows the first trace of differentiation into intestine, stomach, and œsophagus.

22. Profile view of an embryo, somewhat older than fig. 21, at the beginning of the fifth day ; the intestine, *c*, stomach, *d*, and œsophagus, are well separated ; the anal vibratile cord (*v''*) bulges out considerably beyond the depression in the ventral side of the Pluteus.
23. Embryo at the end of the fifth day, seen from the mouth side ; the water-tubes (*w*, *w'*) are only slightly connected with the digestive cavity ; they also show a difference in size. The original limestone rod has given off a shoot, the rod of a new arm to be developed at *v*.
24. Fig. 23 seen from the anal extremity, to show the great change of form which has taken place from the early cylindrical shape of the embryo.
25. A profile view of fig. 23. The embryo has become pear-shaped, the œsophagus has bent over to reach the ventral side ; the anal opening is also somewhat ventrally placed ; the depression at *m*, where the new mouth is to be formed, is in contact with the œsophagus ; the anal and oral vibratile cords have increased in prominence.
26. A profile view of an embryo, taken at the beginning of the seventh day. The mouth, *m*, is open ; the water-tube *w'* reaches nearly to the dorsal surface. The currents, which previous to this stage had carried the food through the only opening, *a*, into the digestive cavity as far as *o*, and then were reversed to eject the digested matter, now come in through the mouth, *m*, pass through the œsophagus, *o*, rotate about in the stomach, *d*, and pass out through the first-formed opening, the anus, *a*, which is hereafter only used to eject the food.
27. A Pluteus at the end of the eighth day, seen obliquely from the ventral side, to show the course and shape of the vibratile cord.
28. Profile view (actinal) of a stage slightly older than that of fig. 27.
29. The same as fig. 28, seen from the ventral side.
30. Somewhat more advanced Pluteus, to show the changes the vibratile cord has undergone since the stage of fig. 27 ; seen obliquely from the ventral side.
31. A Pluteus during the tenth day, seen in profile, shows the beginning of the small arms *c'''* and *c*IV.
32. The same as fig. 31, seen from the mouth side. The arms *c'* have been greatly developed ; the differentiation of the intestine, *c*, the stomach, *d*, and the œsophagus, is quite complete. First appearance of the vibratile epaulettes, *v''*. The water-tubes have not yet united, and have not greatly increased in size from the preceding stage.
33. Profile of a Pluteus during the twenty-third day. The arm *c''* has increased greatly in length, and a considerable increase of the vibratile epaulettes is to be noticed.
34. The same as fig. 33, seen from the dorsal side, to show the relation of the rods of the arms *c'*, *c''*, *c'''*, to each other ; the water-tube *w'* shows the first indication of a large tentacular lobe.
35. Fig. 34, seen somewhat obliquely, in an attitude similar to that of figs. 27 and 30, to show the connection of the different parts of the vibratile cord.
36. A much more advanced Pluteus, fished up from the surface. The rods extending into the arms are made up of three sets of rods united by short transverse bars ; the whole oral extremity of the larval body has greatly lengthened ; the arms *c'''* and *c*IV are longer than in the preceding stages, *c'*, *c''*, and *c'''* being nearly of equal length ; the arms show a tendency to a paired arrangement of *c'*, *c''*, and *c'''*, *c*IV. Additional tentacular lobes have been formed in the water-tube *w'*, and the water-tubes have become united in the oral extremity beyond the saclike pouch of the mouth of the Pluteus.
37. Fully developed Pluteus of *Strongylocentrotus*, in which the young Sea-urchin has already encroached somewhat on the anal extremity ; its spines are quite well marked ; the vibratile epaulettes have acquired a great size ; two very prominent spots, *s'*, *s'*, in the arms *c'*, *c''*. At the base of the oral extremity of the mouth pouch a rudimentary appendage, *f*, appears ; this is perhaps the homologue of the brachiolarian appendages of the Brachiolaria of Asteracanthion. The arms *c'*, *c''*, and *c'''*, *c*IV, are now of nearly equal length, and arranged in pairs.
38. Fig. 37 seen from the oral extremity of the Pluteus.
39. Profile view of fig. 37.
40. A young Echinus, immediately after the resorption of the Pluteus, seen from the abactinal side. The anal opening cannot be traced in the youngest specimens, though it is very apparent in somewhat more advanced stages (*a*, fig. 43).
41. A young Echinus, somewhat more advanced than the stage of fig. 40, seen from the actinal side ; the tentacles have become more slender ; the odd tentacle *t'* especially, when fully extended, more than equals the diameter of the test ; the interambulacral spines of this side are nearly as long as the diameter of the test. The actinal system is not well separated from the coronal test. The two tentacles nearest the actinostome are remarkable for the great development of the sucking disk.
42. The same as fig. 41, seen from the abactinal side ; the spines of the abactinal area are remarkable for their fan-shaped spiny extremities.

43. Young *Strongylocentrotus*, measuring one fifteenth of an inch in diameter, including the spines; a number of long-stemmed pedicellariæ have developed on the abactinal side; the tentacles have become quite slender, and carry a comparatively large sucking disk; the spines have lost their embryonic character, and have assumed the general appearance of those of the adult. The anal system is very prominent, a large circular opening covered by a single plate, *a*, leaving the anal opening on one edge of the anal system.

44. The test of a young Sea-urchin, in the stage of figs. 41, 42, stripped of its spines, seen from the actinal side; the actinal system is comparatively large, and, as in Cidaris, the tubercles are large and few in number; no miliary tubercules are as yet formed. The teeth are simple, and the accessory parts of the jaws are not developed.

PLATE XI.

Development of ECHINOIDEA, *continued. Figures from* JOHANNES MÜLLER, AUGUST KROHN, *and* ALEXANDER AGASSIZ.

Spatangus purpureus.

1, 3, 5. From August Krohn, Ueber die Larve von Spatangus purpureus. Archiv f. Anat. Physiol. u. Wiss. Med., 1853, Pl. VII.

2, 4, 6. From Johannes Müller, Ueber die Larven und die Metamorphose der Echinodermen, Vierte Abhandlung (1850-51), Pl. VIII. Abhandl. d. K. Akad d. Wiss. Berlin, 1852.

7, 8. From Johannes Müller, Ueber die Larven und die Metamorphose der Ophiuren und Seeigel (1846), Pl. III. Abhandl. d. K. Akad. d. Wiss. Berlin, 1848.

9. From Johannes Müller, Ueber die Gattungen der Seeigellarven, Siebente Abhandlung über die Metamorphose der Echinodermen, 1855, Pl. V. Abhandl. d. K. Akad. d. Wiss. Berlin, 1855.

A. First pair of dorsal arms.
B. Second pair of dorsal arms.
C. Pair of anal arms.
D. Odd anal arm.
E. Second pair of oral arms.
F. First pair of oral arms.
G. Third pair of oral arms.
a. Mouth.
a'. Œsophagus.
b. Stomach.
b'. Intestine.
o. Anus.

1. One of the older Plutei raised by artificial fecundation, with a rudimentary odd anal arm, D, and a single pair of dorsal arms, A.
2. Older Pluteus, in which the odd anal arm, D, has greatly increased in size, and the first pair of oral arms, F, has made its appearance. Seen obliquely.
3. Older Pluteus, in which the dorsal arms, A, have still further developed. Dorsal view.
4. Older than fig. 3. The growth of the Pluteus since the last stage has been principally in the elongation of the oral part of the larva and the lengthening of the odd anal arm. Seen from the mouth side.
5. Pluteus somewhat older than stage of fig. 4. The dorsal arms, A, are nearly twice as long as in the preceding stage, and the rudiments of the second pair of dorsal arms are visible. Ventral view.
6. Older stage, in which the second pair of dorsal arms, B, is nearly as long as the first pair, A; the rudiments of the second pair of oral arms, E, have also appeared. Seen from the mouth side.
7. Still older Pluteus; the first pair of dorsal arms is somewhat longer than the second; the third pair of oral arms, G, has been developed, and the anal pair of arms, C, has likewise made its appearance.
8. Older stage, in which the resorption of the Pluteus is well advanced, the anal arms have disappeared, and a part of the oral portion of the larva has also been resorbed by the young Spatangus; the spines and ambulacral suckers of the young Urchin are well seen in the anal part of the Pluteus.
9. Fully developed Pluteus, with all its arms, just before the resorption of the Pluteus begins.

10. *Spatangoid Pluteus.* From Johannes Müller, Ueber die Gattungen der Seeigellarven, Siebente Abhandlung, 1855, Pl. V. Quoted above.

10. This Pluteus may be a younger stage of fig. 9, but, judging from the absence of the pair of anal arms and the great length of the odd anal arm, it probably does not belong to *S. purpureus*.

11. *Echinoid Pluteus.* From Johannes Müller, Siebente Abhandlung, 1855, Pl. V. Quoted above.

11. This remarkable Pluteus differs widely from all known Echinoid larvæ; it has features in common with the Brachiolaria, many of its arms being flexible, without rods. These arms are perhaps only such auricles as we find in the Pluteus of Arbacia (see Plate IX. figs. 34, 41). It is probable, therefore, that this larva will prove to be the Pluteus of a Cidaris or of a Diadema.

12–18. *Echinus lividus.* From Johannes Müller, Vierte Abhandlung (1850–51), Pl. VI., VII. Quoted above.

A. First pair of dorsal arms.
B. Second pair of dorsal arms.
E. Second pair of oral arms.
F. First pair of oral arms.
a. Mouth.
a'. Œsophagus.
b. Stomach.
b'. Intestine.
c. Anus.
d. Cord of vibratile cilia.
f. Vibratile epaulettes.

12. Pluteus on the sixteenth day after artificial fecundation; this Pluteus was remarkably slow in its development.
13, 14. Pluteus on the eleventh day after artificial fecundation, but more advanced than the preceding stage. 13, seen obliquely from the side; *x* is the outline of the depression in which the mouth is placed. 14, seen from the mouth side.
15. Somewhat more advanced Pluteus, on the seventeenth day, seen obliquely from the dorsal side, shows the relative position of the calcareous rods, of the arms, and of the cord of vibratile cilia.
16. Somewhat older Pluteus, in which the arms have greatly lengthened, and there is a slight swelling of the vibratile cord at the base of the dorsal arms, denoting the position of the future vibratile epaulettes.
17. Fully developed Pluteus, with vibratile epaulettes; the young Echinus is well advanced.
18. Stage in which the young Echinus has resorbed the greater part of the Pluteus; only a small part of the oral extremity and short pieces of the rods of the arms of the larva are left. The rudimentary embryonic spines, *x*, are quite prominent; the ambulacral suckers, *y*, are clearly seen; one of the longer tentacles projects beyond the disk, and a few pedunculated pedicellariæ have made their appearance.

19–27. *Echinocyamus pusillus?*

19–21. From Johannes Müller, Vierte Abhandlung (1850–51), Pl. VIII. Quoted above.

A. First pair of dorsal arms.
F. First pair of oral arms.
a. Mouth.
a'. Œsophagus.
b. Stomach.
b'. Intestine.

19. Young Pluteus, seen from the ventral side.
20. The same, seen obliquely in profile from the dorsal side.
21. Somewhat older Pluteus, in which the second pair of oral arms is already formed. It is somewhat problematical if the stages of figs. 19–21 are the younger stages of figs. 22–24.

22–27. From Johannes Müller, Siebente Abhandlung, 1855, Pl. VIII. Quoted above.

a. Mouth.
b. Œsophagus.
c. Stomach.
d. Intestine.
e. Anus.

22. Young Pluteus, with two dorsal and two oral arms, seen obliquely, looking into the mouth cavity.
23. Somewhat older Pluteus, seen from the dorsal side; the second pair of oral arms has made its appearance.
24. Fully grown Pluteus; the young Urchin is not yet far advanced.
25. Pluteus in which the resorption of the anal extremity is well advanced, the young Urchin occupying the whole of the anal extremity of the Pluteus; the oral extremity is still nearly unchanged.
26. The young Urchin seen in profile, after the complete resorption and disappearance of the plutean appendages. $\frac{1}{7}$‴ in diameter. The odd tentacles have already well-developed suckers.
27. The same young Urchin as fig. 26, under compression, showing the five teeth, the limestone plates of the actinostome, and the single row of embryonic spines placed round the ambitus.

28. *Echinarachnius parma?* From Alexander Agassiz, Revision of the Echini, 1874, Part IV., p. 727, fig. 65. Illust. Cat. Mus. Comp. Zoöl., No. VII. Part IV., 1874.

28. Well-advanced Pluteus, remarkable, like the problematic *Echinocyamus Pluteus*, fig. 24, for its rounded anal extremity: *a*, mouth; *a'*, œsophagus; *d*, digestive cavity; *i*, intestine; *a n*, anus. Seen from the mouth side.

29. *Echinus acutus?* From Johannes Müller, Ueber die Larven und die Metamorphose . . . . (1846), Pl. V. Quoted above.

29. Fully developed Pluteus, with rounded anal extremity, large vibratile epaulettes, and comparatively short arms. Seen from the mouth side. A, first pair of dorsal arms; B, second pair of dorsal arms; *a*, mouth; *a'*, œsophagus; *b*, digestive cavity; *d*, cord of vibratile cilia; *e*, calcareous rods of arms; *f*, vibratile epaulettes.

30. *Echinus brevispinosus.* From Johannes Müller, Siebente Abhandlung, 1855, Pl. I. Quoted above.

30. Fully developed Pluteus, seen from the dorsal side. This Pluteus is remarkable for the short pair of anal arms developed at the posterior extremity.

PLATE XII.

Development of Echinoidea, *continued. Figures from* Alexander Agassiz *and* C. Wyville Thomson.

Young Stages of

1–3. *Goniocidaris canaliculata.*
4. *Dorocidaris papillata.*
5, 6. *Asthenosoma hystrix.*
7. *Diadema setosum.*
8–12. *Mellita sexforis.*
13–14. *Mellita testudinata.*
15, 16. *Mellita longifissa.*
17–22. *Echinarachnius parma.*
23, 24. *Encope emarginata.*
26–29. *Conolampas Sigsbei.*
30–35. *Hemiaster cavernosus.*
36, 36′. *Spatangus purpureus.*
37–40. *Brissopsis lyrifera.*

1–3. *Goniocidaris canaliculata.* From Alexander Agassiz, The Zoölogy of the Voyage of H. M. S. Challenger, Vol. III. Part IX. Report on the Echinoidea, Pl. II., London and Edinb., 1881.

1. Young specimen, 2 mm. in diameter, seen from the abactinal side.
2. The same as fig. 1, seen from the actinal side.
3. Another young specimen, 3 mm. in diameter, belonging to the long spined type of the species.

4. *Dorocidaris papillata.* From Alexander Agassiz, Revision of the Echini, Part II., 1872, Pl. II^c. Ill. Catal. Mus. Comp. Zoöl., No. VII. Part II., 1872, Pl. II^c.

4. Young specimen, seen from the abactinal side, partly denuded. 2.4 mm in diameter.

5, 6. *Asthenosoma hystrix.* From Alexander Agassiz, Revision of the Echini, Part II., 1872, Pl. II^c. Quoted above.

5. Part of test of young specimen, measuring 3.1 mm. in diameter, seen from the abactinal side.
6. Part of test of same, seen from the actinal side.

7. *Diadema setosum.* From Alexander Agassiz, Revision of the Echini, Part II., 1872, Pl. II^c. Quoted above.

7. Young specimen, measuring 2.4 mm. in diameter, seen in profile, showing the anal tube projecting between the spines beyond the level of the abactinal surface.

8–12. *Mellita sexforis.* From Alexander Agassiz, Revision of the Echini, Part II., 1872, Pl. XI. Quoted above.

8. Young specimen, 2.4 mm. in diameter, having a Laganum-like shape ; the posterior interambulacral lunule is not as yet to be seen from the abactinal side.
9. The same from the actinal side, deeply concave, showing the commencement of the posterior interambulacral lunule.
10. Young specimen, 4 mm. in diameter, seen from the abactinal side ; first trace of the posterior lunule on the abactinal side.
11. Young specimen, measuring 10.1 mm. in diameter, from the abactinal side. The ambulacral lunules all present, in different stages of growth.
12. Young specimen, measuring 12.7 mm. in diameter, with all the ambulacral lunules completely pierced through and well formed.

13–16. *Mellita testudinata* and *longifissa*, in which the lateral lunules are formed from notches in the edge of the test. From Alexander Agassiz, Revision of the Echini, Part II., 1872, Pl. XI. Quoted above.

13, 14. *Mellita testudinata.*

13. Posterior interambulacrum of fig. 14, showing the posterior interambulacral lunule, which in this type is formed from the lower side, as in *M. sexforis*, and forces its way through the test to the abactinal surface.
14. Young specimen ($\frac{2}{3}$), seen from the abactinal side ; the edge of the test shows as yet no trace of the notches so well developed in fig. 15.

15, 16. *Mellita longifissa.*

15. Young specimen, natural size, in which the notches forming the ambulacral lunules commence to close, seen from the abactinal side.

16. Part of test of a young specimen, about $\frac{3}{4}$ of an inch in diameter, in which the ambulacral lunules have completely closed; seen from the abactinal side.

17–22. *Echinarachnius parma.* From Alexander Agassiz, Revision of the Echini, Part II., 1872, Pl. XII. Quoted above.

17. Young specimen ($\frac{1}{1}^{0}$), seen in profile, elongated Echinometra-like stage.

18. The same as fig. 17, seen from the abactinal side; the anus at this stage opens above the ambitus.

19. Somewhat older stage ($\frac{5}{1}$), seen from the abactinal side; the anal opening is placed nearer the ambitus.

20. Older than the preceding stage ($\frac{7}{1}$), seen from the abactinal side; the outline has become somewhat more elliptical.

21. Older stage, seen from above ($\frac{5}{1}$). In the abactinal part of the ambulacra the pores have become conjugated.

22. Still older stage, seen from above ($\frac{3+3}{1}$); the abactinal part of the ambulacra has become slightly petaloid; the anal opening is partly on the ambitus.

23, 24. *Encope emarginata.* From Alexander Agassiz, Revision of the Echini, Part II., 1872, Pl. XII. Quoted above.

23. Young specimen in the Moulinsia stage ($\frac{1}{1}^{3}$), showing the first trace of the posterior interambulacral lunule on the actinal side.

24. Young Encope, natural size. The posterior interambulacral lunule has forced its way through from the actinal to the abactinal surface, and there are traces of the lateral ambulacral notches, which are to form the lunules (which may remain closed or open) of the older stages.

26–29. *Conolampas Sigsbei.* From Alexander Agassiz, Revision of the Echini, Part II., 1872, Pl. XVI. Quoted above.

26. Young specimen, seen from the abactinal side, partly denuded. 4 mm. in diameter.

27. The same, seen from the actinal side; the anal opening is on the sloping posterior edge of the ambitus of the test.

28. The same, seen in profile, showing the position of the anal system.

29. Young specimen, in its Echinolampas stage, measuring 12.7 mm. in diameter; seen in profile.

30–35. *Hemiaster cavernosus.* From Alexander Agassiz, Report on the Echinoidea of the "Challenger," 1881, Pl. XX^{a}. Quoted above.

30. One of the lateral ambulacral petals of a gravid female, showing the mode in which the young embryos are carried in the deeply sunken petaloid ambulacra. From C. Wyville Thomson, Notice of some Peculiarities in the Mode of Propagation of certain Echinoderms of the Southern Sea. Journ. Linn. Soc. Zoology, XIII., 1876, p. 70, fig. 9.

31. Young, 2 mm. in diameter, taken from the pouch of the petaloid ambulacra, still somewhat circular, with straight primary spines, seen from the abactinal side.

32. Somewhat older than the preceding stage, 3 mm. in diameter; the test carries curved primary spines, seen from the abactinal pole.

33. Young, in about the stage of fig. 32, denuded of spines, showing the simple ambulacral pores, the large anal opening, within the broad peripetalous fasciole, and the ring of large primary tubercles, forming its inner edge; about 3 mm. in diameter.

34. The same as fig. 33, somewhat less magnified, seen from the actinal side.

35. Young Hemiaster, measuring 5.5 mm. in diameter; the anal system is now removed from within the peripetalous fasciole to the outer edge of the broad peripetalous fasciole; seen from the abactinal side.

36, 36′. *Spatangus purpureus.* From Alexander Agassiz, Revision of the Echini, Part II., 1872, Pl. XI^{f}. Quoted above.

36. Young specimen, seen from the abactinal side ($\frac{3}{1}$), showing the straight simple ambulacra of the future petaloid system of the abactinal part of the test.

36′. The actinostome of the same; the posterior actinal lip is as yet scarcely developed.

37–40. *Brissopsis lyrifera.* From Alexander Agassiz, Revision of the Echini, Part II., 1872, Pl. XIX. Quoted above.

37. Young Brissopsis, measuring 5.6 mm. in diameter, from the abactinal side; shows the huge ambulacral tentacles (provided with suckers) of the odd ambulacral area, within the slightly dumb-bell-shaped peripetalous fasciole. The anal system is placed between the posterior edge of the abactinal and of the subanal fasciole.

38. Profile of same, showing the bevelled anterior extremity of the test, surrounded by the peripetalous fasciole.

39. Peripetalous fasciole of a young specimen, measuring about 3.6 mm. in longitudinal diameter; 5 : 4 pairs of simple pores in the anterior, and 4 : 3 pairs in the posterior lateral ambulacrum. There are from five to six simple pores in the odd anterior ambulacrum.

40. Peripetalous fasciole of an older stage, in which the fasciole has become undulating, and the lateral ambulacra somewhat petaloid.

PLATE XIII.

Development of HOLOTHUROIDEA. *Figures from* JOHANNES MÜLLER *and* ELIAS METSCHNIKOFF.

1–11. *Synapta* (*Auricularia with calcareous wheels*).

1, 3, 4. From Johannes Müller, Ueber die Larven und die Metamorphose der Echinodermen, Zweite Abhandlung. 1848, Pl. IV. Abhandl. d. K. Akad. d. Wiss. Berlin, 1849.

2, 5–11. From Johannes Müller, Ueber die Larven und die Metamorphosen der Holothurien und Asterien (Pt. 3), (1849–50,) Pls. I., II., III. Abhandl. d. K. Akad. d. Wiss. Berlin, 1850.

a. Mouth.
b. Œsophagus.
c. Digestive cavity.
c'. Intestine.
d. Dorsal part of the simple vibratile cord.
d'. Oral part of the vibratile cord.
d''. Passage of vibratile cord from the oral to the dorsal cord.
e. Anus.
g. Dorsal pore.
h. Tentacular rosette of the water system.
i. Tentacular lobes of the water system.
o. Calcareous wheel.

1. Young Auricularia, seen from the ventral side.
2. Somewhat older Auricularia, seen from the ventral side.
3. Older stage, in which the arms are developed.
4. Somewhat older Auricularia ; the tentacular lobes of the water system, *i*, are well seen.
5. About in the same stage as the preceding, seen obliquely from the dorsal side.
6. Auricularia at the time of the metamorphosis ; the lateral arms have disappeared, and broad transverse bands of vibratile cilia have been formed.

7–11. *Synapta, continued.*

a. Digestive cavity.
b. Anal opening.
c. Circular ring of the water system.
c'. Polian vesicle.
c''. The five branches of the circular ring leading to the tentacles.
d. Vesicles (otoliths) with granules round the oral water-ring.
e. Calcareous skeleton of the oral ring.
f. Tentacular chamber.
g. Canal with the crescent-shaped limestone arc.
h. Lateral muscular bands.
i. Calcareous gland at the anal extremity.
k. Cavity in which the tentacles are developed.
l. *y* rods of the oral calcareous ring.
m. Intestine.
n. Position of the cavity where the tentacles eventually break through.

7. Synapta pupa, somewhat compressed, and somewhat older than the preceding stage.
8. Synapta pupa, somewhat more advanced than the preceding stage.
9. Young creeping Synapta.
10. Young Synapta, somewhat compressed.
11. Young Synapta, still older, compressed.

In figs. 9–11 the tentacles of the young Synapta have forced their way through the actinal extremity of the pupa, and the broad transverse bands of vibratile cilia disappear with advancing development.

12–17. *Synapta, continued.* From Elias Metschnikoff, Studien über die Entwickelung der Echinodermen und Nemertinen, 1869, Pls. I., II. Mém. Acad. Imp. de St. Pétersbourg, VII^e Sér., XIV., No. 8.

c. Cutis.
c c. Œsophagus.
c d. Cavity of the lateral disk.
d'. Left water-tube.
d r. Right water-tube.
p a. Dorsal pore.
s. Stomach.
s e. Outer layer of the lateral disks.
s i. Inner layer of the lateral disks.
t^{1}–*t*^{5}. First to fifth tentacular lobes of the oral ring of tentacles.
v a. Original pouch of the water system.
v l. Otoliths round the oral water-ring.

12. A very young Auricularia, with yellow pigment spots. This figure is not a younger stage of the following ones, which all belong to Synapta.
13. Young Auricularia, in which the water system pouch and the lateral disks have not yet appeared.
14. Older Auricularia, in which the original problematic body has divided into two, forming the two lateral disks.
15. The lateral disks have now assumed their characteristic appearance, and the water system has become five-lobed.
16. Somewhat more advanced Auricularia; the water system shows a secondary set of smaller lobes between the larger ones, and has taken a horseshoe shape; the lateral disks have increased in size.
17. Shows the horseshoe-shaped water system, with a portion of the left water-tube.

Figs. 13–17 correspond to the period included between the stages figured by Müller. See above, figs. 1–3.

18. *Auricularia with calcareous gland.* From Johannes Müller, Ueber die Larven und die Metamorphose der Holothurien und Asterien (Pt. 3), 1849–50, Pl. IV. Quoted above.

18. Auricularia, seen from the ventral side. *a*, mouth; *b*, œsophagus; *c*, digestive cavity; *d*, intestine; *e*, anus; *f*, calcareous gland; *g*, gray granulation covering *f*.

19. *Auricularia with eleven spheres.* From Johannes Müller (Pt. 3), Pl. IV. Quoted above.

19. Adult Auricularia, seen from the oral side. *a*, mouth; *b*. œsophagus; *c*, stomach; *e*, problematic body (lateral disk); *g*, depression in which the mouth is placed.

20–32. *Auricularia with elastic spheres.*

20–22, 29. From Johannes Müller, Ueber die Larven und die Metamorphose der Echinodermen, Vierte Abhandlung, 1850–51, Pl. I. Abhand. d. K. Akad. d. Wiss. Berlin, 1852.

23–28, 30–32. From Johannes Müller, Ueber den Allgemeinen Plan in der Entwickelung der Echinodermen (Pt. 6), 1852, Pls. III., V., VI. Abhand. d. K. Akad. d. Wiss. Berlin, 1853.

20–21. Auriculariæ in the stage of development preceding the cylindrical form. 20 is seen from the dorsal side, 21 from the ventral side.

a. Mouth.
b. Œsophagus.
c. Stomach.
c'. Intestine.
d. Vibratile cord.
e. Problematic bodies.
f. Lobes of the oral tentacular system.
g. Calcareous ring of dorsal pore.
h. Water system.
h'. The eleven elastic spheres.
i. Calcareous gland.
o. Anus.

22. Auricularia somewhat younger than the preceding stages, at the time when the calcareous ring of the dorsal pore begins to form.

a. Mouth.
b. Œsophagus.
c. Digestive cavity.
d. Intestine.
e. Anus.
f. Tentacular system.
g. Calcareous ring of the future madreporic opening.
o. Calcareous sphere.
x. Part of the bilateral vibratile cord, which disappears.
I, II, III, IV, V. Portions of the bilateral vibratile cord, which become the first to fifth transverse ciliated bands.
3', 4'. Lobes of the dorsal part of the bilateral vibratile cord, which become part of the third and fourth transverse ciliated band on the dorsal side.

23. Fully developed larva, of which the mouth and œsophagus can still be seen. The bilateral vibratile cord is in process of passing into the transverse ciliated band.
24. A pupa without a mouth, seen obliquely from the ventral side; on the ventral side only can the anterior part of the bilateral vibratile cord be recognized; the posterior transverse ciliated bands are fully formed.
25. Another pupa without a mouth, seen from the dorsal side; the transverse ciliated bands are not yet all closed; the first and second are not yet complete.
26. A pupa shortly before the oral tentacles force their way through; 1', dorsal part of the first vibratile cord, I.
27. A pupa, still pelagic; the tentacles have just forced their way through the anterior extremity.
28. Somewhat older pupa, in which the membrane uniting the tentacles and connecting with the perisome is developed.
29. Young Holothuria, in which, besides the transverse ciliated bands, traces of the bilateral ciliated cord can still be seen.
30. Young Holothuria, with a ventral sucker, under compression, seen in profile, showing the ventral ambulacral canal and its vesicle connecting the sucker with the circular canal.

31. Young Holothuria, about in the stage of fig. 30; the vibratile cilia have disappeared, and the young Holothurian now creeps by means of its tentacles and ambulacral sucker.
32. Young Holothuria, somewhat older, under compression, seen from the dorsal side. The circular oral canal, the stone canal, the Polian vesicle, and the ventral ambulacral canal, are well seen.

33–37. *Auricularia with dendritic and calcareous gland.*

33–35, 37. From Johannes Müller, Ueber die Larven und die Metamorphose der Holothurien und Asterien (Pt. 3), 1849–50, Pl. V. Quoted above.

36. From Johannes Müller, Ueber die Larven und die Metamorphose der Echinodermen, Vierte Abhandlung, 1850–51, Pl. I. Quoted above.

33, 34. Two successive stages of the pupa, under compression.
35. Holothurian larva of the same, with free tentacles. *a*, digestive cavity; *c*, circular canal; *c'*, Polian vesicle; *c''*, the five branches of the circular oral canal leading to the tentacle; *e*, calcareous oral ring; *f*, tentacles; *g*, stone canal, with its calcareous ring; *h*, the lateral elastic spheres; *h'*, the odd terminal anal sphere; *i*, the terminal anal dendritic gland; *k*, the remnants of the vibratile cord; *l*, transverse bands of vibratile cilia.
36. Somewhat more advanced young Holothuria, with a small ventral ambulacral sucker: the vibratile cilia of the transverse bands have disappeared. *d*, the tentacular-like bodies at the base of the oral tentacles along the calcareous ring; *f*, circular canal; *f'*, Polian vesicle; *g*, stone canal and its calcareous ring; *o*, extremity of the ventral ambulacral canal.
37. Young Holothuria, in a stage intermediate between figs. 35 and 36.

PLATE XIV.

Development of Holothuroidea, *continued. Figures from* Emil Selenka, *and* D. C. Danielssen *and* J. Koren.

1–12. *Holothuria tubulosa.* From E. Selenka, Zur Entwickelung der Holothurien (Holothuria tubulosa und Cucumaria doliolum), Ein Beitrag zur Keimblättertheorie, 1876, Pls. IX., X. Zeits. f. Wiss. Zool., XXVII.

a. Anal opening.
b l. Blastoderm.
e k. Ectoderm.
e n. Entoderm.
f. Segmental cavity.
m. Mesoderm.
m'. Exterior mesodermal plate.
m''. Interior mesodermal plate.
o. Mouth.
w. Cord of vibratile cilia.
x. Water-system pore.
A. Œsophagus.
B. That part of the digestive cavity from which the vasoperitoneal sac has separated.
H. Stone canal.
N. Nucleus.
P. Peritoneal sac.
Pr. Right peritoneal sac.
Pl. Left peritoneal sac.
u. Original digestive cavity of larva.
V. Water-system sac.
Vp. Vasoperitoneal sac.

1. Six hours after fecundation. Optical section. *n*, nucleolus ; *α*, membrane of egg.
2. Blastula, fifteen hours after segmentation ; the segmentation is nearly complete. *s*, spermatozoön ; *μ* micropyle. Many of the blastoderm cells already have a ciliated lash. The blastoderm rotates slowly and irregularly within the egg membrane.
3. Gastrula, twenty-three hours after fecundation ; longitudinal optical section. Commencement of the invagination ; a few cells, the mesoderm, have separated from the ectoderm ; the egg membrane has been ruptured, and has disappeared.
4. A transparent larva, seen from the ventral side, forty-four hours after fecundation ; the digestive cavity, *u*, already shows a constriction, the point of subsequent separation of the vasoperitoneal sac from the distal extremity of the digestive cavity. *R*, green bodies of the vibratile cord containing cells.
5. Optical section of a larva, fifty-one hours after segmentation ; the vasoperitoneal sac, *Vp*, has become separated from the anal part of the digestive cavity, *B*.
6. Diagrammatic profile view of the same larva. Formation of an atrium, *A*, the future œsophagus, by invagination of the blastoderm. The vibratile cords and mesoderm cells have not been drawn.
7. Optical section of a larva, sixty-nine hours after segmentation, seen from the dorsal side. *b*, blood cells in the vasoperitoneal sac ; *R*, the green granules, containing cells of the vibratile cord ; *p*, contents of the digestive cavity. The œsophagus and intestine are now connected ; the vasoperitoneal sac is pushed to the left side.
8. The transparent larva, seventy-one hours after fecundation. *st*, vertical axis of the larva when swimming in a natural attitude, and round which it slowly rotates, moving forward in long spirals at the same time.
9. The transparent larva, a hundred hours after the fecundation. The vasoperitoneal sac has divided into three distinct sacs, the water-system sac, and the two lateral disks.
10. Diagrammatic profile view of fig. 8.
11. Diagrammatic profile view of fig. 9 ; a few mesoderm cells, *q*, round the stone canal, *x*, have been indicated.
12. Sketch of the digestive cavity and the surrounding parts of the same larva (fig. 9), a few hours later (seven hours).

13–27. *Holothuria tremula.* From D. C. Danielssen and J. Koren, Observations sur le Développement des Holothuries, 1856, Pls. VII., VIII. In Fauna littoralis Norvegiæ, par Dr. M. Sars, J. Koren, et D. C. Danielssen, Seconde Livraison, 1856, Pls. VII., VIII.

13. Young embryo, recently hatched ; still covered with vibratile cilia.
14. Somewhat older embryo, with a mouth opening, *a*.

15. Slightly older than the preceding figure. *b*, stomach.
16. Young embryo, in which the depression *b* indicates the point where the five tentacles are to force their way through.
17. Embryo, somewhat compressed, to show the calcareous ring, *a*, round the base of the stone canal, *b*.
18. Embryo, seen from the ventral side, compressed. *a*, mouth ; *b*, circular ambulacral ring ; *c*, the five primary ambulacral tentacles ; *d*, the five small calcareous tentacular appendages of the circular canal ; *e*, the stone canal.
19. Embryo, seen from the mouth side. *a*, mouth ; *b*, depression for the five primary ambulacral tentacles of the circular canal ; *c*, depression for the passage of the first pair of ventral ambulacral tentacles.
20. Embryo, seen from the ventral side, compressed. *a*, mouth ; *b*, circular vascular ring ; *c*, ambulacral tentacle.
21. Embryo, in which the oral tentacles have forced their way through ; seen from the dorsal side, with the tentacles protruded.
22. Embryo, about in the stage of fig. 21, seen from the side, compressed. *a*, mouth ; *b*, circular canal ; *c*, oral tentacle ; *d*, stone canal ; *e*, Polian vesicle ; *f*, stomach ; *g*, intestine.
23. Young embryo, somewhat older than the stage of fig. 21, seen in profile.
24. Embryo, about in the stage of fig. 23, seen in profile, under compression. *a*, mouth ; *b*, digestive sac ; *c*, anal, and *d*, oral tentacles ; *e*, the vesicles of the circular vascular ring at the base of the oral tentacles ; *f*, calcareous oral ring ; *g*, the five longitudinal water-canals ; *h*, water-tubes leading to the base of the ambulacra ; *i*, ambulacral tentacles of the ventral side ; *k*, Polian vesicle ; *l*, stone canal ; *m*, circular oral vascular ring.
25. Young embryo, seen from the dorsal side, with the first-formed five oral ambulacral tentacles branching, and with five new tentacles placed in between them.
26. Embryo, about in the stage of fig. 25, seen from the mouth side under compression. *a*, the ten oral tentacles ; *b*, mouth ; *c*, membranous ring round the actinostome ; *d*, outline of the oral calcareous ring ; *e*, circular water-ring ; *f*, Polian vesicle ; *g*, longitudinal water-canal ; *h*, branch of water-canal leading to the ventral ambulacral suckers ; *i*, ventral ambulacral suckers ; *k*, transverse muscular bands ; *l*, longitudinal muscular bands ; *m*, stone canal ; *n*, anus.
27. Embryo, seen from the dorsal side, with three pairs of ventral ambulacral tentacles, and ten branching oral tentacles.

PLATE XV.

Development of HOLOTHUROIDEA, *continued, and Comparison of* ECHINODERM LARVÆ. *Figures from* EMIL SELENKA *and* JOHANNES MÜLLER.

1 – 13. *Cucumaria doliolum.* From E. Selenka, Zur Entwickelung der Holothurien (Holothuria tubulosa und Cucumaria doliolum), Ein Beitrag zur Keimblattertheorie, 1876. Pls. XI., XII. Zeits f. Wiss. Zool., XXVII.

a. Anal opening.
b l. Blastoderm.
e k. Ectoderm.
e n. Entoderm.
f. Segmental cavity.
m. Mesoderm.
m'. Outer mesoderm plate.
m''. Inner mesoderm plate.
o. Mouth.
w. Cord of vibratile cilia.
x. Water-system pore.
A. Œsophagus.
B. Stomach from which has separated the vaso-peritoneal vesicle.
H. Stone canal.
N. Nucleus.
P. Peritoneal sac.
P r. Right peritoneal sac.
P l. Left peritoneal sac.
u. Original digestive cavity of larva.
V. Water-system sac.
V p. Vasoperitoneal sac.

1. Egg found floating on the surface, in process of segmentation. *n*, germinative vesicle.
2. Completely segmented blastula. *s*, the part of the blastoderm where the invagination will take place.
3. The blastula has become larger. *a*, position of the future anus ; *m*, mesoderm cells.
4. Gastrula at the end of the second day ; longitudinal section. The migratory cells have accumulated in part towards the ectoderm at *d*, to form later the circular muscular system, and in part remain free in the segmental cavity. *s*, the part of the blastoderm where the invagination to form the digestive cavity can be traced by the slight depression at that pole.
5. Longitudinal section of an older gastrula.
6. Sagittal section of larva at the end of the fourth day.
7. *A'*, *B'*, *C'*, show the mode of formation of the water system, and of the two peritoneal sacs as diverticula from the original digestive cavity ; *h*, the point where the fully formed invaginated œsophagus strikes the digestive cavity.
8. Free swimming embryo. ξ, oil globule of the head.
9. Section of a larva, about in the stage of fig. 8. Lettering as before, with the following additions : —

   E. Circular vascular ring, with the five oral tentacular vesicles.
   F. The five ambulacral canals.
   G. The ventral ambulacral canal, with two ambulacral tentacles.
   X. Stone canal.
   J. Spheres of food in the stomach.
   K. Anterior lobe of embryo.
   P'. Wall of the peritoneal sac.
   δ. Cells with lashes, originating from the vibratile cord.
   +. Polian vesicle. (This is cut off.)

10. Older embryo, swimming freely.

    T. The five oral tentacles, which can be nearly entirely contracted.
    G. The two ventral ambulacral tentacles, with rudimentary sucking disks.
    ξ. Oil globule in anterior part of the head.

11. Young Cucumaria creeping. The bands of vibratile cilia have disappeared ; the anterior portion of the young Cucumaria is rounded, and the oil globule of the interior has been resorbed. *D*, ventral ambulacral tentacles, with calcareous sucking disks ; *S*, calcareous plates of the ectoderm.

12–13. *Abnormal Blastulæ of Holothuria tubulosa.* From E. Selenka, Zur Entwickelung der Holothurien, 1876, Pl. XIII. Quoted above.

14–27. *Homologies of Echinoderm Larvæ.* From Johannes Müller, Ueber den Allgemeinen Plan in der Entwickelung der Echinodermen, Pt. VI., 1852, Pl. II. Quoted above.

A. Anterior or oral plastron.

B. Posterior or anal plastron, in which is placed *o*, the anal opening.

D. Intermediate oral area, in which is placed *C'*, the mouth, and *a*, the anterior, *b*, the posterior edge of the transverse part of the oral vibratile cords; *c*, the connecting vibratile cord between the oral and anal plastrons.

d. Posterior lobe of the vibratile cord of the oral plastron.

d'. Anterior lobe of the vibratile cord of the anal plastron.

e, *e'*. Arms of the anterior and posterior plastrons on the oral side.

g, *g'*. Arms of the anterior and posterior part of the dorsal vibratile cord.

x, *x*. Processes forming in Echini arms at the anal extremity, not in the line of the vibratile cord.

M. Connected vibratile cord of the dorso-anal system.

N. Connected vibratile cord of the oral ventral plastron.

y, *y*. Brachiolarian appendages of the Starfish larva. The whole of the Brachiolaria of fig. 27, beyond the brachiolarian arms, corresponds to the Starfish larval organ, such as has been figured by Sars, Thomson, Ludwig, and others.

14–16. Shows the development of an Auricularia from the typical Echinodermal larva, fig. 14.

17–19. The development of an Ophiuran Pluteus from the typical Echinodermal larva, fig. 17.

20–23. The development of an Echinoid Pluteus from the typical Echinodermal larva, fig. 20.

24–27. The development of a Starfish Brachiolaria from the typical Echinodermal larva, fig. 24.

For modifications of the typical form of development of the Holothurians, see Pl. XIV. figs. 13–27, Pl. XV. figs. 5–11.

For modifications of the typical form of development of the Ophiurans, see Pl. III. figs. 1–20, 26–31.

For modifications of the typical form of development of the Starfishes, see Pl. V. figs. 1–4, 15–49, Pl. VI.

For modifications of the typical form of development of the Sea-urchins, see Pl. XII. figs. 30–34.

INDEX.

PAGE

Amphiura ? Pl. III. 14
Amphiura squamata, Pl. III 13, 14
Antedon Larva, Pl. II. 12
Arbacia punctulata, Pl. IX. 29, 30
Arbacia pustulosa, Pl. IX. 28, 29
Asteracanthion berylinus, Pl. VII. 22
Asteracanthion flaccida, Pl. VI. 20
Asteracanthion pallidus, Pls. VII., VIII. . . 23–27
Asteracanthion violaceus, Pl. VI. 20
Asterias glacialis, Pl. VIII. 27
Asterina gibbosa, Pls. V., VI. 17–19
Asteroidea, Development of, Pls. V.–VIII. . . 17–27
Asthenosoma hystrix, Pl. XII. 36
Auricularia with calcareous wheels, Pl. XIII. . 38
Auricularia with calcareous gland, Pl. XIII. . . 39
Auricularia with cleven spheres, Pl. XIII. . . 39
Auricularia with elastic spheres, Pl. XIII. . . 39
Auricularia with dendritic anal gland, Pl. XIII. 40

Bipinnaria asteriyera, Pl. VIII. 27
Brissopsis lyrifera, Pl. XII. 37

Crinoidea, Development of, Pls. I., II. . . 9–12
Comatula, Pls. I., II., ... 9–12
Comatula rosacea, Pls. I., II. . . . 9–12
Comatula mediterranea, Pl. I. 9
Conolampas Sigsbei, Pl. XII. 37
Cucumaria doliolum, Pl. XV. 43

Diadema setosum, Pl. XII. 36
Dorocidaris papillata, Pl. XII. 36

Echinarachnius parma, Pls. XI., XII. . . 35, 37
Echinaster sanguinolentus, Pl. VI. . . . 20
Echinaster Sarsii, Pl. VI. 21
Echinaster sepositus, Pl. V. 17
Echinoidea, Young Stages of, Pl. XII. . . . 36
Echinocardium cordatum, Pl. IX. . . . 29
Echinocyamus pusillus, Pl. XI. 35
Echinoderm Larvæ, Homologies of . . . 44

PAGE

Echinoidea, Development of, Pls. IX.–XII. 28–37
Echinoid Pluteus, Pl. XI. 34
Echinus acutus, Pl. XI. 35
Echinus brevispinosus, Pl. XI. 35
Echinus lividus, Pl. XI. 35
Echinus miliaris, Pl. IX. 28
Encope emarginata, Pl. XII. 37

Goniocidaris canaliculata, Pl. XII. 36

Hemiaster cavernosus, Pl. XII. 37
Holothuria tremula, Pl. XIV. 41
Holothuria tubulosa, Pl. XIV. 41
Holothuroidea, Development of, Pls. XIII.–XV. 38–44
Homologies of Echinoderm Larvæ, Pl. XV. . . 44

Mellita longifissa, Pl. XII. 37
Mellita sexforis, Pl. XII. 36
Mellita testudinata, Pl. XII. 36

Ophiocoma rosula, Pl. III. 14
Ophiopholis ? Pl. III. 14
Ophiopholis bellis 14
Ophiothrix fragilis, Pl. IV. 15
Ophiothrix versicolor, Pl. IV. 15
Ophiuroidea, Development of, Pls. III., IV. . 13–16

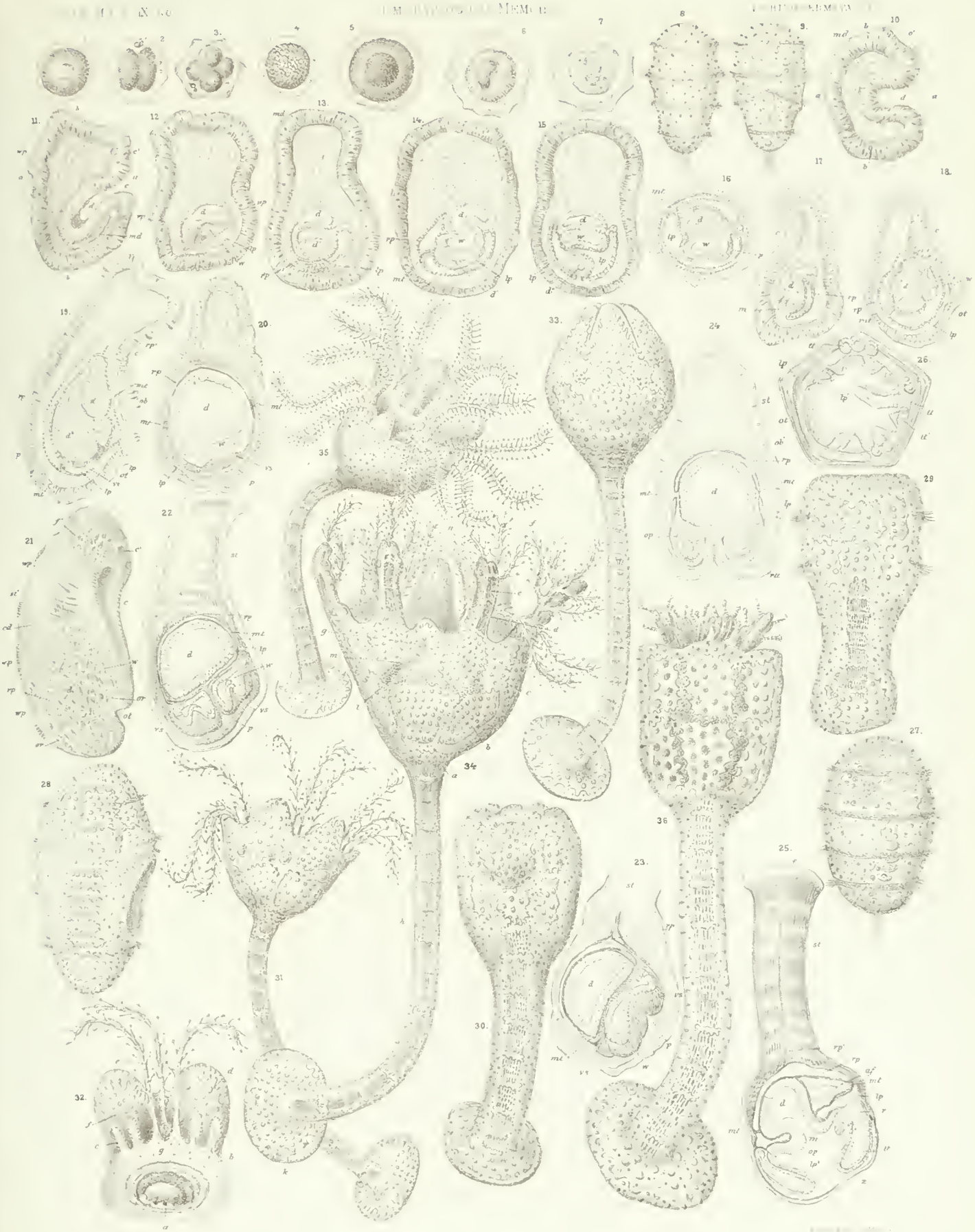
Pluteus bimaculatus, Pl. IV. 15
Pteraster militaris, Pl. VI. 20, 21

Spatangoid Pluteus, Pl. XI. 34
Spatangus purpureus, Pls. XI., XII. . . . 34, 37
Strongylocentrotus Dröbachiensis, Pl. X. . 31–33
Strongylocentrotus lividus, Pl. IX. . . . 28
Synapta, Pl. XIII. 38

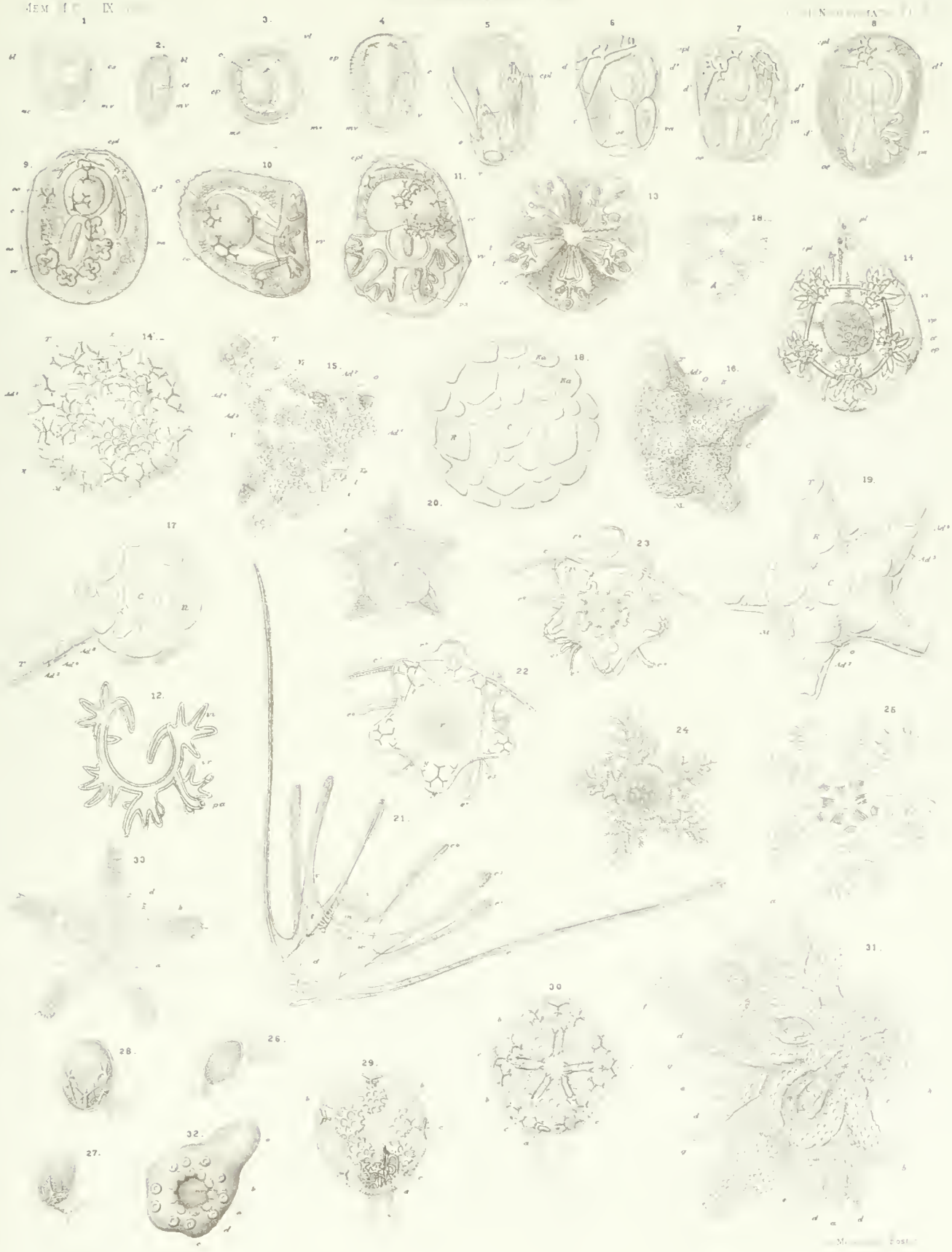
Viviparous Ophiurans, Pl. III. 13, 14

Wurmförmige Asterie, Pl. VI. 21

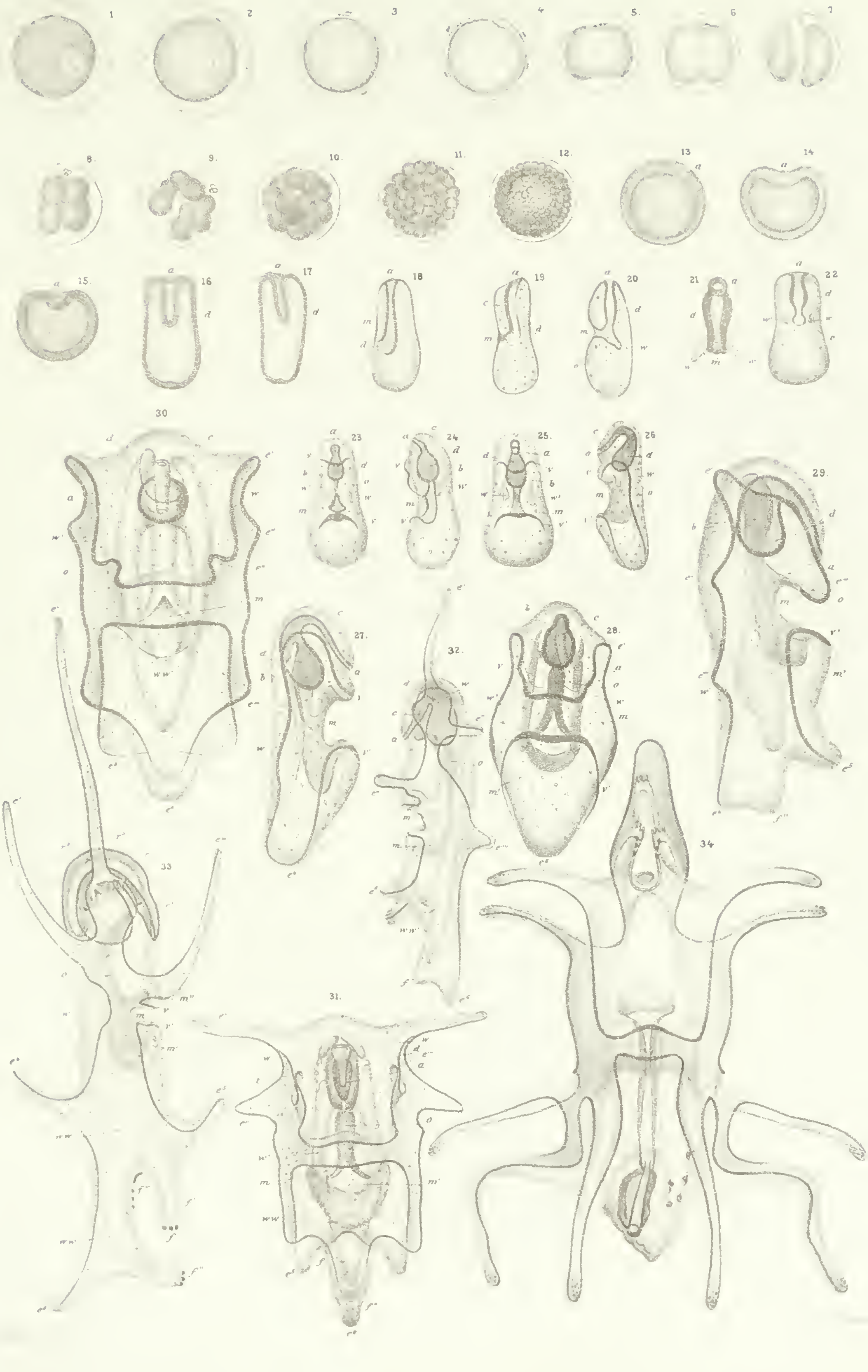
Young Stages of *Echinoidea*, Pl. XII. . . . 36

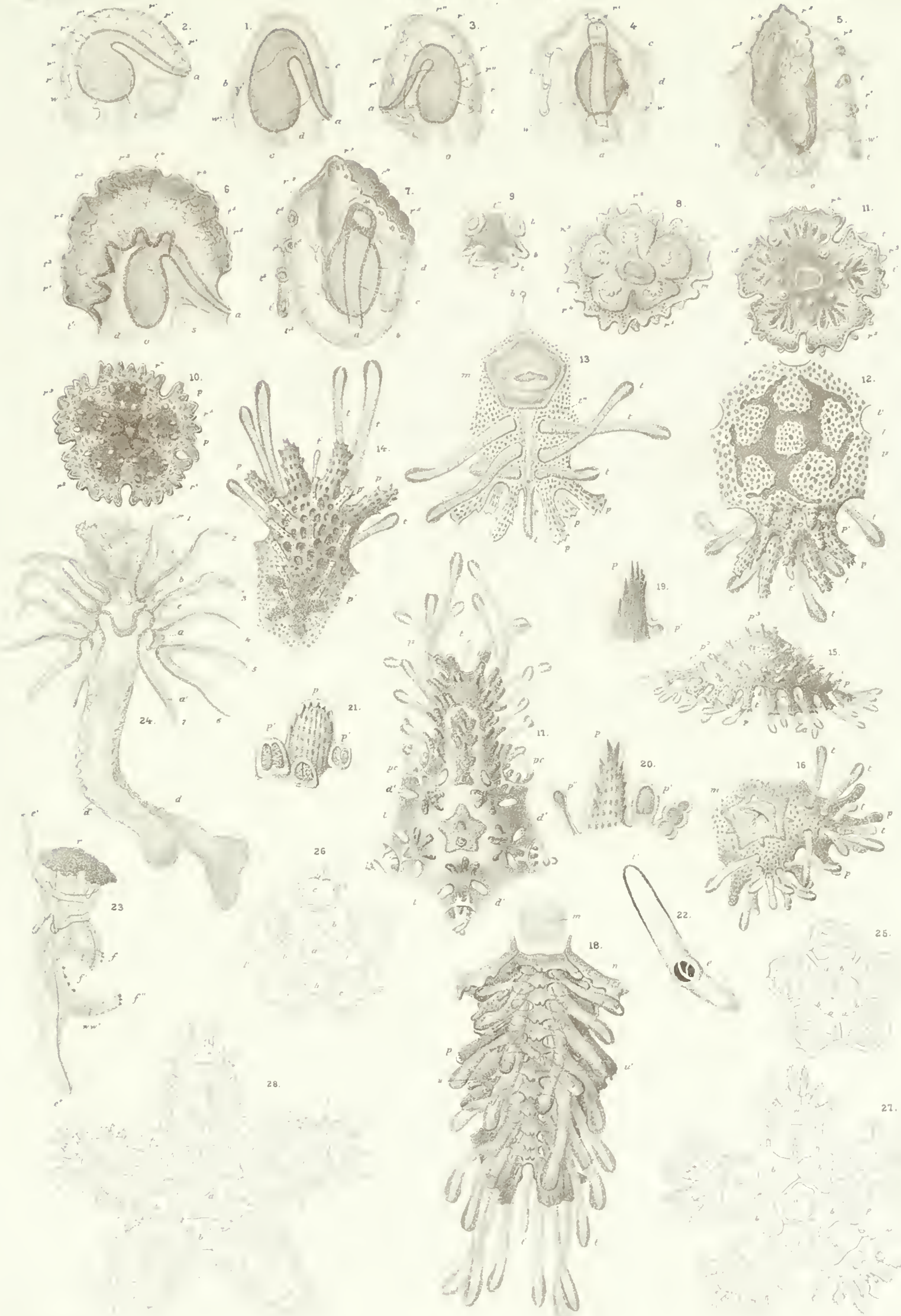


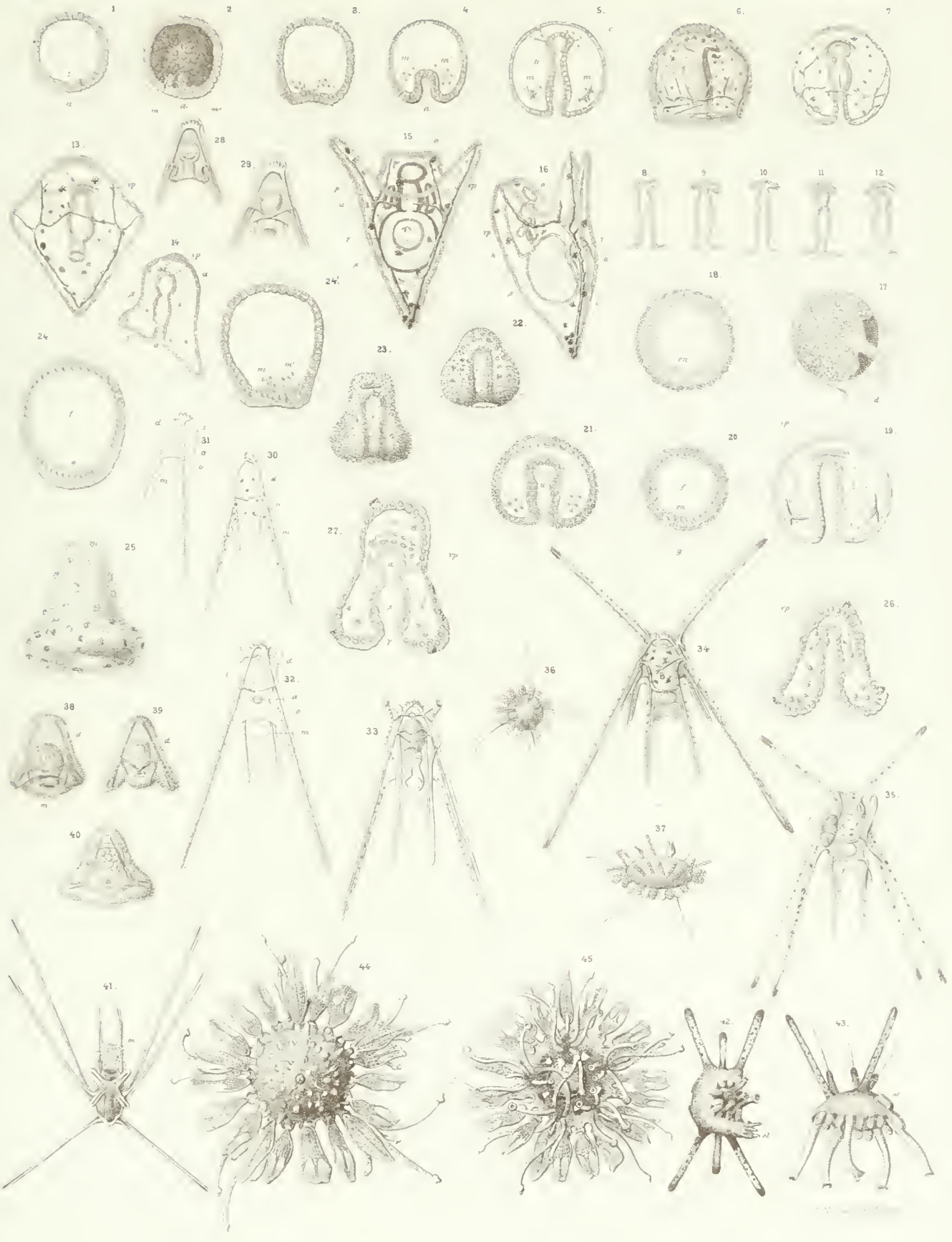

1.
2.
3.
4.
5.
6
7.
8.
9.
10.
11.
12.
13.
14
15.
16.
17
18.
19.
20.
21.
22.
23

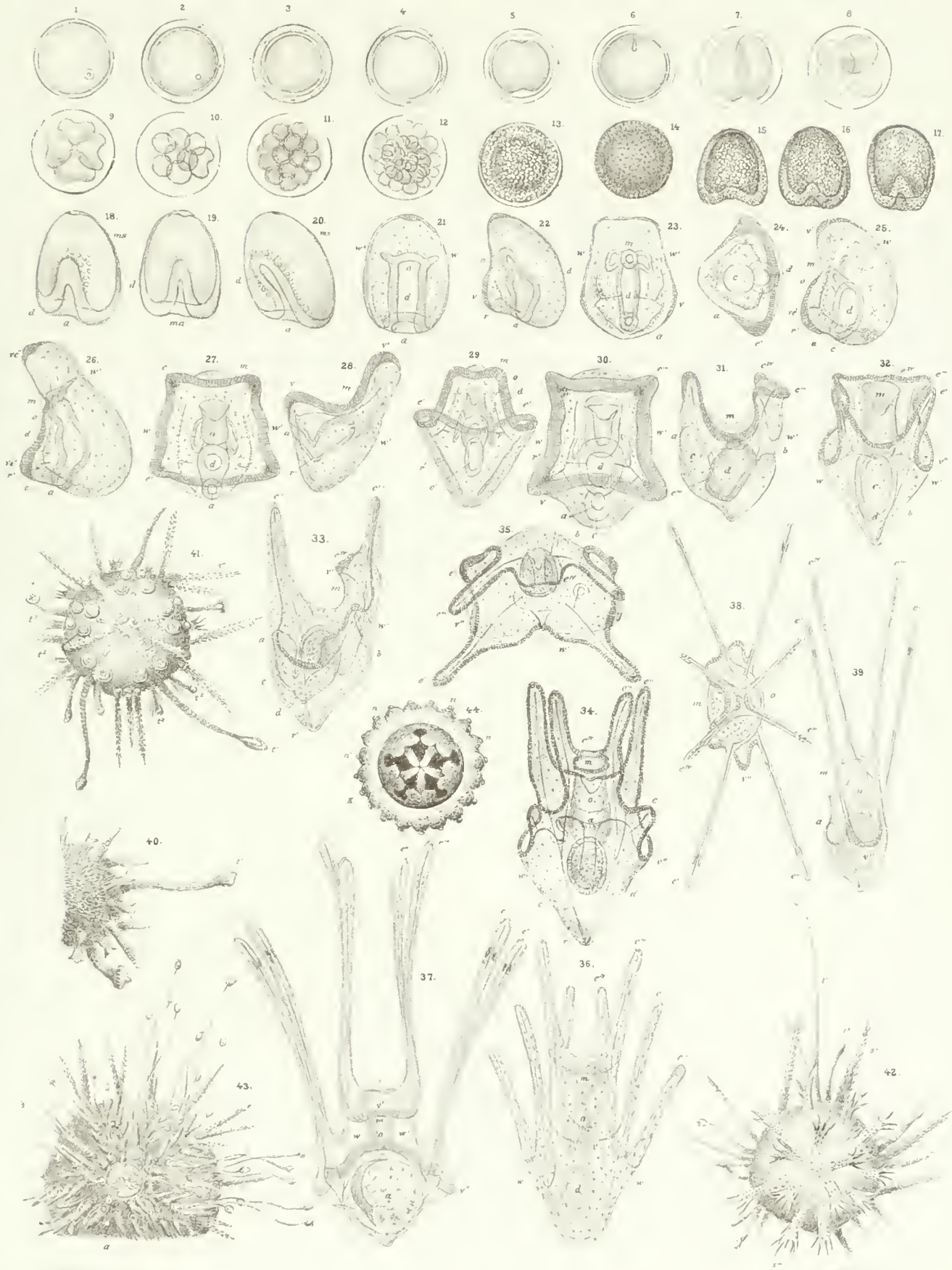



1
2
3.
4.
5
6
7
8
10.
9.
11.
13
12
18
14
19
23
21.
17.
15.
24
22
20.
16
26
27
25.
28
29.
30
31.
34.
33
32

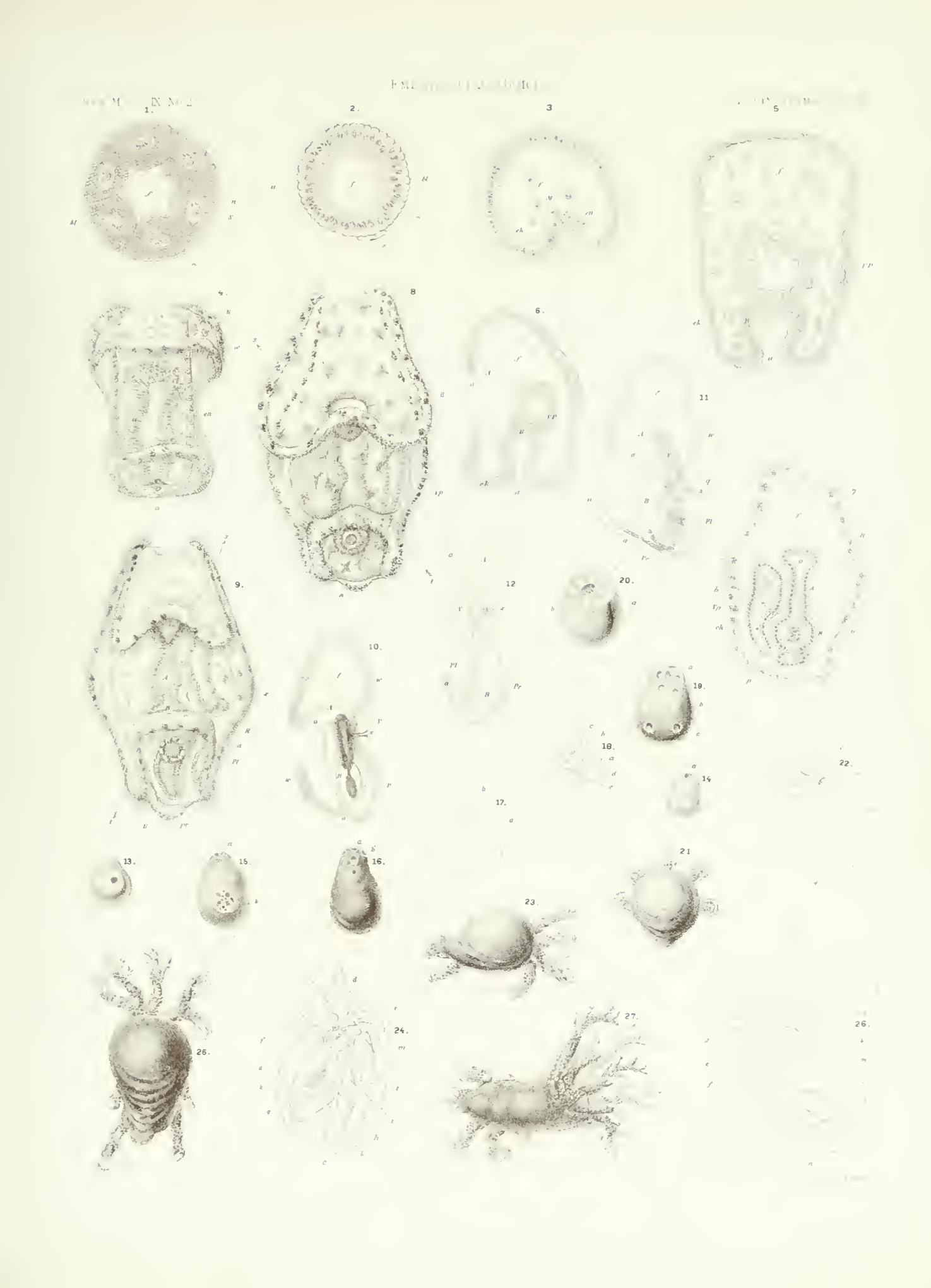

1
2
3
4
5.
6
7
8.
9.
10.
11.
12.
13.
14.
15.
16
17
18
19
20
21
22
23
24
25.
26
27.
28.
29.
30
31.
32.
33
34






1
2
3
4
5
6
7
8
9
10.
11.
12
13.
14
15
16
17.
18.
19.
20.
21
22
23.
24.
25.
26.
27.
28.
29
30.
31.
32.
33.
35.
38.
39
41.
44
34.
40.
37.
36.
43.
42.


1
2
3.
5.
8
6
4
7.
10.
11.
9.
30.
13.
15.
20
21
19
24.
23.
14
16
22.
17.
12
25.
29
28.
27.
26
18



Memoirs of the Museum of Comparative Zoölogy
AT HARVARD COLLEGE.
Vol. IX. No. 3.

SELECTIONS

FROM

EMBRYOLOGICAL MONOGRAPHS.

COMPILED BY

ALEXANDER AGASSIZ,
WALTER FAXON, AND E. L. MARK.

III.

ACALEPHS, AND POLYPS.

By J. WALTER FEWKES; By E. L. MARK.

WITH THIRTEEN PLATES.

CAMBRIDGE:
Printed for the Museum.
September, 1884.

NOTICE.

The present number of the Memoirs of the Museum forms the third Part of the Plates accompanying the Selections from Embryological Monographs.

Part I.	Crustacea, by Walter Faxon . . .	Mem.	M. C. Z.,	IX.	No. 1
" II.	Echinodermata, by Alexander Agassiz . .	"	"	"	2
" III.	Acalephs, by J. Walter Fewkes; Polyps, by E L. Mark	"	"	"	3

The Bibliography thus far published consists of: —

I.	Crustacea, by Walter Faxon . . .	Bull.	M. C. Z.,	IX.	No. 6
II.	Echinodermata, by Alexander Agassiz .	"	"	X.	" 2
III.	Acalephs, by J. Walter Fewkes . . .	"	"	XI.	" 10

Other Parts of the Bibliography and of the Plates are in preparation.

ALEXANDER AGASSIZ.

Museum of Comparative Zoölogy,
Cambridge, Mass., U. S. A.

June, 1884.

TABLE OF CONTENTS.

PLATES I–VIII. — *Development of the* HYDROZOA. Figures from ALEXANDER AGASSIZ, LOUIS AGASSIZ, GEO. J. ALLMAN, CARL CHUN, J. WALTER FEWKES, H. FOL, E. HECKEL, NICOLAUS KLEINENBERG, G. VON KOCH, A. KOWALEWSKY, JOHN MCCRADY, E. METSCHNIKOFF, and P. E. MÜLLER.

PLATES I., II., III., IV., and V. *Development of the* HYDROIDA.

PLATE I. —	1–11	*Hydra*	From NICOLAUS KLEINENBERG.
	12–22	*Candelabrum* (*Myriothela*) *phrygium*	" GEO. J. ALLMAN.
PLATE II. —	1–16	*Coryne mirabilis*	" LOUIS AGASSIZ.
	17–23	*Hybocodon prolifer*	" " "
PLATE III. —	1–5	*Obelia commisuralis*	" " "
	5ª	*Obelia geniculata*	" GEO. J. ALLMAN.
	6–11	*Clytia poterium*	" LOUIS AGASSIZ.
	12–16	*Laomedea flexuosa*	" GEO. J. ALLMAN.
	17, 18	*Laomedea amphora*	" LOUIS AGASSIZ.
	19–25	*Eucope polystyla*	" A. KOWALEWSKY.
	26–30	*Tubularia larynx*	" G. VON KOCH.
PLATE IV. —	1–10	*Polyxenia leucostyla*	" E. METSCHNIKOFF.
	11–13	*Cunina rhododactyla*	" " "
	14–17	*Cunina octonaria*	" JOHN MCCRADY.
	18–20	*Cunina rhododactyla*	" E. HECKEL.
	21–26	*Geryonia*	" H. FOL.
PLATE V. —	1–3	*Glossocodon curybia*	" E. HECKEL.
	4–7	*Glossocodon tenuirostris*	" J. WALTER FEWKES.
	8–15	*Clavatella*, *Dicoryne*, *Tubularia*, *Perigonimus*, and *Bougainvillia*	" GEO. J. ALLMAN.
	16	*Occania languida*	" J. WALTER FEWKES.
	17–18	*Zygodactyla Groenlandica*	" " "
	19	*Willia ornata*	" ALEXANDER AGASSIZ.
	20–22	*Lizzia octopunctata*	" J. WALTER FEWKES.
	23	*Lucernaria?*	" ALEXANDER AGASSIZ.
	24–25	*Schizocladium*, and *Aglaophenia*	" GEO. J. ALLMAN.
	26	*Cyanea artica*	" J. WALTER FEWKES.

PLATES VI. and VII. *Development of the* DISCOIDEA *and* SIPHONOPHORA.

PLATE VI. —	1–4	*Physalia* and *Velella*	From ALEXANDER AGASSIZ.
	5–7	*Rataria*	" J. WALTER FEWKES.
	8, 9	*Porpita* and *Velella*	" ALEXANDER AGASSIZ.
	10–19	*Epibulia*, *Globa*, *Halistemma*, and *Agalmopsis*	" E. METSCHNIKOFF.
	20–23	*Physophora magnifica*	" E. HÆCKEL.
	24	*Praya*	" E. METSCHNIKOFF.
	25	*Diplophysa inermis*	" J. WALTER FEWKES.
	26, 27	*Diphyes Sieboldii*	" P. E. MÜLLER.
	28	*Eudoxia Lessonii*	" J. WALTER FEWKES.
	29–31	*Eudoxia*, *Monophyes*, and *Muggiæa*	" CARL CHUN.

Plate VII. — 1, 2	*Agalma Sarsii*	"	E. Metschnikoff.
3–5	*Agalma elegans*	"	J. Walter Fewkes.
6, 7	*Agalma Sarsii*	"	E. Metschnikoff.
8–10	*Agalma elegans*	"	Alexander Agassiz.
11	*Agalma Sarsii*	"	E. Metschnikoff.
12–17	*Agalma elegans*	"	Alexander Agassiz.
18–19	*Agalma Sarsii*	"	E. Metschnikoff.
20	*Agalma elegans*	"	J. Walter Fewkes.
21	*Agalma Sarsii*	"	E. Metschnikoff.
22–29	*Agalma elegans* and *Physophora hydrostatica*	"	J. Walter Fewkes.

Plate VIII. *Development of the* Acraspeda.

Plate VIII. — 1–49	*Aurelia flavidula* and *Cyanea arctica*	From	Louis Agassiz.

Plates IX. and X. *Development of the* Ctenophora. Figures from Alexander Agassiz, Carl Chun, and J. Walter Fewkes.

Plate IX. — 1–37	*Beroë roseola* and *Pleurobrachia rhododactyla*	From	Alexander Agassiz.
38–40	*Callianira bialata*	"	Carl Chun.
41–47	*Beroë, Chiaja,* and *Hormiphora*	"	" "
48–50	*Beroë roseola*	"	Alexander Agassiz.
Plate X. — 1–19	*Cestus, Chiaja,* and *Lampetia*	"	Carl Chun.
20	*Ocyroë crystallina*	"	J. Walter Fewkes.

Plates XI–XIII. *Development of* Anthozoa. Figures from Alexander Agassiz, Angelo Andres, Wilhelm Busch, Carl Claus, Henri de Lacaze-Duthiers, Oscar Hertwig und Richard Hertwig, Étienne Jourdan, G. von Koch, A. O. Kowalevsky, Edward L. Mark, R. von Willemoes-Suhm, and Edmund B. Wilson.

Plate XI. *Development of* Zoantharia (Actiniæ).

Plate XI. — 1–25	*Actinia mesembranthemum*	From	Henri de Lacaze-Duthiers.
26–31	*Actinia sp.?*	"	A. O. Kowalevsky.
32–34	*Actinia equina*	"	Étienne Jourdan.
35, 36	*Adamsia diaphana*	"	Oscar Hertwig und Richard Hertwig.
37	*Aiptasia lacerata — Scissiparity*	"	Angelo Andres.

Plates XII. 1–36; XIII. 1–28. *Development of* Zoantharia.
Plates XII. 37–43; XIII. 29–59. *Development of* Alcyonaria.

Plate XII. — 1–6	*Cerianthus membranaceus*	From	A. O. Kowalevsky.
7	*Cerianthus membranaceus*	"	Étienne Jourdan.
8, 9	*Cerianthus membranaceus*	"	A. O. Kowalevsky.
10–15	*Cerianthus?* (*Dianthea nobilis* Busch)	"	Wilhelm Busch.
16–23	*Edwardsia sp.?*	"	Alexander Agassiz.
24–33	*Edwardsia lineata?*	"	Edward L. Mark.
34	*Edwardsia?*	"	Carl Claus.
35, 36	*Edwardsia?* (*Kallipha appendiculata* Busch)	"	Wilhelm Busch.
37–43	*Alcyonium digitatum*	"	A. O. Kowalevsky.
Plate XIII. — 1–11	*Astroides calycularis*	"	Henri de Lacaze-Duthiers.
12–15	*Balanophyllia regia*	"	Étienne Jourdan.
45,[1] 17	*Astræa sp.?*	"	A. O. Kowalevsky.
18–28	*Asteroides calycularis*	"	G. von Koch.
29–42	*Corallium rubrum*	"	Lacaze-Duthiers.
43, 44, 46	*Gorgonia verrucosa*	"	G. von Koch.
16[1]	*Gorgonia verrucosa*	"	A. O. Kowalevsky.
47–52	*Renilla reniformis*	"	Edmund B. Wilson.
53–56	*Umbellularia sp.?*	"	R. von Willemoes-Suhm.
57–59	*Alcyonium digitatum*	"	A. O. Kowalevsky.

(For continuation of Alcyonium, see Plate XII. Figs. 37–43.)

[1] Figures 15 and 16 were interchanged by the lithographer.

REFERENCES TO THE PRINCIPAL PHASES OF DEVELOPMENT IN HYDROZOA AND CTENOPHORA.

For a comparison of the earliest stages of development from the ovum to the morula, see *the Segmentation of the Egg* on

Plate I. figs. 1–6, Plate II. fig. 1, Plate III. figs. 13^a, 13^f, 15, 19–21, for the Hydroida (Hydra, Coryne, Laomedea, and Eucope).
Plate IV. figs. 1–4, 21–30, for the Trachymedusæ (Polyxenia and Geryonia).
Plate VIII. figs. 1–8, for the Acraspeda (Aurelia).
Plate IX. figs. 1–7, 9–13, 14–19, for the Ctenophora (Beroë and Pleurobrachia).

For the formation of the *Blastula* and *Gastrula*, see

Plate I. figs. 7–11, Plate III. figs. 14^c–14^k, 20–25, for the Hydroida (Hydra, Eucope, and Laomedea).
Plate IV. figs. 5–7, 31–34, for the Trachymedusæ (Polyxenia and Geryonia).
Plate VI. figs. 10, 20, Plate VII. figs. 1–5, for the Siphonophora (Epibulia, Physophora, and Agalma).
Plate VIII. figs. 9, 10, 11–23, for the Acraspeda (Aurelia).

For the development of the *Larva when Sessile*, see

Plate V. figs. 24^a–24^d, for the hydroid formed from a free frustule (Schizocladium).
Plate III. figs. 6–11, 12^a–12^c, 17, 18, for the development of the hydrauth (Clytia and Laomedea).
Plate V. figs. 25^a–25^c, for the development of the Corbula (Aglaophenia).
Plate VIII. figs. 24–39, Plate V. fig. 23 (Aurelia and Lucernaria).

For the development of the *Bud which becomes a Gonophore*, see

Plate I. figs. 1–6, 12–14 (Hydra and Myriothela).
Plate II. figs. 2–11, 14–21 (Coryne and Hybocodon).
Plate III. figs. 1–4, 15, 16, 26 (Obelia, Laomedea, and Tubularia).
Plate III. figs. 7–19, Plate V. figs. 20–22 (Cunina and Lizzia).

For the *Free swimming Larva developed from the Bud*, see

Plate I. figs. 20–22, Actinula (Myriothela).
Plate II. figs. 12, 13, 22, 23 (Sarsia).
Plate III. figs. 5, 5^a (Obelia). Plate III. figs. 27–30, Plate V. fig. 10, Actinula (Tubularia).
Plate IV. figs. 16–20, 35, 36 (Cunina and Geryonia).
Plate V. figs. 8, 9, Sporosac (Dicoryne); fig. 11, Ambulatory medusa (Clavatella); figs. 12, 14, 15, 16, 17, 18, 19 (Perigonimus, Bougainvillia, Oceania, Zygodactyla, and Willia).
Plate VI. figs. 8, 9 (Porpita, Velella).
Plate VIII. figs. 40–49, Plate V. fig. 26, for the Ephyra (Aurelia).

For the development of the *External Outlines of Larvæ which are never sessile*, see

Plate IV. figs. 7–10, 16, 20, 34–36 (Polyxenia, Cunina, and Geryonia). Plate V. figs. 1–7, 26 (Glossocodon and Cyanea).
Plate VI. figs. 2–7, for the Discoidea (Velella and Porpita), Plate VII. figs. 1–29, Plate VI. figs. 1, 10–31, for the Siphonophora (Physalia, Epibulia, Gleba, Halistemma, Agalmopsis, Agalma, Physophora, Praya, Diplophysa, Diphyes, and Muggiæa).
Plate IX. figs. 24–50, for the Ctenophora (Beroë, Chiaja, Callianira, Hormiphora, Pleurobrachia), Plate X. figs. 1–20 (Beroë, Cestus, Chiaja, Lampetia, Ocyroë).

REFERENCES TO THE PRINCIPAL PHASES OF DEVELOPMENT IN ANTHOZOA.

Segmentation.

PLATE XIII. 58, 59, and PLATE XII. 37, 38, for Alcyonium digitatum.
" XIII. 43, for Gorgonia verrucosa.

Blastosphere (in section).

PLATE XI. 26, for Actinia mesembranthemum.
" XII. 1, " Cerianthus membranaceus.

Gastrula.

PLATE XI. 27, 28, for Actinia mesembranthemum.
" XII. 2, 3, " Cerianthus membranaceus.

Free-swimming larva.

PLATE XI. 5–23, for Actinia mesembranthemum.
" XII. 3–15, " Cerianthus membranaceus.
" " 16–20, 26, 34–36, for Edwardsia.
" " 39, for Alcyonium digitatum.
" XIII. 1–6, " Astroides calycularis.
" " 12, " Balanophyllia regia.
" " 16, " Gorgonia verrucosa.
" " 29–31, " Corallium rubrum.
" " 45, " Astraea sp. ?
" " 47, " Renilla reniformis.

Mesenteries and mesenterial filaments.

PLATE XI. 5–25, for Actinia mesembranthemum.
" " 29–31, " Actinia sp. ?
" " 33, " Actinia equina.
" " 35, 36, " Adamsia diaphana.
" " 37, *H'. J'. K'.* Aiptasia lacerata. (New mesenteries in the offshoot.)
" XII. 5, 8, 9, for Cerianthus membranaceus.
" " 16, 18, 20, 22, 23, 27–36, for Edwardsia.
" " 41–43, for Alcyonium digitatum.
" XIII. 2–5, 19, 20, for Astroides calycularis.
" " 15, for Balanophyllia regia.
" " 17, " Astraea sp. ?
" " 47–52, " Renilla reniformis.

Tentacles.

PLATE XI. 20–25, for Actinia mesembranthemum.
" XII. 5, 6, 12–15, for Cerianthus membranaceus.
" " 16–23, 26, 33, for Edwardsia.
" XIII. 4, 10, for Astroides calycularis.

The corallum.

PLATE XIII. 8, 10, 11, 18–28, for Astroides calycularis.
" " 38, 41, for Corallium rubrum.
" " 46, " Gorgonia verrucosa.

Scissiparity.

PLATE XI. 37, for Aiptasia lacerata.

EMBRYOLOGICAL MONOGRAPHS.

PLATE I.

Development of the HYDROIDA. *Figures from* NICOLAUS KLEINENBERG *and* GEORGE J. ALLMAN.

C. c a v. Cavity of the planula.
c p. "Structureless capsule."
E. e b. Epiblast.
e b'. Epiblastic prominence.
e x. s. External pellicle, or perisarc.
G. g a. Gastric cavity.
H. h b. Hypoblast.
h b'. Hypoblastic elevation under the epiblastic.
I. i. Internal pellicle, or perisarc.
M. m b. Membrane.
N. n l. Nucleus (?).
O. o m. Ovum.
o r'. Thin region of walls at one pole where a mouth is later formed.
T. t a. Permanent tentacular processes.
t a'. Provisional tentacular appendages.
ζ. Sucker-disk at "proximal" extremity.
η. Situation of mouth at "distal" extremity.
θ. Cellular bodies surrounding the ovum.
λ. Orifice formed by an invagination of a tentacular process (*t a'*).
μ. Chamber filled with "granular protoplasm."
ο. Diverticulum from the cavity of the blastostyle from which the hernia-like bud forms.
ω. Highly refractile body.

1-11. Development of *Hydra*, from Kleinenberg, Hydra. Eine Anatomish — Entwicklungsgeschichtliche Untersuchung. Pl. II., Figs. 10, 11, 16, 17, 18, 19; Pl. III., Figs. 11, 12, 13, 14, 15.

1. Ovum of *H. aurantiaca* in amœboid condition, with chlorophyll granules and yolk spherules (pseudocells). The large cell in the center of the figure is the germinative vesicle. "Der Keimfleck des Keimbläschen ist in der Fig. nicht zu sehen, war aber noch vorhanden," Kleinenberg. The processes thrown out in all directions are protoplasmic. The yolk cells are formed from the protoplasm.
2. Germinative vesicle liberated from the enveloping substance. *m b.* Membrane. *n l.* Germinative dot. *ω.* Refractile body in the germinative dot.
3. Ovum shortly before the rupture of the surrounding cells (*θ*). *o m.* Ovum.
4. Segmented ovum with two spheres.
5. Still older ovum, with four spheres. No segmentation cavity is formed.
6. Morula.
7. Section through the germinative vesicle of *H. viridis.* *e x. s.* External pellicle. *g a.* Body cavity. *i. s.* Internal pellicle.
   There is a layer of cells surrounding the body cavity inside the internal pellicle. The external pellicle (perisarc of marine hydroid ?) is ultimately lost; the internal is absorbed.
8. Embryo of *H. aurantiaca.* *e b.* Epiblast. *h b.* Hypoblast. *i. s.* Internal pellicle. The external pellicle is ruptured and thrown off. The caudate cells ("nerve-muscular") form in the outer layer (*e b*). The inner layer (*h b*) in this stage becomes cellular.
9. Embryo of last-named species, seen in plane of longer axis. The future mouth opens near *o r'*. *e b.* Epiblast. *h b.* Hypoblast. *i. s.* Internal pellicle.
10. The same with the walls of the two poles similar. *e b.* Epiblast. *h b.* Hypoblast. *i. s.* Internal pellicle.

11. Embryo after the formation of the mouth. A small cluster of cells, not represented in the figure, is represented in Kleinenberg's figure just above the mouth. The tentacles appear in pairs, as hollow processes.

12–22. Development of *Candelabrum phrygium*, De Blain. *Myriothela phrygia*, Fab.). From Allman, On the Structure and Development of Myriothela. Phil. Trans. Roy. Soc. CLXV., Pl. LVII., figs. 1, 2, 3, 4; Pl. LVIII., figs. 1, 2, 4, 5, 6, 7, 8.

12. Very young bud, which later forms a gonophore. *e b*. Epiblast forming a slight elevation. *h b'*. Accompanying hypoblastic prolongation into the epiblastic prominence. *μ*. Cavity filled with granular protoplasm. *σ*. Diverticulum from the chamber or cavity of the blastostyle.
13. "More advanced stage (female); the gonophore has formed a very decided projection from the external surface of the blastostyle, and the gonogenetic chamber (*μ*) has begun to show a differentiation in its contents." Allman. *e b'*. Epiblastic prominence above the surface of the blastostyle. *h b*. Hypoblastic layer. *μ*. Gonogenetic chamber. *σ*. Diverticulum from the cavity of the blastostyle.
14. The female gonophore still more developed. *mb*. Membrane. *μ*. Gonogenetic chamber. *σ*. Diverticulum from the cavity of the blastostyle.
15. A gonophore older than the last.
    The wall of the gonophore in a stage of the same, older than figure 15, is ruptured, and the contents escape. It (the portion escaping) is, however, grasped by a peculiar clasper, which holds fast to its capsule by a sucker-like body, and certain changes take place while it is in this embrace.
16. Planula. A segmentation about which there is little known has taken place, and the planula has an outer layer (*e b*), an inner layer (*h b*), while a cavity (*cav.*) has been formed by the liquefaction of the central part of the mass. It is enveloped in a membrane (*mb*), and enclosed in a capsule, which is firmly held by the claspers. There are *no* cilia.
17. Embryo with minute pits (\) forming the orifices of invaginations of the wall of the planula, and enclosed in a capsule (*cp*). These invaginations are composed of two layers, and later, when reversed, form the provisional appendages (*ta'*).
18. Embryo still enclosed in a capsule and held by the claspers, both of which structures are not represented. The invaginated appendages (*ta'*) have been turned outward.
19. Embryo taken from a capsule in which small papillæ have begun to form at one end. These (*ta*) later elongate into the permanent tentacles. *ta'*. Provisional appendages.
20. Embryo free from the capsule, which has begun to fasten itself at one extremity by a disk (*ζ*). *η*. Position of the mouth. *ta*. Permanent tentacles. *ta'*. Transitory arms.
21. The larva permanently fastened, possessing permanent arms (*ta*), but destitute of transitory appendages.
22. Free, locomotive embryo (actinula), just after its escape from the capsule, and younger than the earliest attached condition (20). *ta*. Permanent arms. *ta'*. Transitory arms. *ζ*. Disk for fixation. *η*. Mouth region. The arms are represented extended. When retracted, they have the form of ovoid bodies of small size. The larva remains in the actinula condition only a few days.

PLATE II.

Development of the Hydroida, *continued. Figures from* Louis Agassiz.

C. can. crc. Circular canal.
cav. Cavity.
E. e b. Epiblast.
eb. gm. Epiblastic bud.
ex. man. External wall of the manubrium.
ex. ta. External wall of the tentacle.
ex. vel. External wall of the velum.
F. fd. Constriction in umbrella.
G. gn. Stomach.
gm. Bud.
H. h b. Hypoblast.
hb. gm. Hypoblastic bud.
I. i. man. Internal wall of the manubrium.
i. ta. Internal wall of the tentacle.
i. vel. Internal wall of the velum.
i. w. Internal bell wall.
M. man. Manubrium.
man'. Confluence of the manubrium and bell.
mds. gm. Medusa bud.
2 *mds. gm.* } Successively formed medusa buds.
3 *mds. gm.* }
m. w. Middle wall.
N. ncl. Nucleolus.
nl. Nucleus.
O. ocl. Ocellus.
O. or. Mouth.
P. pig. Pigment.
py. Polyp.
py. ta. Tentacle of the hydroid.
py. ta'. Inside (around the mouth) row of hydroid tentacles.
R. r. tb. Radial tubes.
T. ta. Tentacles.
ta'. Tentacular bulb cavity.
tab. Enlargement of the tentacle at the union with the border of the bell.
tb. – *tb*^{6}. Chymiferous tubes.
tb. ta. Tube which lies in the same portion of bell (spheromere) as that from which the tentacle hangs.
U. ubr. Umbrella.
V. vel. Velum.
vt. Vitellus.
vt. m. Vitelline membrane.
X. x^{1}, x^{2}. Inverted external wall.
ξ. Projection of the umbrella near the margin.
θ. Chitinous perisarc.
θ'. Ferule-like enlargement of the perisarc.
λ. λλ. Hydroid head.

The figures on this plate were arranged by A. Agassiz.

1–23, from Agassiz, Contributions to the Natural History of the United States, Vol. III. Pls. XVII. figs. 2, 11, 12 ; XVIII. 1, 2, 3, 4, 5, 6, 10, 11, 12, 14, 15^{a}. Vol. IV. Pl. XXV. figs. 2, 2^{a}, 3, 4, 5, 9, 12, 13, 14, 15.

1–16. *Coryne mirabilis*, Ag.

1. Ovum. *ncl.* Nucleolus. *nl.* Nucleus. *vt.* Vitellus. *vt. m.* Vitelline membrane.
2. A medusa bud just beginning to form. *e b.* and *h b.* Outer and inner layer of the hydroid. *eb. gm.* and *hb. gm.* Outer and inner layer of the bud.
3. Bud little older than the last; "stretched longitudinally." *e b.* and *h b.* Outer and inner layers of the hydroid. *eb. gm.* and *hb. gm.* Outer and inner layers of the bud. *tb.* Beginning of the system of chymiferous tubes.
4, 5. Buds more advanced in age, in the latter of which radial tubes have developed, two of which are shown in profile. *e b.* and *h b.* Outer and inner layers of the hydroid. *tb.* Chymiferous tube.
6. Older bud showing chymiferous tubes from the side and face. *e b.* Epiblast of hydroid. *h b.* Hypoblast of the hydroid. *hb. gm.* Hypoblast of the bud. It will be noticed that the latter would seem to be the epiblast. I think it is either hypoblastic or a third layer, — the gelatinous layer (mesoblast ?). *tb.* Chymiferous tube in profile. *tb'.* Chymiferous tube in face.

7. Older embryo, in which a "horn-like sheath" (θ) (perisarc) has formed over the surface of the bud. *e b.* Epiblast of hydroid. *h b.* Hypoblast of the hydroid. *hb. gm.* Hypoblast of bud (?). This may be epiblastic. *tb.* Tube in profile. *tb'.* Tube in face.
8. Older bud, in which hypoblast and epiblast are well marked. *e b.* Epiblast. *h b.* Hypoblast. The circular canal (*can. crc.*) is beginning to form by an approximation of two radial chymiferous vessels on each side. x^1, x^2. Infolded outer wall. θ. Perisarc.
9. In this bud, somewhat older than the preceding, the circular canal (*can. crc.*) has formed by a coalescence of the extremities of the radial tubes. *e b.* Epiblast. *h b.* Hypoblast. *i. w.* Internal bell wall. *m. w.* Middle bell wall. *man.* Manubrium. *ta.* Tentacle.
10. Older bud, in which the circular canal (*can. crc.*) is fully formed, and a velum is developed. *e b.* Epiblast. *ex. ta.* External wall of the tentacle. *ex. man.* External wall of the manubrium. *ex. vel.* External wall of the velum. *i. man.* Internal wall of the manubrium (?). *i. ta.* Internal wall of the tentacle. *i. vel.* Internal wall of the velum. θ. Perisarc.
11. Older medusa bud, with tentacles coiled up in the future bell cavity. *can. crc.* Circular canal. *e b.* Epiblast. *ex. man.* External wall of the manubrium. *ex. ta.* External wall of the tentacle. *ex. vel.* External wall of the velum. *i. man.* Internal wall of the manubrium. *i. ta.* Internal wall of the tentacle. θ. Perisarc.
12. A constriction takes place at the point where the medusa bud rises from the hydroid, and the bud is separated from its attachment and swims away. The perisarc is ruptured to allow this escape. Free medusa, called *Sarsia*, which, according to Agassiz, develops from the buds of *Coryne* (tentacles cut off). *fd.* Folds in the side walls of the bell. *man.* Manubrium. *or.* Mouth. *tb.* Chymiferous tube. σ. Remnant of a tube which formerly connected the cavity of the hydroid and that of the manubrium.
13. Older *Sarsia*. *man.* Manubrium; the upper letters (*man.*) indicate a bulbous enlargement of the cavity of the manubrium where it joins the hydroid. *can. crc.* Circular canal. *or.* Mouth. *ta.* Tentacles. *ubr.* Umbrella. *vel.* Velum.
14. *Coryne*, showing the relationship of the medusa-buds (future *Sarsia*) to the tentacles of the hydroid. *mds. gm.* Medusa buds. *py.* Hydro-polyp axis. *py. ta.* Polyp tentacles.
15. The male hydroid; the almost perfect medusa is persistent, "developing the spermatic mass around the proboscis to an enormous extent," Agassiz. *or.* Mouth. *py. ta.* Tentacles of the hydroid. *py. s.* Stem of the polyp. *man.* Manubrium, "loaded with sperm." *ta.* Tentacle. σ. Point of attachment of bud (gonophore ♂) to the hydroid.
16. A more developed male gonophore, which, according to Agassiz, is persistent, and has discharged the spermatic contents. *vel.* Infolded velum. σ. Point of attachment of the umbrella to the hydroid.

17–23. *Hybocodon prolifer*, Ag.

17. A profile view of the head of the hydroid, crowded with medusa buds (*mds. gm*). *py. ta.* Peripheral row of tentacles. *py. ta'.* Middle row of tentacles. *py.* Hydroid axis. θ. Ferule-like enlargement of the perisarc. λ. λλ. Bases of tentacles (peripheral).
18. Head of a hydroid, with the circle of peripheral tentacles (*ta.*) cut off. *mds. gm.* Medusa buds. *py.* Hydroid axis. θ'. Ferule-like enlargement of the perisarc.
18a. Head of the hydroid without medusa buds, showing the position of the two rows of tentacles. *py. ta.* and *py. ta'.* Tentacles drawn together.
19. A young bud in earliest condition.
19a. The same; somewhat older. *e b.* Epiblast. *h b.* Hypoblast. *tb.* Chymiferous tubes.
20. A well developed medusa, just before rupturing its connection with the hydroid, and showing the tentacles on one side. *cav.* Bell cavity. *can. crc.* Circular canal. *e b.* Epiblast. *h b.* Hypoblast. *man.* Manubrium. *man'.* Base of manubrium, the cavity of which is somewhat enlarged. *mds. gm.* Medusa buds. The second and third formed buds have begun to appear, and are lettered in order of appearance, — 2 *mds. gm.*, and 3 *mds. gm.* *ta.* Tentacle. *ta'.* Base of tentacle not yet enlarged into a bulb. *tb. ta.* Chymiferous tube in the same spheromere as that to which the tentacle hangs. tb^3. Tube diametrically opposite the tentacular tube. tb^6. Chymiferous tube facing the observer. tb^4. Continuation of a chymiferous tube into one of the tentacles. ξ. Enlargement of the tube at the junction of tb^4 and the circular canal (*can. crc.*).
20a. A (female ?) medusa partially developed from the base of the tentacle. *cav.* Internal cavity. *e b.* Epiblast. *hb.* Hypoblast. *tb., tb'.* Chymiferous tubes in profile and in face. 2 *mds. gm.* A secondary medusa, budding from the walls of the first. The medusa buds represented in the figure are taken from a medusa already formed.
21. View of a medusa older than the last, still attached to the hydroid (seen looking at the inner face of the tentacle). *cav.* Bell cavity. *e b.* Epiblast. *gm.* A small bud, which will probably later develop into a tentacle. *hb.* Hypoblast. *man.* Manubrium. *man'.* Base of manubrium. *mds. gm.*–3 *mds. gm.* Medusa

buds in various conditions of growth. *ta.-ta*^{3}. Tentacles. *tb. ta.* Chymiferous tube, which lies in the same spheromere as the cluster of tentacles.

22. Medusa just escaped from its hydroid connection with a single well developed tentacle. *can. crc.* Circular canal. *man.* Manubrium. *r. tb.* Radial tube. *ta.* Tentacle. *ta'.* Cluster of small bodies at the tentacular base. *tb. ta.* Tentacular tube. *vel.* Velum. ♀. A symmetrical development of the umbrella near the origin of the tentacle.

23. The same, a day after freedom from hydroid (seen from oval side). *can. crc.* Circular canal. *man.* Manubrium. *pig.* Pigment ? *ta.* Tentacle. *ta'.* Cluster of bodies at the base of the tentacle. *tb. ta.* Tentacular tube. *vel.* Velum.

PLATE III.

Development of the Hydroida, *continued. Figures from* Louis Agassiz, George J. Allman, G. von Koch, *and* A. Kowalewsky.

A. apex. Apex. Opercular summit of gonangium.
B. bl sto. Blastostyle.
C. can. circ. Circular Canal.
cal. Calyx, calycle, hydrotheca.
cav. Cavity.
E. e b. Epiblast.
e b'. Epiblast of stem.
G. ga. Stomach.
ga. cav. Gastric cavity.
H. h b. Hypoblast.
h b'. Hypoblast of stem.
M. man. Manubrium.
mem. Membrane.
O. o cy. Otocyst.
or. Mouth.
om. Ovum.
P. pr. Club-shaped body.
R. r. tb. Radial tubes.
T. ta. Tentacles of free or unattached form, gonophore.
ta'. Tentacles of hydrauth.
tb. Radial tubes.
U. ubr. Umbrella.
γ. Perisarc.
θ. Perisarc of calycle.
σ. Ferule-like enlargement of the peduncle of the calycle.
φ. Spadix of the sporosac.

Figures 1–5, 6–12ᵃ, 15, 16, were arranged by A. Agassiz.

1–5. *Obelia commisuralis*, McCr. From Agassiz, *op. cit.* Vol. IV., Pl. XXXIV. figs. 13, 13ᵃ, 16, 17, 18.

1–5ᵃ. Development of the medusa.

1. Profile view of a medusa bud just forming on the hydroid. *tb.* Chymiferous tube. *ubr.* Umbrella.
2. End view of a bud of the same age. *tb.* Chymiferous tube.
3. Two medusa-buds in different stages of growth. *e b.* Epiblast. *h b.* Hypoblast. *man.* Manubrium. *t b.* Chymiferous tube. *ubr.* Umbrella.
4. A medusa-bud, in the calycle, from the blastostyle. *e b.* Epiblast. *hb.* Hypoblast. *t b.* Chymiferous tube. *ubr.* Umbrella.
5. Free medusa (gonophore) as it escapes from the calycle (view from below). *can. circ.* Circular canal. *man.* Manubrium. *o cy.* Otocyst. *or.* Mouth. *ta.* Tentacle.

5ᵃ. *Obelia geniculata*, Allm. from Allman, A Monograph of Gymnoblastic or Tubularian Hydroids. *Ray Soc.*, 1869, p. 35, fig. 10.
Sexual zooid with ova (*om.*) budding from the radial canal (*r. t b.*) *ubr.* Umbrella. *φ.* "Spadix of the sporosac."

6–11. Development of the hydroid head (hydranth).

6–11. Clytia poterium, Ag. From Agassiz, *op. cit.* Vol. IV., Pl. XXVIII. figs. 4, 6, 7, 8, 9.
These figures show the successive stages in the growth of the hydranth up to the stage (fig. 11) in which it approximates the form of the adult. *cav.* Cavity of the calycle surrounding the axis. *cal.* Calycle (horny cup). *e b.* Epiblast. *e b'.* Epiblast of the pedicle. *ga.* Stomach. *h b.* Hypoblast. *h b'.* Hypoblast of the pedicle. *θ.* Perisarc.

12ᵃ–12ᶜ. Development of *Laomedea flexuosa*. From Allman, *op. cit.* p. 72.
12ᵃ–12ᶜ. Development of the hydranth.

12ᵃ. "Very early condition, in which the bud forms a simple cylindrical cæcal offset from the coenosome."
12ᵇ. "The distal extremity of the bud has become enlarged, so as to present the form of an inverted cone."

12ᵉ. "The cone has increased in size, and the soft parts towards its proximal end have become retracted from the external chitinous walls."

12ᵈ. "The internal structures have still further withdrawn themselves from the chitinous walls, with which they are now in contact only by a narrow proximal and a wider distal zone, between which they present the form of a tubular cylindrical column."

12ᵉ. "The distal zone of contact has become retracted from the summit of the cup-like envelope of chitine, tentacles have begun to sprout from its circumference, and a hypostome has risen from its centre. The leading features of the completely-formed hydranth are thus established, and its chitinous envelope has become the hydrotheca."

"The arrows in the figure indicate the direction of the currents in the somatic fluid." Allman, p. 72.

13ᵃ–13ᶠ, 14ᵍ–14ᵏ. *Laomedea flexuosa*. From Allman, *op. cit.* p. 86.
13ᵃ–13ᵇ. Development of the morula from the ovum.

13ᵃ. "Young ovum in the gonophore previously to the disappearance of the germinal vesicle; the germinal vesicle is here seen to contain several germinal spots."

13ᵇ. "The germinal vesicle and spots have disappeared."

13ᶜ. "The vitellus has become cleft into two segment spheres."

13ᵈ. "The ovum after a second cleavage."

13ᵉ. "The segmentation-spheres have become numerous, and many of them now show a distinct nucleus."

13ᶠ. "The segmentation-spheres have greatly increased in number, and a nucleus can now be detected in each of them."

14ᵍ–14ᵏ. Development of a planula from the morula.

14ᵍ. "The segmentation-spheres have still further increased in number, while the most superficial have become arranged into a stratum distinguishable from the deeper portion of the ovum."

14ʰ. "The superficial stratum has become more distinct, and is now seen to be composed of long prismatic cells."

14ⁱ. "The ovum has begun to elongate itself, and one end has become folded on the remainder."

14ᵏ. "The embryo, just after its escape in the form of a ciliated planula."

(Quotations from Allman, in 12–14.)

15. *Laomedea flexuosa*. 16. *Obelia geniculata*. From Allman, *op. cit.* p. 48.

15. Gonangium, with ova in its cavity in different conditions of development. *apex*. Opercular summit. *bl sto*. Blastostyle. *mem*. Membrane investing the contents of the gonangium. The ova appear in different stages of growth inside this membrane.

16. Gonangium, with medusæ in different conditions of growth, budding from the blastostyle. *apex*. Opercular summit. *bl sto*. Blastostyle. *mem*. Membrane investing the budding medusæ. *γ*. Calycle. The buds escape through an apical orifice.

17, 18. *Laomedea amphora*, Ag. From Agassiz, *op. cit.* Vol. IV., Pl. XXX. figs. 3, 5.

17. Portion of a stem with attached hydranths and calycles.

18. Magnified view of a single hydranth. *cal*. Hydrotheca. *g a*. Stomach. *p r*. Proboscidiform elevation. *t a'*. Tentacles. *σ*. Ferule-like formation of the perisarc.

19–25. *Eucope polystyla*. From Kowalewsky, НАБЛЮДЕНІЯ НАДЪ РАЗВИТІЕМЪ COELENTERATA., Pl. I. figs. 1, 3, 5, 8, 9, 10.

19. Segmented ovum.

20. Blastosphere, with the hypoblastic cells (*h b.*) budding into a central cavity. *e b*. Epiblast.

21. An older stage, more elongated and with thicker epiblastic cells. *h b*. Hypoblastic cells.

22. Planula with solid central mass of hypoblastic cells (*h b.*), surrounded by epiblast (*e b.*).

23, 24. Planula with a segmentation (gastric) cavity (*g. cav.*). According to Kowalewsky the epiblast in an embryo of this age divides into two layers. The deeper of these layers is in our figure lettered hypoblast (*h b.*), as it is considered hypoblastic in origin. *e b*. Epiblast. *h b*. Hypoblast.

25. Section of embryo showing the four infolding walls. (Compare with the four infolding walls dividing the young attached Scyphostoma of *Chrysaora*, and the young Actinozoan.)

26–30. *Tubularia larynx*. From Koch, Vorläufige Mittheilungen über Coelenteraten. *Jenaisch. Zeitsch.* Vol. VII., Pl. XXVI. figs. 12, 15, 16, 17, 19. "More or less schematic.")

26. A Tubularian bud showing (*e b.*) Epiblast, and *h b*. Hypoblast. Between these an intermediate layer?

27. Section of an embryo (actinula?), showing beginnings of tentacles on each side.

28. Actinula. *cav*. Cavity. *e b*. Epiblast. *h b*. Hypoblast. *t a*. Tentacle. The axis of the tentacle is solid, and composed of hypoblastic cells.

30. An embryo which has just attached itself. (Section.)

PLATE IV.

Development of the TRACHYMEDUSÆ. *Figures from* HERMANN FOL, JOHN MCCRADY, ELIAS METSCHNIKOFF, ERNST HÆCKEL, *and* B. ULJANIN.

B. *blp.* Blastopore.
E. *e b.* Epiblast.
e b'. Epiblastic cells.
e pl. Epiplasm.
G. *ga.* Stomach.
gm^1, *gm*^{2}. Buds in different conditions of growth.
H. *h b.* Hypoblast.
hb. c. Hypoblastic cells in centre of larva.
hb. ta. Hypoblast in the tentacular axes.
h pl. Hypoplasm.
L. *lab.* Lips.
M. *man.* Manubrium.
N. *n.* Nerve.
nl. Nucleus.
nt cy. Nematocyst.
O. *o cy.* Otocyst.
or. Mouth.
P. *pli.* Folds.
S. *se. cav.* Segmentation cavity.
S. *sp.* Spermatozoan.
T. *ta.* Tentacle.
ta^1. Points of attachment (tentacles ?).
ta^2. Tentacular prominence.
tb. Chymiferous tube.
U. *ubr.* Umbrella.
V. *vc.* Vacuoles.
vel. Velum.
vt. Vitellus.
vt. m. Vitelline membrane.
β. Star-shaped figure with dotted rays.
θ. Bridge connecting inner and outer cells.
σ'. Epiblastic cells.
ϕ. Rib connecting tentacular appendages with the bell margin.
ξ. Conical tongue projecting from the extremity of the tentacle with base surrounded by a cluster of nematocysts.

Figures 11, 12, 13, 19–27, 29, 30, were arranged by the author; the remainder were arranged by A. AGASSIZ.

1–10. *Polyxenia leucostyla.* From Metschnikoff, Studien über die Entwickelung der Medusen und Siphonophoren, *Zeit. f. Wiss. Zoöl.*, Vol. XXIV. Pl. III. figs. 1, 2, 3, 4, 5, 7, 8, 9, 10.

1. Free ovum just dropped in the water.
2. Ovum with four segments.
3. Segmented egg with eight segments.
4. Segmented ovum more advanced.
5. Morula.
6. A ciliated larva with an external (epiblastic) layer, and a spongy mass of vitelline cells.
7. An older larva, the body of which has become very much elongated, and the extremities are about to become tentacles. *hb. c.* Hypoblast of the central region of the body. *hb. ta.* Hypoblast of the tentacles. The difference between the cells in the two regions is evident.
8. Larva still older, in which two tentacles are formed.
9. Larva three days old, still ciliated, showing two long tentacles and the beginning of a new pair (*ta*^{2}). A gastro-cavity is seen in the middle of the larva below the new tentacle.
10. Larva four days old, with four tentacles, a well-marked stomach, and mouth. In older larvæ of *Polyxenia* four otocysts, each alternating with the tentacles, are next formed; and later, an increase of the number of tentacles, until the adult form is reached.

11–13. *Cunina rhododactyla.* From Metschnikoff, *op. cit.*, Pl. V. figs. 1, 2, 7.

11. Youngest observed "cunina bud," found in the gastric cavity. Perhaps developed from an egg. The long projection upward, with solid hypoblastic axis, is a tentacle. There are two layers, and a gastric cavity in the body.
12. The same, still older, with two tentacles and a mouth opening already formed. In stages intermediate between this and figure 13 there is little change besides the addition of new tentacles and the growth of a "stolon" from the middle of the disk. From this stolon, when there are twelve tentacles, buds develop.
13. A larva with two buds (gm^1. and gm^2.) on the stolon. The oldest bud (gm^1.) has two tentacles and an open mouth. The second bud has no tentacles. While the fate of these buds is unknown, the original medusa, upon which the budding has ceased, was observed to develop into a medusa resembling the parent.

14–17. *Cunina octonaria*, McCr. From McCrady, Description of Oceania (Turritopsis) nutricula, *nov. spec.*, and the Embryological History of a singular Medusan Larva, found in the cavity of its Bell, Pl. VI. figs. 20, 27 ; Pl. VII. figs. 32, 33.

14. Larval *Cunina*, found hanging in the bell cavity of *Modeeria* (*Turritopsis*) *nutricula*, McCrady. *ga.* Stomach opening through a long, flexible, tube-like body, through a terminal mouth (*or*). *ta.* Tentacles by which the larva hangs.
15. A still older larva, in which the umbrella (*ubr.*) and the otocysts (*o cy.*) have begun to form. Four tentacles have developed from the body in place of the two already formed. *ga.* Stomach. *or.* Mouth.
16. The young medusa now leaves the bell cavity of its host, and escapes in the form here represented. Seen from below (oral). *ga. c.* Gastric chamber. *man.* Manubrium. *o cy.* Otocyst. *ta.* Tentacle. *ubr.* Umbrella. This stage may be called the Ephyra stage.
17. Side view of the last. *o cy.* Otocyst. *ta.* Tentacle. *ubr.* Umbrella.

18–20. Development of *Cunina rhododactyla.*

18. A stolon taken from its attachment to the tongue of *Carmarina hastata*, with medusa buds in all conditions of growth.
19. From Uljanin, О ПРОИСХОЖДЕНІИ КУНИНЪ ПОЧКУЮЩИХСЯ ВЪ ЖЕЛУДКѢ ГЕРІОНИДЪ. ИЗВѢСТІЯ ИМПЕРАТОРСКАГО ОВЩЕСТВА ЛЮБИТЕЛЕЙ ЕСТЕСТВОЗНАНІЯ, АНТРОПОЛОГІИ И ЭТНОГРАФІИ. МОСКВА. 1876. Pl. 1. fig. 9. A similar but smaller stolon, with many attached medusæ before liberation from attachment. ta^1. Points of attachment to the "tongue" of the *Carmarina.*
20. From Hæckel, *op. cit.*, Pl. VI. fig. 76. A bud which has loosened its attachment to the stolon and become free (Ephyra stage). *ga.* Stomach. *n.* Nerve. *o cy.* Otocyst. *or.* Mouth. *ta.* Tentacle. *tb.* Tube (?). *ubr.* Umbrella. *vel.* Velum.

21–36. Development of *Geryonia.* From Fol, Die erste Entwickelung der Geryoniden eies, *Jenaisch. Zeitsch.*, Vol. VII. Pl. XXIV. figs. 1, 2, 3, 5, 6, 7, 11, 12, 13, 15 ; Pl. XXV. figs. 16, 17, 18, 19, 23, 24.

21. Fertilized ovum with spermatozoa (*sp.*) in the mucus envelope. *pli.* Folds in the egg membrane. *n.* Nucleus. *c pl.* Epiplasm (upper plasmic layer). *h pl.* Hypoplasm (lower plasmic layer). *vt. m.* Vitelline membrane. λ. Mucus covering.
22. The first plane of segmentation, dividing the ovum into two segmentation spheres. *c pl.* Epiplasm. *h pl.* Hypoplasm. *nl.* Cell nucleus. β. Protoplasmic dots arranged in star rays.
23. Embryo after the formation of a second plane of segmentation. *c pl.* Epiplasm. *h pl.* Hypoplasm. *nl.* Nucleus. *pli.* Folds in the membrane of the egg. *vc.* Vacuoles between the spheres. *vt. m.* Vitelline membrane.
24. Embryo after the formation of the fourth plane of segmentation, consisting of sixteen cells. A segmentation cavity is found within, into which opens a blastopore (*blp*). *nl.* Cell nucleus. *vc.* Row of vacuoles.
25. The ovum after the formation of the fifth plane of segmentation, consisting of thirty-two cells. The process of cell division, known as delamination, has begun in this embryo. *blp.* Blastopore. *vc.* Row of vacuoles. Each of the thirty-two segments is divided into two unequal parts, of which the smaller is formed of granular, and the larger of granular and transparent protoplasm. In the next stage a division of the thirty-two larger cells takes place, and in each of these a line separates the granular from the transparent protoplasm. The sixty-four masses of lens-like shape, composed of granular protoplasm, thus formed, go to make up an outer epiblastic layer, while the thirty-two masses of transparent protoplasm form the hypoblast.
26. The ovum after the sixth plane of segmentation. It consists of thirty-two small cells, external (*c pl*), and thirty-two large cells (*h p'*). *sc. cav.* Segmentation cavity. Already the division of the cells (*c pl*) into σ, σ', has begun.

27. Embryo with sixty-four lenticular cells, forming the epiblastic vesicle, and thirty-two masses, composed of transparent protoplasm, the hypoblast (*h b*).
28. Cell at the beginning of the sixth plane of segmentation. *c pl.* Epiplasm. *h pl.* Hypoplasm.
29. The epiblastic layer now grows faster than the hypoblast, and the space between them increases, while at points they grow together. Appearance of the ovum towards the close of the formation of the seventh plane of segmentation. *c pl.* Epiplasm. *h pl.* Hypoplasm. *β.* Bridge connecting the two.
30. Appearance of an ovum a day after fructification. *c pl.* Epiplasm. *c b.* Epiblast. *h b.* Hypoblast. *h pl.* Hypoplasm. *nl.* Cell nucleus. *vt.* Vitellus.
31. The wide cavity between the two layers, epiblast and hypoblast, now becomes filled with a gelatinous layer. The embryo becomes ciliated, and at the point where epiblast and hypoblast fuses, the epiblast (*c b.*) is thickened and forms a disk, through which opens a mouth. Embryo thirty hours after impregnation. *c b.* Epiblast. *c b'.* Disk-like epiblastic thickening. The disk is seen between the dots (*c b'*). *h b.* Hypoblast. *ubr.* Umbrella, gelatinous tissue of a middle layer.
32. Embryo forty hours after impregnation. *c b'.* Edge of the epiblastic disk. *h b.* Hypoblast, which fuses with the epiblast at this point. *ubr.* Umbrella. The epiblast (*c b.*) is spread as a thin invisible layer over the surface of the umbrella.
33. The oral pole of the embryo three days and ten hours after fecundation. *c b.* Epiblast. *or.* Thickened epiblast, which later breaks through and forms a mouth. *h b.* Hypoblast.
34. Oral pole of an embryo six days and twelve hours old (after fecundation), with mouth widely open, and the border of the umbrella (*ubr.*) drawn somewhat together. *c b.* Epiblast. *h b.* Hypoblast. *ϕ.* Solid axis of tentacle. *ζ.* Conical projection at the extremity of the tentacle.
35. Older larva with lips and umbrella shown from below. The tentacles are widely extended. *eb.* Epiblast. *ga.* Stomach. *lab.* Lips of entrance to stomach cavity. *nt cy.* Nematocyst. *vel.* Velum. *ϕ.* Connection of the bases of the tentacle with the bell margin.
36. Oldest larva, which swims for the most part by means of movements of the velum (*vel*). No cilia. *ga.* Stomach. *lab.* Lip. *nt cy.* Nematocyst. *ta.* Tentacle. The small buds on the rim of the bell indicate the future sense bodies as well as rudimentary tentacles. *ubr.* Umbrella. *ϕ.* Tentacular axis of solid hypoblastic cells, and the same axis continued from the base of the tentacle to the bell margin.

PLATE V.

Development of the Trachymedusæ, *continued. Young Stages of the Medusæ of the* Hydroida, *and* Acraspeda. *Figures from* Alexander Agassiz, George J. Allman, J. Walter Fewkes, Ernst Haeckel, *and* Fritz Müller.

C. can. crc. Circular canal.
cav. Cavity.
E. em. ta. Embryonic tentacle.
G. ga. Stomach.
gm. Bud.
H. hy th. Hydrotheca.
L. lab. Lip.
l. rm. Lateral ramus, corbula rib.
M. man. Manubrium.
mds. gm. Medusa bud.
N. nt cy. Nematocyst.
O. oa. vs. Ovarian vesicle.
ocl. Ocellus.
ocy. Otocyst.
or. Mouth.
P. pap. Papilla.
R. r. tb. Radial tube.
r. tb'. Radial tube which has not yet grown to the circular canal.
T. ta. Tentacle.
tb., *tb'.* Chymiferous tubes.
U. ubr. Umbrella.
V. vel. Velum.
α. Unruptured perisarc at the extremity of a branch.
β. Chitinous envelope ruptured, and the cœnosarc protruding.
ζ. The cœnosarc protruding more than in β.
γ. Body escaped from the hydroid.
η. New branch.
θ. Tube formed about the bud.
π. Base of attachment.

1–2. *Glossocodon eurybia* (*Liriope eurybia*). From Haeckel, Beiträge zur Naturgeschichte der Hydromedusen, Erstes Heft. Die Familie der Russelquallen (Geryonida), Pl. III., figs. 29, 30.

1. Young larva, with bell fully formed, seen from the oval side. The beginnings of four tentacles, which later form the embryonic tentacles, are seen as four small buds. *vel.* Velum.
2. Larva of about the same age, seen from one side. *ubr.* Umbrella.

3. From Fritz Müller, *Archiv für Naturgeschichte.* 1859. Pl. XI., fig. 16.

3. Still older medusa, seen from one side. The provisional tentacles are considerably developed, and from their tips project the tongue-like spurs. *cav.* Cavity of the bell. *ubr.* Umbrella.

4–7. *Glossocodon tenuirostris*, sp. Ag. From Fewkes, Notes on Acalephs from the Tortugas, with a Description of New Genera and Species. *Bull. Mus. Comp. Zoöl.* Vol. IX., No. 7, Pl. VII., figs. 2–5.

4. Larval medusa with stiff embryonic (transitory) tentacles (*em. ta.*), in which the permanent tentacles are not developed. *man.* Manubrium (rudimentary in character). *r. tb.* Radial chymiferous tube. The club-shaped bodies are, comparatively speaking, very large.
5. Older larva, in which the embryonic tentacles (*em. ta.*) have somewhat diminished in size, and a true tentacle (*ta.*) has begun to form.
6. Older larva, where the tentacles (*ta.*) have grown much longer. The manubrium (*man.*) has also increased very greatly in size. Embryonic tentacle (*em. ta.*) reduced in size; almost lost.
7. Older larva, wholly destitute of embryonic tentacles, while the true permanent tentacles (*ta.*) are very long, as in adult. *man.* Manubrium. *r. tb.* Radial tube. *ubr.* Umbrella.

8–15. From Allman, *op. cit.*, Pl. VIII. figs. 3, 7 ; Pl. IX. figs. 3, 4 ; Pl. XI. fig. 9 ; Pl. XVIII. fig. 4 ; Pl. XX. fig. 4.

8, 9. *Dicoryne conferta*, Alder.

8. "The female locomotive, ciliated sporosac, shortly after its liberation," "as it appears when swimming." It is viewed at right angles to the plane of its two tentacles.

9. Longitudinal section (optical) of a female sporosac made at right angles to the plane of the tentacles, and viewed under slight pressure.

10. Actinula of *Tubularia indivisa.*, Linn. A zoöid homologous to a free medusa, which is formed in small spherical sacs, hanging from an axis, dependent between the tentacles of the hydroid.

"The actinula, shortly after liberation. It is figured in the attitude assumed when moving from place to place ; the mouth is turned to the surface over which the actinula is moving, while some of the long tentacles are bent in the same direction, and are employed as ambulatory organs." Allman.

11. *Clavatella prolifera*, Hincks. An ambulatory larva, seen from the side, using its outstretched tentacles as walking organs.

12. Young stage of a free medusa (gonophore) of *Perigonimus.*

13. Young medusa of *Bougainvillia*, represented as it appears in motion. The bell walls are contracted, and the velum is pushed outward.

14. An older (?) *Bougainvillia*, floating passively, with tentacles widely extended. Subsequent growth from a medusa in this condition into that of the adult takes place simply by an increase of the number of tentacles and eye-spots in the bundles at the bell-rim, and an additional complication of the lips.

15. The same, older.

16. Medusa of *Occania languida.* From a sketch by Fewkes.

The youngest stage of this gonophore. *man.* Manubrium. *ta.* Tentacle. *tb.* Chymiferous tube. *ubr.* Umbrella. *vel.* Velum.

17–18. *Zygodactyla Groenlandica*, A. Ag. From Fewkes, Studies of the Jelly-fishes of Narragansett Bay. *Bull. Mus. Comp. Zoöl.* Vol. VIII., No. 8, Pl. V. figs. 5, 6.

17. Youngest known medusa of this genus, seen from the oral side of the disk. *can. crc.* Circular canal. *man.* Manubrium. *o cy.* Otocyst. *r. tb.* Radial tube. *r. tb'.* Radial tube, which has not yet extended to the circular canal. *ta.* Tentacle.

18. Same larva seen in profile. *man.* Manubrium. *r. tb.* Radial tube. *r. tb'.* Intermediate radial tube, which has not yet extended to the circular canal. *o cy.* Otocyst. *ta.* Tentacle. The fully-grown medusa has a very large number of radial chymiferous tubes, otocyst and tentacles.

19. *Willia ornata.* From A. Agassiz, *op. cit.*, fig. 274[a]. Young gonophore in which the tubes have just begun to bifurcate (*r. tb.*). The youngest form has four undivided tubes, alternating with four simple bundles of nematocysts in the bell walls.

20–22. *Lizzia octopunctata.* From Fewkes, Studies of the Jelly-fishes of Narragansett Bay. *Bull. Mus. Comp. Zoöl.*, Vol. VIII., No. 8, Pl. I. figs. 1, 3, 6.

20. Mother medusa, with buds in various conditions of growth forming on the outer walls of the proboscis. *mds. gm.* Medusa buds. The larger (*mds. gm.*) approximates in shape that of a medusa. *lab.* Lip. *o cl.* Ocellus. *or.* Mouth. *ta.* Tentacle. *ubr.* Umbrella. *vel.* Velum.

21, 22. Developed buds, with the form which they have when just escaped from the parent manubrium.

21. Young medusa (oral view). *cav.* Bell cavity. *o cl.* Ocellus. *ta.* Tentacle. *ubr.* Umbrella. *vel.* Velum.

22. Side view of the last. *man.* Manubrium, at the base of which are buds of a third generation. *r. tb.* Radial tube. *ubr.* Umbrella. At the apex there is a canal which formerly afforded free communication between the cavity of the manubrium of the parent and that of the bud. The bud, when it severs its connection with the parent, has on the bell rim sixteen tentacles, consisting of four bundles of three tentacles each, and, alternating with these, four single tentacles.

23. Young of *Haliclystus* (*Lucernaria?*) From A. Agassiz, North American Acalephæ. *Illustrated Catalogue Mus. Comp. Zoöl*, No. 2, p. 63. *or.* Mouth. *ubr.* Umbrella. π. Base of attachment.

23[a]. A group of tentacles of the same, in different stage of growth.

24[a]–24[d]. *Schizocladium ramosum.* From Allman, *op. cit.*, p. 152.

24[a]. "Part of an adult colony, magnified about six diameters." α. A terminal part of a branch still invested by a chitinous perisarc. β. The perisarc of this branch has been ruptured, while the contained cœnosarc has protruded a little, and is visible at the extremity. ζ. The separation of a small body of cœnosarc from

the branch has been completed, and the portion thus separated has almost freed itself from the branch. γ. A body of cœnosarc (frustule) has dissolved its connection with the hydroid, and become a free planula-like body swimming in the water.

24^{b}. Hydroid formed by a gemmation from the free frustule.

24^{c}. The frustule (γ), after swimming about in the water, secretes a mucus tube (θ), into which it is represented in the figure as partially drawn on the right hand side (of figure).

24^{d}. A bud has been sent out from the extremity of the frustule ($g\,m$). This bud increases in size, and ultimately forms the hydroid, with hydranth (24^{b}). From the side of this hydroid a branch (η) is emitted.

25^{a}–25^{e}. Development of a Corbula in the family of *Plumularidæ*. From Allman, *op. cit.*, p. 60.

25^{a}–25^{e}. *Aglaophenia pluma.*

25^{a}. A very young corbula. *l. rm.* Lateral branch.

25. Older stage of the corbula, with the ovarian vesicles (*oa. vs.*) already formed as spherical sacs, arising from the midrib of the corbula, between the lateral rami (*l. rm*).

25^{c}. The same, older. *oa. vs.* Ovarian vesicles, called gonangia. *l. rm.* Lateral rami (costæ.) *hy th.* Single hydrotheca.

25^{d}. Mature corbula. The serrated bodies along the sides are called nematophores. The corbula is a specialized basket-shaped structure found in certain sertularian hydroids, for the protection of the vesicles and their ova.

26. Young *Cyanea arctica*, showing the umbral papillæ. From Fewkes, Studies of the Jelly-fishes of Narragansett Bay. *Bull. Mus. Comp. Zoöl.*, Vol. VIII., No. 8, Pl. VII. fig. 1.

PLATE VI.

Development of the Discoidea *and* Siphonophora. *Figures from* Alexander Agassiz, Carl Chun, J. Walter Fewkes, Ernst Heckel, Elias Metschnikoff, *and* P. E. Müller.

A.	*a.* Anterior.		*ms b.* Mesoblast.
	a. nc x. Anterior nectocalyx.	*N.*	*nc x.* Nectocalyx.
	ax. Axis.		*nt cy* Nematocyst.
C. C. P. L.	Chamber or tube in the primitive hydrophyllium, which is derived from a cavity early formed in the ovum.	*O.*	*oa.* Ovary.
			or. Mouth.
		P.	*pab.* Undigested food in the stomach.
	cil. Cilium.		*pig.* Pigment.
	cl. Cell.		*pm cy.* Pneumatocyst.
E.	*e b.* Epiblast.		*p nc x.* Posterior nectocalyx.
	e b'. Infolded portion of the epiblast.		*pyt.* Polypite.
	em. ta. Embryonic tentacle.	*R.*	*r. tb.* Radial tube.
F.	*fil. hy cy.* Filament of the hydrocyst.	*S.*	*so cy.* Somatocyst.
G.	*ga.* Stomach.	*T.*	*ta.* Tentacle.
	gm. Bud.	*U.*	*ubr.* Umbrella.
	go ph. Gonophore.	*V.*	*vel.* Velum.
H.	*h b.* Hypoblast.		*vt.* Vitellus.
	h b'. Large cells (vitelline cells), hypoblastic ?		α. Float.
			β. Partitions which separate the chambers found in the frame-work supporting the sail.
	hp. Liver ? Cluster of "brown cells."		
	hy ph. Hydrophyllium.		
	hy cy. Hydrocyst.		γ. Partitions which separate the concentric chambers of the float in the disk.
I.	*i.* Interior of bell.		
L.	*la. ap.* Peduncle of a tentacular appendage (tentacular knob).		θ. Rim of the disk.
			λ. Feelers on the under side of the disk.
M.	*mb.* Membrane.		σ. Sail.
	mds. gm. Medusa bud.		

1. From a Sketch by A. Agassiz.

1. Sexual cluster of male and female gonophores of *Physalia*. *mds. gm.* Undeveloped medusa bud. *go ph.* Female gonophore ♀, male ♂.

2–4. From A. Agassiz, Exploration of the Surface Fauna of the Gulf Stream. *Mem. Mus. Comp. Zoöl.* Vol. VIII., No. 2, Pl. VI. figs. 1, 2, 3.

2. Young *Velella* in profile. *hp.* Liver ? θ. Rim of the disk. λ. Prehensile tentacle (hydrocyst ?). σ. Sail. A large feeding polyp (polypite) hangs down from the middle of the disk on the under side.
3. Young of the same, from below (oral view). In the centre is seen the mouth (*or*). θ. Border of the disk. λ. Prehensile "tentacles" ? These bodies (λ), like the hydrocysts of *Physophora*, are prehensile.
4. The same, a little older, in which the ramifications of the liver extend to the disk margin or horizontal mantle. *pyt.* Central feeding polyp or polypite. λ. Prehensile tentacles (hydrocysts).

5–7. *Rataria*. From Sketches by Fewkes.

5. Section through *Rataria* (young *Porpita* or *Velella* ?), found with *Velella spirans*. The section passes vertically through sail, disk border, and retracted polypite. The sail is seen to be composed of a superficial

wall or membrane (*mb.*) stretched over two vertical plates, which are parallel, and united by horizontal floors (β.). The lowest of the chambers between two floors (α) is a float. γ. Chambers (seven) situated between horizontal curved partitions in the body of the disk. *hp.* Liver? (brown cells). θ. Disk margin. *pyt.* Polypite.

6, 7. *Rataria*, from one side. *pyt.* Polypite. θ. Disk rim. λ. Prehensile tentacles (hydrocysts?). σ. Sail. Notice the characteristic vertical lines on external wall of the sail. The form of the sail, although unlike that of fig. 2, is not very distant from that of a *Velella* a little younger.

8, 9. From Agassiz, *op. cit.*, Pl. II. fig. 10; Pl. VIII. fig. 8.

8. Medusa of *Porpita*. *ubr.* Umbrella.

9. Medusa of *Velella*. *r. th.* Radial tubes with yellow cells. *ubr.* Umbrella. *ta.* Tentacle. Rows of nematocysts are seen on the surface of the bell.

10–19. From Metschnikoff, Studien über die Entwickelung der Medusen und Siphonophoren. *Zeit. f. Wiss. Zoöl.* Bd. XXIV., Pl. VI. figs. 5, 7, 8, 9; Pl. VII. figs. 11, 14, 16; Pl. XI. figs. 6, 8; Pl. XII. fig. 9.

10–15. *Epibulia aurantiaca.*

10. Planula with interior filled with spongy cells, and an epiblastic cap (*e b.*) on the pointed pole. *a.* is arbitrarily taken as the anterior pole. *cl.* Spongy mass of cells.

11. Older embryo, in which a nectocalyx and tentacle have begun to form. The epiblast (*e b.*) rises in two prominences, the smaller of which is the bud of a tentacle (*ta.*), and the other a nectocalyx (*nc x.*) Under the epiblast is another layer, probably the hypoblast. The epiblast forms the lining of a cavity (the bell cavity). Cilia (*cil.*) still remain over the whole body. The whole vitellus (*vt.*) is taken up by the spongy mass of cells.

12. An older embryo than the last. Although this is a faithful copy of Metschnikoff's figure, it is, like his, believed to be faulty in this particular. The course of the epiblast, after it leaves the lower surface of the bell, on the side turned to the observer, probably passes by reflection into the walls of the tentacle, instead of to the upper pole of the embryo. The hypoblast closely covers the infolded part of the epiblast in the bell, and extends, also, into the tentacles. It also forms a loop (*so cy.*), the future somatocyst. A gelatinous layer also appears between hypoblast and external epiblast in the nectocalyx. Whole surface ciliated.

13. Older larva, with the primary nectocalyx of considerable size. *e b.* Epiblast which lines the bell cavity (*i.*) and is also stretched over the whole ovum. *h b.* A layer of hypoblast in the bell. At *so cy.* this hypoblast forms a loop, the future somatocyst. Between it (*h b.*) and the epiblast of the surface of the bell is a gelatinous layer (? it mesoblast.) *h b.* Swollen hypoblastic cells. *vt.* Vitellus with spongy cell mass. The large projection lined by cells (*h b'.*) becomes later a polypite. *Epibulia*, like *Crystallodes*, absorbs the vitellus, which is not directly changed into the polypite, as in some species of *Agalma*.

14. Older larva (primitive larva). *pyt.* Polypite with two layers best marked near the pointed end. *so cy.* Somatocyst. *ubr.* Umbrella. *vt.* Vitellus.

15. Oldest larva, in which the vitellus is wholly absorbed, and a small hydrophyllium (*hy ph.*) has formed in its place. A second nectocalyx (*a. nc x.*) has formed, which, from its future position, is called the anterior. It is regarded as homologous with *a. nc x.* of figures 30, 31. The distal end of the polypite (*pyt.*) is open, forming a mouth. *so cy.* Somatocyst. Although the intermediate larvæ between this and the adult *Epibulia* are not known, it is probable that the larger nectocalyx, with the somatocyst, is transitory, and is later lost. It can then be supposed that fig. 15 corresponds with a *Monophyes* larva, or a definite stage (fig. 29) in the cyclical development of *Muggiæa*.

16–17. *Gleba hippopus.* Forsk.

16. Embryo, with first nectocalyx beginning to form. Around the whole embryo is stretched an epiblast (*e b.*). The infolded portion of the epiblast (*e b'.*) forms the inner bell wall. The hypoblast (*h b.*) is found just below these two. Whole remainder of the vitellus taken up by a spongy mass of cells, which closely resemble the "fatty cells" of *Ctenophora* and other cœlenterate larvæ. The bell cavity probably forms by a dissolution of epiblastic cells (*e b'.*).

17. Larva, with a helmet-shaped bell (*ubr.*), fully formed. This stage may be called the primitive larva or *Monophyes* stage, and is homologous with figs. 14 and 29. The helmet-shaped bell is probably provisional. *e b.* Epiblast. *h b.* Hypoblast. *r. th.* Radial tube. *vt.* Vitellus.

18. *Halistemma rubrum.* From Metschnikoff, *op. cit.*, Pl. X. fig. 6.

Larva with primitive nectocalyx (*nc x.*) beginning to form, showing also the young pneumatocyst (*pn cy.*). In larvæ younger than this we have two layers — epiblast and hypoblast — formed first; then an elevation of both, by which a cavity is left between the hypoblast and the vitellus. The first structure formed is a bell (*nc x.*); the second (*pn cy.*), a pneumatocyst; and the third (*ym.*), probably a tentacle. The pneumatocyst

is formed from a portion of the epiblast, which becomes surrounded by hypoblast. The cavity, as that of a nectocalyx, seems to form by an at first crescentic-formed dissolution of the epiblast. The vitellus (*vt.*) passes directly into the polypite. The bell (*nc x.*) is probably (?) provisional (primitive nectocalyx). The pigmentation (*pig.*) is characteristic.

19. *Agalmopsis* (*Stephanomia*, auct.) *pictum*, Fewk. From Metschnikoff, *op. cit.*, Pl. XII. fig. 9.
Embryo in which the pneumatocyst and embryonic tentacles are well developed. The development of this Physophore is exceptional in forming a float, instead of a nectocalyx, at the very beginning. The youngest larvæ becomes covered with a superficial layer — epiblast — which is ciliated, and concentrates at one pole, where it forms a pneumatocyst. The second structure to develop is the tentacle, and no sign of a nectocalyx has yet appeared. *pn cy.* Pneumatocyst, around which is what is left of the unabsorbed vitellus. The ovum has the spongy mass in its center. *pig.* Pigment on the pneumatocyst. *pyt.* Polypite, with a terminal mouth (*or.*). The distal end is pigmented. The prominent appendage to the polypite, the tentacle (*cm. ta.*), as well as the knot-like bodies which hang from it, are provisional structures.

20–23. Development of *Physophora*. From Hæckel, Zur Entwickelungsgeschichte der Siphonophoren. Eine von der Utrechter Gesellschaft für Kunst und Wissenschaft Gekrönte Preisschrift, Pl. I. figs. 4, 8 ; Pl. II. fig. 20 ; Pl. III. fig. 24.

20. Embryo of *Physophora* at the close of the segmentation of the ovum. *e b.* Epiblast. *vt.* Spongy mass of vitelline cells.

21. Older larva, in which a primitive hydrophyllium has begun to form at one pole. *C. P. L.* Chamber in the first formed hydrophyllium. *e b.* Epiblast. *h b.* Hypoblast, which also encloses the chamber *C. P. L.* *ubr.* The layer between *e b.* and *h b.*, which forms the gelatinous body of the hydrophyllium. *vt.* Vitelline, or "spongy mass of cells."

22. An older larva (primitive larva), in which a primitive hydrophyllium is fully formed. *C. P. L.* Chamber of the primitive larva. *cm. ta.* Embryonic tentacle. *gm.* Buds, the fate of which is not clearly known (probably hydrocysts). *h b.* Hypoblast. *ms b.* Gelatinous layer (mesoblast ?). *pyt.* Polypite. *nt cy.* Nematocyst. *η.* Canal leading from the chamber, *C. P. L.*, to the cluster of nematocysts (*nt cy.*) (Radial tube of a nectocalyx ?) The primitive hydrophyllium of this stage is a transitory structure.

23. Larva, after the loss of the primitive hydrophyllium. *fil. hy cy.* Filament of the hydrocyst. *hy cy.* Hydrocyst. *ga.* Stomach. *la. ap.* Lateral appendages to the embryonic tentacle. *ta.* Embryonic tentacle. *n cx.* First formed nectocalyx. *nt cy.* Nematocyst. *or.* Mouth, not yet open (?).

24. *Praya*. From Metschnikoff, *op. cit.*, Pl. VII. fig. 16.
Embryo in what may be called a *Monophyes* stage, which corresponds with the so-called primitive larva. *nc x.* Nectocalyx. *pyt.* Polypite. *so cy.* Somatocyst. *ubr.* Umbrella. The helmet-shaped body (primitive hydrophyllium), probably provisional.

25. *Diplophysa inermis*. From Fewkes, Studies of the Jellyfishes of Narragansett Bay, *Bull. Mus. Comp. Zoöl.*, Vol. VIII., No. 8 ; Pl. VI. fig. 12. *a. nc x.* Anterior nectocalyx. *go ph.* Gonophore ♀. *oa.* Ovary. *so cy.* Somatocyst. *ta.* Tentacle.

26, 27. *Diphyes Sieboldii*. From P. E. Müller, Iagttagelser over nogle Siphonophorer, *Naturh. Tidsskr.*, 3 R. 7 B., Pl. XI. fig. 1 ; Pl. XII. fig. 4.

26. Portion of a stem with two attached members, which later develop separately from each other and from the axis. *ax.* Axis. *hy ph.* Hydrophyllium. *pyt.* Polypite. A tentacle is also developed, and is shown retracted under the hydrophyllium.

27. "*Eudoxia* form" of one of the last after separation from the axis. *go ph.* Gonophore (♂ ?). *so cy.* Somatocyst. *ta.* Tentacle. *ubr.* Umbrella.

28. *Eudoxia Lessonii*. From Fewkes, *op. cit.*, Pl. VI. fig. 8. Fully developed *Eudoxia*. *go ph.* Gonophore ♀. *nc x.* nectocalyx. *oa.* Ovary. *so cy.* Somatocyst.
The tentacle is cut off below the third tentacular knob.

29–31. From Chun, Ueber die Cyclische Entwickelung und die Verwandtschaftsverhältnisse der Siphonophoren. *Sitzungs. Acad. Wiss. Berlin.* No. LII. p, 1155., Pl. XVII. figs. 1, 2, 4.
The successive stages in the cyclical growth of *Eudoxia*, according to Chun, are : I. *Monophyes* (29). II. *Muggiæa* (31). III. *Eudoxia* (28).

29. *Monophyes primordialis*. Chun, "First generation." A larva probably homologous with figs. 17, 24, and the young *Agalma* (Pl. VII. fig. 11), which has been called the primitive larva. *pyt.* Polypite. *r. th.* Radial tube. *so cy.* Somatocyst. *ubr.* Umbrella.
The anterior nectocalyx (*Muggiæa* nectocalyx) may be developed from the small bud at the base of the polypite.

30. A larva which still retains a nectocalyx with the form of that of *Monophyes*, but has a second nectocalyx (*a. nc x.*) and a well-developed axis. The second nectocalyx (*p. nc x.*) is shaped like that of a *Muggiæa*. *a.* Anterior end of bell, as it moves in water. *p. nc x.* Posterior nectocalyx (nectocalyx of *Monophyes*). *pyt.* Polypite. *r. tb.* Radial tube. *ta.* Tentacle.

31. "*Muggiæa* larva." A larval (?) condition with a single characteristic nectocalyx, often, according to Chun, mistaken for a *Diphyes* with bell (posterior) broken off. *a. nc x.* Anterior nectocalyx. *ax.* Axis. *goph.* Gonophore. *hyph.* Hydrophyllium. *pyt.* Polypite. *socy.* Somatocyst.

Each of these clusters on the stem probably develops into an *Eudoxia*-like medusa (28).

PLATE VII.

Development of the Siphonophora *continued. Figures from* Alexander Agassiz, J. Walter Fewkes, *and* Elias Metschnikoff.

A.	*a.*	Anterior.
	ax.	Axis.
C.	*C. P. L.*	Chamber in the larva, which ultimately becomes a canal in the primitive hydrophyllium.
	cl.	Cell.
	cn.	Canal.
E.	*e b.*	Epiblast.
	e b'.	Infolding or thickening of the epiblast to form the future pneumatophore.
	em. ta.	Embryonic tentacles, with embryonic knobs.
F.	*fil. hy cy.*	Filament of the hydrocyst.
G.	*ga.*	Stomach.
H.	*h b.*	Hypoblast.
	hy cy.	Hydrocyst.
I.	*iv.*	Involucrum.
L.	*l. vs.*	Lateral vesicle.
M.	*ms b.*	Middle layer (between epiblast and hypoblast), which forms the gelatinous body of the hydrophyllium (mesoblast ?).
N.	*nc x.*	Nectocalyx.
	nc x'.	Undeveloped nectocalyxes.
	nl.	Nucleus.
	nt cy.	Nematocyst.
O.	*or.*	Mouth.
P.	*p.*	Posterior.
	pap.	Papilla (?).
	pig.	Pigment.
P.	*pn cy.*	Pneumatocyst.
	pn ph.	Pneumatophore.
	pr. hy ph.	Primitive hydrophyllium.
	py.	Polyp.
	py. s.	Polyp stem.
	pyt.	Polypite.
R.	*r. tb.*	Radial tube.
S.	*sac.*	Sacculus.
	scr. hy ph.	Serrated hydrophyllium.
T.	*ta.*	Tentacle.
	t. vs.	Terminal vesicle.
V.	*v.*	Ventral.
	vt.	Vitellus.
	α.	Ampulla-like enlargement of the canal of the first formed hydrophyllium.
	β.	Canal connecting this ampulla with that of the axis.
	γ.	Central tube in the serrated hydrophyllium.
	ζ.	Portion of a chamber in the primitive larva, which remains at the proximal end of the canal passing into the primitive hydrophyllium.
	θ.	Enlargement of the cavity in the tentacular knob.
	λ.	Point of internal attachment of the coiled part of the tentacular knob to the walls of the body which envelops it, and forms the outer walls of the knob.

1–25. Development of *Agalma*.

1–11. From the ovum to the "primitive larva." 12–20. From the primitive larva to the "*Athorybia* larva." 21, 22. From the "*Athorybia* larva" to the young resembling the adult.

1, 2. *Agalma Sarsii.* From Metschnikoff, *op. cit.*, Pl. VIII. figs. 1, 2.

1. Youngest larva, in which the epiblast (*e b.*) forms a polar cap. The vitellus (*vt.*) is penetrated by a protoplasmic network, which divides it into a spongy mass of glass-clear cells, as in *Ctenophora* and other *Siphonophora*. The external surface is ciliated.
2. An older larva, which has become elongated and more pyriform. The deeper layer (*h b.*), which is called endoderm (hypoblast) by Metschnikoff, may be the beginnings of the chamber *C. P. L.* The epiblast and hypoblast, probably both together, form the layer *e b.*

3–5. *Agalma elegans*, Fewkes. From sketches by Fewkes.

3. Larva older than the last, with the polar cap more raised and a central chamber (*C. P. L.*). The layer *e b.* was not observed to be differentiated into two or more divisions, although it may have component parts corresponding to the epiblast, hypoblast, or even an intermediate gelatinous layer (mesoblast). Nuclei (?) were observed in the vitelline cells.
4. Older larva, with the chamber (*C. P. L.*) surrounded by two layers. *e b.* Epiblast. *h b.* Hypoblast.
5. Side view of the last. The chamber (*C. P. L.*) of the primitive elevation, which is the primitive hydrophyllium, has become tube-like. *cl.* Vitelline cells (?). *nl.* Nucleus (?). *pig.* Pigment patches, with rough projections on the surface of the ovum.

6, 7. *Agalma Sarsii.* From Metschnikoff, *op. cit.*, Pl. VIII. figs. 6, 7.

6. Larva, showing the first formation of the pneumatocyst, which first appears as an epiblastic structure (*e b'.*). *e b.* Epiblast. *ms b.* Gelatinous thickening, forming the body of the primitive hydrophyllium, and destined later to increase to a very large size, when the epiblastic layer becomes a thin superficial layer of cells stretched over it. *ʃ.* Recess above the spongy mass of vitelline cells.
7. Primitive larva. A common larval condition of the *Siphonophora*, which many genera of Physophoræ and Calycophoræ pass through, distinguished on account of a provisional hydrophyllium (or nectocalyx), covering as a helmet the vitellus, which may or may not pass directly into a polypite. The chamber *C. P. L.* is lined with hypoblast (*h b.*). The epiblast (*e b.*) is stretched over the vitellus, and extends as a very thin layer over the primitive hydrophyllium. The great size of the hydrophyllium is caused by the growth of the middle or gelatinous layer. *pn cy.* Pneumatocyst. *ʃ.* Recess between the vitelline cells and the hydrophyllium.

8–10. *Agalma elegans.* From sketches by A. Agassiz.

8. Larva a little older than the last. *C. P. L.* Chamber of the hydrophyllium. *pr. hy ph.* Primitive hydrophyllium. *pn cy.* Pneumatocyst.
9. Still older larva. *C. P. L.* Chamber of the primitive hydrophyllium. *pr. hy ph.* Primitive hydrophyllium. *vt.* Vitellus. Of the three buds shown in the figure, the larger is the pneumatocyst, and the two smaller (lateral) the rudiments of the serrated hydrophyllia, which later assume great size. *vt.* Vitellus.
10. Older larva, with the primitive hydrophyllium (*pr. hy ph.*) bent over so as to hide the cavity (*C. P. L.*), and expose in profile the polypite and serrated hydrophyllium. By this movement the pneumatocyst (*pn cy.*) is brought to the middle of the figure, while at its left are several buds, which later develop into hydrophyllia.
11. *Agalma Sarsii.* From Metschnikoff, *op. cit.*, Pl. VIII. fig. 11.
Profile view of a larva, in which the margin of the provisional hydrophyllium has grown downward, covering the vitellus, from which, however, it is free at the edges. The epiblast (*e b.*) appears at a projection, generally more or less pigmented, which is beginning to push out at the side of the ovum. The hypoblast (*h b.*) is also visible at the same point, and also lines the chamber *C. P. L.* The vitelline cells are somewhat reduced in number. There are two regions of crimson pigment (*pig.*). The serrated hydrophyllia (*ser. hy ph.*) are conspicuous by reason, in part, of the large nematocysts in their walls.

12–17. *Agalma elegans.* From sketches by A. Agassiz.

12. Larva of about the same age, and represented in the same position as fig. 10, showing the serrated hydrophyllia (*ser. hy ph.*) in profile. *pn cy.* Pneumatocyst. *vt.* Vitellus.
13. Larva, showing the relation of the primitive hydrophyllium (*pr. hy ph.*) and the pneumatocyst (*pn cy.*) *vt.* Vitellus.
14. Primitive larva, seen in profile with the spongy mass of cells (*vt.*) hugging closely the inner wall of the epiblast. They here occupy a position similar to the same cells in *Epibulia* (Pl. VI. fig. 13 *h b*). *pn ph.* Pneumatophore. *pap.* Small tubercles, not figured in other figures, and doubtfully called papillæ. *ser. hyph.* Serrated hydrophyllia in profile. *C. P. L.* Chamber of the primitive hydrophyllium now reduced to a tube. *vt.* Vitellus.
15. Larva of the same age as the last, seen in a plane at right angles, laterally, and from below, indicating the position of the large cells in the vitellus (*vt.*). *or.* Mouth. *pn cy.* Pneumatocyst. *ser. hy ph.* Serrated hydrophyllia.
16. Older larva, in which the size of the serrated hydrophyllia (*ser. hy ph.*) has greatly increased, and a terminal cluster of nematocysts has appeared at the distal extremity of a tube situated medially in the hydrophyllium. *pn cy.* Pneumatocyst. *C. P. L.* End of the cavity of the hydrophyllium.
17. Larva older than the last, in which the primitive hydrophyllium has disappeared, and the polypite has become very much elongated. A single serrated hydrophyllium (*ser. hy ph.*) is sketched on one side to show its relations to the pneumatocyst (*pn cy.*). Of the small buds below it, the lowest — that with four black spots — is probably a tentacle, and the others are immature hydrophyllia.

18, 19. *Agalma Sarsii.* From Metschnikoff, *op. cit.*, Pl. IX. figs. 15, 17.

18. Larva, showing the connection of the embryonic appendages (primitive hydrophyllium and serrated hydrophyllia) with the polypite and pneumatocyst (*pn cy.*), by means of an axis (β). Four serrated hydrophyllia are shown. The connection of the cavity *C. P. L.* with that of the polypite is through an enlargement (ampulla α), into which the tubes of the several hydrophyllia appear also to open. The cluster of bodies at the base of the polypite, near its junction with the pneumatocyst, are embryonic tentacular knobs (figs. 23, 24). *ga.* Stomach cavity. *or.* Mouth.

19. Larva about the same age as the last, turned in such a way that a serrated hydrophyllium is shown in full face. The fore-shortened extremity of the tube (*C. P. L.*) of the primitive hydrophyllium is just visible. *pr. hy ph.* Primitive hydrophyllium. *pig.* Pigment at the base of the float (*pn ph.*). *ga.* Stomach. *nt cy.* Nematocyst. γ. Tube of the serrated hydrophyllium.

20. *Agalma elegans.* From Fewkes, Studies of the Jelly-fishes of Narragansett Bay. *Bull. Mus. Comp. Zoöl.*, Vol. VIII., No. 8, Pl. IX. fig. 2.

"*Athorybia* larva," embryo with a ring of provisional serrated hydrophyllia (*ser. hy ph.*), and embryonic tentacle (*em. ta.*), with a provisional (?) axis. There is a remnant of a vitellus (*vt.*) which, in this species, does not pass into the polypite. Our species of *Agalma* seems to resemble *Crystallodes* in its method of absorption of the vitellus. The pneumatophore (*pn ph.*) is permanent. *pyt.* Polypite. γ. Median canal of the serrated hydrophyllium.

21. From Metschnikoff, *op. cit.*, Pl. XI. fig. 2.

An embryo older than the "*Athorybia* larva," with the serrated hydrophyllia characteristic of that stage, and with embryonic tentacle (*em. ta.*). It has developed two nectocalyces at least (*nc x.*), a permanent axis (*ax.*), permanent tentacular knobs, two of which are to be seen in the lower centre of the figure just above the letters (*em. ta.*). A radial tube (*r. tb.*) is developed in the tentacle, and the pneumatophore (*pn ph.*) approximates in shape that of the adult.

22–29. From Fewkes, *op. cit.*, Pl. IX. figs. 1, 9, 9ª. Fig. 25, from sketch.

22. Larva still retaining, as an embryonic feature, the provisional tentacle and knob; but in other respects like the adult. Provisional hydrophyllia lost, and in their place permanent covering-scales (hydrophyllia). Axis divided into two parts; that which bears the nectocalyx (*nc.s.*), called the nectostem, and that which bears the remaining appendages, the polyp stem (*py. s.*). The permanent tentacle, with knobs characteristic of the genus *Agalma*, coexists with the larval tentacle (*em. ta.*). Hydrocysts (*hy cy.*), with their filaments (*fil. hy cy.*) present. *nc x'.* Rudimentary nectocalyces. *pn ph.* Pneumatophore. *pyt.* A polypite.

23–24. Embryonic tentacular knob of *Agalma elegans.*

23. Side view.

24. Seen from below.

25. Outline of an undeveloped hydrophyllium, not serrated, found in a larval *Agalma elegans.* *a.* Anterior (place of attachment). *p.* Opposite end. *v.* Ventral (side turned to the axis).

26–29. Development of the tentacular knob of *Physophora hydrostatica.* From Fewkes, Contributions to a Knowledge of the Tubular Jelly-fishes. *Bull. Mus. Comp. Zoöl.*, Vol. VI. No. 7, Pl. I. figs. 4, 5, 6, 7.

26, 27. Young condition of the knob. *t. vs.* Embryonic vesicle, resembling the terminal vesicle of the adult knob in *Agalma.* This is reduced in size, and lost in the adult *Physophora.* θ. Enlargement of the cavity of the knob, which later grows into a canal (*ca.*) along the side of the coiled part of the adult knob. λ. Point of origin of the coiled part of the knob.

28. In this figure the vesicle (*t. vs.*), formerly terminal, has become lateral (*l. vs.*), and the cavity (θ) has been elongated into a canal (*ca.*) by the growth of the point of attachment of the coiled part of the knob to the pole opposite its peduncle, or attachment to the tentacle. *iv.* Involucrum. *sac.* Sacculus.

29. Knob similar to that of the adult. The lateral (embryonic) vesicle is lost, the canal (*ca.*) tube-like, and the attachment (λ) of the sacculus to the inner wall of the involucrum at the opposite pole to that where it formerly hung.

PLATE VIII.

Development of the Acraspeda. *Figures from* Louis Agassiz.

B. *bl p.* Blastopore.
C. *con. crc.* Circular Canal.
con.[1]—*con.*[3] Constrictions which ultimately become deep enough to separate the intermediate disks as Ephyræ from the Strobila.
E. *e b.* Epiblast.
G. *ga.* Stomach.
gm. Bud.
ga c. Portion of the stomach, which forms a dish-shaped cavity, as distinguished from that within the oral folds.
L. *lab.* Hypoblast.
H. *h b.* Lip of oral tentacle.
M. *man.* Manubrium.
N. *ncl.* Nucleolus.
nl. Nucleus.
O. *oa.* Ovary.
o cy. Otocyst.
o cy. lb. Otocyst lobe.
o cy. s. Style bearing the otocyst.
or. Mouth.
or.[1] Mouth.
or. ta. Oral tentacle.
P. *p.* Posterior pole of the planula.
py. gm. Bud forming on the side of the Strobila.
T. *ta.* Tentacle.
ta.[1] Tentacle of the Scyphostoma.
ta,[3] *ta.*[4] Undeveloped tentacle.
tb. Enlargement of circular canal at the junction of the ocular tube.
tb.[1] Tube passing radially from stomach to vicinity of sense organ, opening at the periphery into the enlargement (*tb*) and centrally into radial tube (*tb*[3]).
tb.[2] Tube passing directly from stomach to bundle of tentacles.
tb.[3] Tube from stomach in sense octant, before division.
tb.[4] Centripetal tube arising from circular canal at the peripheral end, ending blindly at the other extremity.
tb.[5] Tube in the lappets of the otocyst (?).
tb.[6] Angle in tube (*tb*) which later pushes itself into the lappet.
U. *ubr.* Umbrella.
V. *vel.*, *vel.*[1] Velum.
vt., *vt.*[1] Vitellus.
vt. m. Vitelline membrane.
α. Rim of the orifice leading into ovarian cavity.
β. Base of attachment, also abnormal unattached bases.
β.' Base of a Strobila with large number of constrictions.
γ. Chitinous basal support (perisarc ?)
ζ,ζ.' Gelatinous portion of the umbrella between two chymiferous tubes.
φ. Phacellen (sexual filaments).
φ.' Phacellen, seen through the ovarian opening.

The figures on this plate were arranged by A. Agassiz.

1–9. *Aurelia flavidula*, from Agassiz, *op. cit.*, Vol. III. Pl. X. figs. 1, 2; Pl. X[a]. figs. 16, 17, 19, 20, 22, 23, 24.

1–21. Development of the planula from the ovum.

1, 2. Ovum (life-size) from ovary. The early conditions are passed through in the ovary and folds of the mouth.
3. Enlarged view showing the yolk cells in the middle of the ovum.
4. The vitelline cells occupy the whole vitellus (*vt*).
5–8. Consecutive stages, with nucleus (*nl*) and nucleolus (*ncl*). *vt.*, *vt.*[1] Vitellus. *vt. m.* Vitelline membrane.
9. Morula. *nl.* nucleus. *vt.* Vitellus.

10–20. Acraspedote medusa, Genus? These figures resemble the stages of segmentation of *Cyanea*. They illustrate the formation of a blastosphere (fig. 20) from an egg where segmentation has just begun.

18–19. Optical sections showing a segmentation cavity. After fig. 20 is reached, the outer wall (epiblast?) — there is but a single wall to the blastosphere — of the blastosphere folds inward, forming in *Chrysaora* a gastrula.

21–49, from Agassiz, *op. cit.*, Vol. III. Pl. X. figs. 4, 4ª, 10, 10ª, 12, 14, 14ª, 14ᵉ, 19, 26, 35, 36ª; Pl. Xª. figs. 2, 4, 10, 11, 13, 19, 22, 25, 28; Pl. XI. 6, 19, 20, 29; Pl. XIᵇ. figs. 5, 10, 16, 17, 20.

21–33. Development of the Scyphostoma from the planula.

21. Planula of *Aurelia*.

22. Pyriform planula with a blastopore (*bl p.*), In *Chrysaora*, according to Claus, after the formation of the gastrula the blastopore closes, forming a closed sac. In Agassiz's figures it remains open, and forms the mouth of the Scyphostoma. The relationship of the mouth and inner cavity of the gastrula remains doubtful. *p.* Pole opposite the blastopore.

23. Still more elongated planula, resembling that of the *Hydroida*. *bl p.* Blastopore. *p.* Posterior pole.

24. The planula has attached itself at *β*, and beginnings of several organs of the Scyphostoma have appeared. *bl p.* Blastopore. *e b.* Epiblast. *ga.* Stomach cavity known as stomodæum. *h b.* Hypoblast (In *Chrysaora* infolded epiblast of the blastosphere forms the hypoblast), whose origin in this genus is unknown. *ta.* Tentacles.

25–26. Two other attached planulæ. Fig. 25 has a wide-open blastopore (*bl p*) leading into the stomach (*ga*), and fig. 26 retains its cilia. *γ.* Ring of perisare at the base of attachment.

27. Fixed larva with two tentacles (*ta*[1]) and mouth (*bl p*). *e b.* Epiblast. *h b.* Hypoblast.

28. An abnormal attached larva. *bl p.* Blastopore. *e b.* Epiblast. *ga.* Stomach. *h b.* Hypoblast. *β.* Base of attachment.

29. Scyphostoma with four tentacles. *bl p.* Mouth. *ga.* Stomach. *ta.*[1] Tentacles. In *Chrysaora*, between this stage and a following, there form in the cavity of the stomodæum in intermediate planes as respects the tentacles four ridges, thickenings of the hypoblast, which grow in such a way as to divide the cavity into four chambers, as in a young Actinozoan.

30. Older Scyphostoma. *bl p.* Mouth. *e b.* Epiblast. *h b.* Hypoblast. *β.* Basal attachment. Tentacles probably solid hypoblast.

31. Scyphostoma with eight tentacles. *bl p.* Mouth. *e b.* Epiblast. *ga.* Stomach. *h b.* Hypoblast. *β.* Attachment. *γ.* Perisare.

32. Scyphostoma with mouth (*or*[1]) mounted on a protuberance rising in the midst of the circle of tentacles (*ta*[1]). The oral region is bent over towards the observer, in order to show the oral prominence.

32.[1] Nematocyst from tentacle.

33. Scyphostoma seen from the side. *bl p.* Mouth.

34–40. Development of the Ephyra from the Strobila.

34. A Strobila with its first constriction (*con*[1]).

34′. Attached larva with a bud (*gm*) from its base.

35. A larva beginning its second constriction (*con*[2]). *con.*[1] First constriction. 1-2. Disks constricted from the Strobila, later to separate from the fixed larva as Ephyræ.

36. A larva beginning a third constriction (*con*[3]). *con.*[1] First constriction. 1-3. Constricted disks. *ta.*[1] Tentacles. *β.* Base of attachment, and appendages near by.

36′. A deformed Strobila.

37. Upper portion of a Strobila with five constrictions (1–5). *o cy.* Otocysts (?). *or.* Mouth. *py. gm.* Bud from the side of the body. *ta.* Tentacle. *β.* Base near attachment.

38. Showing a Strobila just breaking its attachment of the Ephyra, whose umbrella (*ubr*) is reversed. The axial attachment (*man*) becomes the manubrium of the Ephyra below it. 1–3. Three attached Ephyræ. *or.* Mouth. *ta′.* Tentacles not the same as *ta* (*fig.* 27). *β.* Base.

39. A Strobila with its second row of tentacles (*ta′*) present and the transitory tentacles of the Scyphostoma dropped. There are 13 (1–13) constricted disks, of which the upper (1) is the oldest. *o cy.* Otocyst. *o cy. lb.* Otocyst lobe. *ta.* Position of future tentacle. *ta′.* Second set of tentacles. *β.* Base.

40–49. The Ephyra.

40. An Ephyra in youngest condition, derived from a strobila with "false" deciduous tentacles, and probably the first disk to fall off. *o cy.* Otocyst. *o cy. lb.* Otocyst lobe. *ta.* The longer of the appendages marked *ta* is probably a "false" tentacle, which has not yet fallen off. The other may be the true Ephyra tentacle. *ubr.* Umbrella.

41. Profile view of an Ephyra in which the mouth (*or*) with its lips, and the veil (*vel*)? are well developed. *man.* Manubrium. *o cy.* Otocyst. *ubr.* Umbrella.

42. Ephyra with umbrella (*ubr*) thrown back, leaving the manubrium (*man*) projecting outward. *ga. c.* Gastric chamber (in this early stage only a part of the stomach). *o cy.* Otocyst. *tb.* Tube to the otocyst from the gastric chamber. *tb.*[1] Tube from the gastric chamber to the region from which the tentacles later arise.

43. Ephyra of about the same age as the last from the aboval side. *ga. c.* Gastric chamber. *or.* Mouth seen through the body walls. *tb.*[1] Tentacular tube. *tb.*[2] Tube to the otocyst.

44. An older Ephyra seen from the oral side. *ga. c.* Gastric chamber. *o cy.* Otocyst. *or.* Mouth. *tb.*[1] Tentacular tube. *tb.*[2] Ocular tube. *ubr.* Umbrella.

45. A sense octant (from oral side) of an Ephyra of about this age. *o cy.* Otocyst. *o cy. s.* Stalk upon which the otocyst is carried. *tb.*[1] Chymiferous tube from gastric chamber to the region of the bell margin from which the tentacles arise. *tb.*[2] Tube to the peduncle of the otocyst. *tb.*[5] Blindly ending tube. *tb.*[6] Enlargement of ocular tube.

46. Quadrant of an Ephyra (oral view), older than the last in which the clusters of tentacles are formed. *can. crc.* Circular canal. *ga.* Stomach. *lab.* Lips. *oa.* Ovary. *o cy.* Otocyst. *or.* Mouth. *ta–ta.*[6] Tentacles. *tb–tb.*[6] Chymiferous tubes. *vel.* Velum. ζ, $\zeta.'$ Intervals of muscular lower floor separating tubes. The circular muscles are seen at $\zeta.'$

46.[1] Ovarian opening. *oa.* Ovary. *y.* Portion of bell-wall near ovary. α. Rim of opening. ϕ. Phacellen (sexual filaments). $\phi.'$ Phacellen, seen through opening.

47. Profile view of a young medusa, older than the Ephyra strictly so called, with bell expanded. *o cy.* Otocyst. *or.* Mouth. *or. ta.* Oral tentacles. *ubr.* Upper side of the umbrella.

48. The same with bell-walls contracted. *or. ta.* Oral tentacles.

49. Oral view of a young medusa older than the Ephyra, but without tentacles.

PLATE IX.

Development of the Ctenophora. *Figures from* Alexander Agassiz, *and* Carl Chun.

B. *bl p.* Blastopore.
E. *e b.* Epiblast (?) A superficial layer of "small cells."
e b. t. Tentacular bulb, an eminence formed in part of epiblast, which later develops into a tentacle.
G. *ga.* Stomach.
ga.[1] Stomodæum.
H. *h b.* Hypoblast.
L. *l tb.* Lateral tube.
O. *o cy.* Otocyst.
ol. Otolith.
or. Mouth.
P. *pig.* Pigment.
p pl. Layer of protoplasm (?)
S. *sph.* Funnel.
T. *ta.* Tentacle.
V. *vt.* Vitellus.
vt. cl. Vitelline cells, "cell masses."
ζ. External envelope.
η. Swimming flappers.
θ. Polar elevation of protoplasm (?)
ω. Prominences of the body walls on each side of the otocyst.

Figures 1–33 on this plate were arranged by A. Agassiz.

1–37. From Agassiz, Embryology of the Ctenophoræ, *Mem. Acad. Arts and Sciences*, Vol. X. No. III. Pl. I. figs. 1, 2, 4, 5, 8, 12, 17, 18, 28, 29, 31, 37, 38. Pl. IV. figs. 8, 19, 23, 25, 28, 32, 34, 38, 42, 45. Pl. V. figs. 1, 2, 3, 5, 6, 7, 12, 15, 18, 19, 26, 27, 29, 30.

1–8. *Beroë (Idyia) roscola.*

1. Ovum of *Beroë* just after fecundation. The ovum is surrounded by a transparent envelope (*ζ*). *p pl.* Layer of granular protoplasm. *vt.* Vitellus.
2. First change in the ovum by which the "germinal layer" is concentrated at and about one pole, "the formative pole" (*θ*). The envelope *ζ* is gone. *vt.* Vitellus.
3. Somewhat older ovum with a prominent projection of the protoplasm at the pole (*θ*). *vt.* Vitellus. If the eminence (*θ*) be seen from a plane at right angles to figure 3, two prominences appear.
4. An embryo in which the projection has increased in size, and been deeply divided by a transverse furrow. Each elevation is lettered *e b.*[1] *vt.* Vitellus.
5. The furrow has deepened in this stage, so that the yolk is divided into two masses. The protoplasmic superficial layer extends over and surrounds them both. The deep slit is the position of a gastric cavity (*ga'*). *e b.* Epiblast (?)
6. The "bent dumb-bell stage," in which there are four yolk masses, the additional pair formed from the last by a fresh plane of segmentation. The pairs last formed are united by a bridge, as shown in the figure.
7. Embryo with four large vitelline masses, which will hereafter be lettered *vt. cl.*, and as many epiblastic prominences (*e b*).
8, 9. Dumb-bell stages of *Pleurobrachia rhododactyla*, seen from oral side, divided into eight vitelline masses. *e b.* Epiblast. *vt. cl.* Vitelline cells.
10. *Beroë roscola*, "Side view of (the) yolk-mass, in which the actinal segmentation of the smaller cells has commenced to form sixteen unequal masses." Agassiz.
11. An embryo with smaller spheres (*e b*) more numerous. *vt. cl.* Vitelline spheres.
12. "Yolk-mass seen from the actinal pole; the masses are arranged round a vertical axis, each small mass forming a small overhanging projection, at the extremity of which the germinal layer is concentrating, preparatory to a rapid segmentation, to be accomplished as in earlier stages of segmentation." Agassiz. *e b.* Epiblast. *ga.*[1] Gastrula cavity. *vt. cl.* Vitelline cells.
13. Embryo in which the smaller cells of the outer layer have undergone further division.

14–37. *Pleurobrachia rhododactyla.*

14. Embryo of *Pleurobrachia* of about the same age, showing the relative position of the larger and smaller cells.
15. A view of the same from the (oral ?) (actinal) axis. There is a confusion in different authors as to these two regions of the embryo.
16. Older embryo of *Pleurobrachia*, showing the "actinal trench" (?) in profile. *e b.* Epiblast. *ga.*[1] Gastric cavity. *vt. cl.* Vitelline masses.
17. A schematic section, showing the relation between the cavity *ga*,[1] the layer of small cells *e b*, and the vitelline masses (*vt. cl.*) *bl p.* Blastopore.
18. Embryo of *Pleurobrachia*, seen from the pole on which the blastopore (*bl p*) opens. *e b.* Outer layer of small cells.
19. An embryo of the same, of about the same age as the last, seen from the opposite pole. *e b.* Small cells. *vt. cl.* Large cells.
20. Morula in which the small cells have almost completely enveloped the vitelline masses.
21. An embryo showing the first elevation of epiblastic cells to form an otocyst (*o cy*). *e b.* Epiblast. *vt. cl.* Vitelline cells.
22. Embryo older than the last, showing an infolding of the outer walls to form a stomach (*ga*). *e b.* Epiblast. *e b. t.* Prominence of the epiblast at the points where the tentacles later appear.
23. An embryo of about the same age as the last, seen from the actinal pole (*o cy*).
24. Profile of the embryo in which the stomach cavity has formed. From A. Agassiz's account it seems that a part at least of the gastric cavity is hollowed out among the vitelline cells. This is the region of the funnel or the upper part of the cavity (*ga*). The lower portion or the true stomach is formed as a gastrular invagination of the epiblast. As interpreted by Balfour, the alimentary canal of the Ctenophore would be made up of two sections: (1) a true hypoblastic section, consisting of the infundibulum, and the gastro-vascular canals derived from it; and (2) an epiblastic section — the stomodæum — forming the stomach.
25. Older larva in which four otoliths (*ol*) have formed. *e b. t.* Tentacular prominence. *η.* Row of vibratile flappers.
26. The same, a little older, seen from the actinal pole. *ol.* Otolith.
27. Still older embryo. *e b. t.* Tentacular prominence. *ga.* Stomach. *ol.* Otolith.
28. Older larva. The otocyst is well formed, and the first of the two sections of the alimentary canal, mentioned above, has begun to have definite walls. *ga.* Stomach.
29. View of a larva younger than the last, seen from the actinal pole. *eb. t.* Tentacular prominence. *ol.* Otolith.
30. An older larva with tentacles still more developed. Otoliths (*ol*) brought close together into an otocyst (*o cy*). *ta.* Tentacle.
31. Still older larva, seen from one side, in which the tentacles are well formed. *ga.* Stomach. *sph.* Funnel.
32. Older larva. *ga.* Stomach. *sph.* Funnel. *ta.* Tentacle. *η.* Row of locomotive flappers.
33. View of a slightly older larva showing a tentacle on the middle line. *or.* Mouth. *η.* Row of locomotive flappers.
34. More advanced embryo. *or.* Mouth. *η.* Vibratile flappers.
35. Side view of a larva a little older than the last. *ga.* Stomach. *o cy.* Otocyst. *ol.* Cluster of otoliths. *ta.* Tentacle.
36. More mature embryo than the last (side view). *ga.* Stomach. *or.* Mouth. *ta.* Tentacle. *η.* Vibratile flappers.
37. The same in another plane. *ga.* Stomach. *or.* Mouth.

38–40. *Callianira bialata*, Delle Chiaje, from Carl Chun, Fauna und Flora des Golfes von Neapel, I. Monographie: Ctenophoræ. Pl. III. figs. 1, 2, 3.

38. Larva before the formation of the lobes of the body on each side of the otocyst.
39. Side view of the same or an older larva. *ga.* Stomach.
40. An older larva, with beginnings of the wing-like extensions of the body (*ω*). *l. tb.* Lateral tube. *η.* Vibratile flapper.

41–45. From Chun *op. cit.* Pl. VII. fig. 18. Pl. III. fig. 8. Pl. VIII. fig. 8. Pl. XIV[a]. figs. 9, 10.

41. Larva of *Chiaja* (*Eucharis*) *multicornis*. *h b.* Hypoblast. *η.* Position of the vibratile flappers. The thin layer which embraces the whole embryo is the epiblast, and the infolded region at the lower pole is the future mouth. Rows of combs should be represented at *η*, and on the corresponding opposite side, while a line indicating the lower edge of the mouth should connect the two prominences at the lower pole.
42. Embryo of *Beroë Forskâlea*, Chun (optical section). *e b.* Epiblast. *h b.* Hypoblastic cells. *or.* Mouth. *sph.* Lumen of the hypoblast. This cavity in the centre of the larva is the beginning of the future funnel. *η.* Row of vibratile flappers. *o cy.* Otocyst.

43. Larva of *Hormiphora plumosa*, *gen.* Ag. *sp.* Sars. *ga.* Stomach. *l.tb.* Lateral tube. *o cy.* Otocyst. *or.* Mouth. *sph.* Funnel.
44. Embryo of *Beroë rufescens*, Forsk. (*Forskâlea*, Chun.) *l. tb.* Lateral tube. *ol.* Otolith. The otocyst is not yet formed about the otolith. *or.* Mouth.
45. Larva of the last named, which has reached sexual maturity. *ol.* Otolith already enclosed in its otocyst. *or.* Mouth. *pig.* Pigment.
46. *Beroë roseola*, from Agassiz, *op. cit.* Pl. III. fig. 18. Embryo seen from "abactinal" pole. *ol.* Otolith. *η.* Row of vibratile flappers.
47. *Beroë rufescens*, from Chun, *op. cit.* Pl. XIV[a]. fig. 11. Larva seen from one side. *o cy.* Otocyst. *or.* Mouth. *tb.* Chymiferous tubes.

48–50. *Beroë roseola*, from Agassiz, *op. cit.* Pl. III. figs. 19, 20, 22.

48. Larva somewhat older than that shown in figure 47, in which the two chymiferous tubes, under the combs nearest the medial line of the figure, have pushed their way to the vicinity of the mouth. *ga.* Stomach, which occupies the whole body cavity. *or.* Mouth. *η.* Vibratile flappers.
49. View of an older larva, seen at right angles to the last. The two tubes, which in fig. 48 were represented as approaching the mouth, have in this united, forming a ring about it. The other tubes are advancing to the labial region. *ga.* The whole cavity of the larva forms a stomach; the portion marked (*ga*) one of the tubes of the body walls. *o cy.* Otocyst. *η.* Vibrating flapper.
50. Larva of *Beroë roseola*. *ga.* Stomach. *o cy.* Otocyst.

PLATE X.

Development of the Ctenophora, *continued. Figures from* Carl Chun *and* J. Walter Fewkes.

A. *adr. tb.* "Adradial" chymiferous tube. The adradial tube passes to the short rows of flappers. It arises from the interradial tube.
aur.[1]–*aur.*[4] Auricles.
C. *cil.* Cilium.
cil'. Tuft of cilia before closure of otocyst.
E. *ex*[1]., *ex.*[2] External openings from the funnel, probably excretory.
ex. l. tb. External lateral tube bounding the lower rim of the body lobes (*lb*).
G. *ga.* Stomach.
ga. en. Bifurcation of the stomach tube.
ga. sch. Magengefässschenkel.
ga. tb. Stomach tube.
gaw. Appendage to the stomach.
H. *h b.* Hypoblast.
h b.,[1] *h b*[2]. Large hypoblast cells.
h b[3]., *h b*[4]. Beginning of the chymiferous system of vessels.
I. *i.l.tb.* Internal lateral tube.
i.r.tb. Internal radial tube.
L. *lb.* Body lobes.
l.mu. Lateral muscles.
M. *my.w.* Median gelatinous prolongation near the otocyst.
mu. Muscles.
mu.circ. Muscles surrounding the stomach.
N. *n.*–*n.*[8] Nerves.
n c. Nerve centre
O. *ocy.* Otocyst.
ol. Otolith.
or. Mouth.
P. *per. en.* Radial canal before division.
S. *sch.* Tentacular cover.
s.g w. Gelatinous elevations on the side of the otocyst.
sph. Funnel.
sph. tb. Tubular region of the funnel.
T. *ta.* Tentacle.
tb.–*tb.*[8] Chymiferous tube extending to the tentacle.
X. *x.* Junction of three chymiferous tubes.
Y. *y.*[2], *y.*[3] Line of the internal wall of the lobe at the point where the chymiferous tubes seem to cross it.
Z. *z.*[1]–*z.*[4] Junction of tubes at base of auricles.
η.–*η.*[8] Vibratile flappers.
θ. Simple division of chymiferous tubes without tentacle in genus *Ocyroë*.

1–19. From Chun, *op. cit.*, Pl. II. figs. 9, 10; Pl. VII. figs. 1, 4, 6, 11; Pl. VIII. fig. 4; Pl. IX. figs. 3, 4, 8, 15, 16; Pl. XII. 3, 4, 6, 7, 8, 11.

1–10. Development of *Chiaja* (*Eucharis*) *multicornis*.

1. Segmented ovum, showing the larger cells, "vitelline cells" within, surrounded by smaller cells of epiblast. The opening through which the larger cells appear is a blastopore.
2. Embryo in which the epiblastic cells have almost completely closed the opening (*blp*) seen in figure 1. The remains of this orifice appears as a long narrow slit.
3. Optical section of the gastrula.
4. The gastral mouth now completely closes, and the wall of the epiblast begins to infold to form the future mouth and stomach.
   Embryo in which this infolding has assumed considerable size, and in which, also, the tentacular prominences (*ta*) have begun to form. An otocyst is already formed, while a single otolith is represented in Chun's figure, which has not yet grown into the otocyst. The investing layer is the epiblast. *h b.* Endoderm, hypoblast. At the point *mu.* is the beginning of the muscular layer which later becomes very prominent. *η.* Vibratile row of flappers. *cil'.* Tufts of cilia.
5. Still older larva in which the size of the layer between the outer thin epiblast and the larger cells, hypoblast (*h b*[1]., *h b.*[4]), has increased greatly in size. In the latter the star-like muscular cells can be seen.

This layer is an enormous growth of the layer designated by the letters *mu.* in figure 4. *cil'* Cilia at the actinal pole. *or.* Mouth. *ta.* Tentacle. At *h b.*^{3}, *h b.*^{4} begin to arise sacs, which later develop into the circulatory-tube system. The tube *h b.*^{3} is best marked of these. *h b.*^{1}, *h b.*^{2} Remains of the original large cells.

6. Sexually mature, "Cydippe-formed larva," of *Chiaja* (*Eucharis*). At the peripheral extremity of the eight tubes (*adr. tb.*) are swollen cavities, filled with sexual products. These lie just beneath the rows of combs or vibratile flappers. *adr. tb.* Adradial tube, ultimate division of the chymiferous tubes, which extend to a meridional tube below the rows of flappers. *ga.* Stomach. *ga. tb.* A chymiferous tube, in this stage ending blindly in the bell-walls, and called the stomach tube from its relation in position to the stomach. *i.r.tb.* Internal radial tube. There are four of these which arise from the base of the funnel and each divides into two adradial tubes (*adr. tb.*). *n.*^{4}, *n.*^{5} Nerves. *sph. tb.* Tube of the funnel, which spreads itself out at the upper pole (*sph. tb.*) under the nerve centre (*n c.*) Above the nerve centre is the otocyst with its otoliths.

7. A larva at about the same stage, seen in a plane at right angles to the last. *ga.* Stomach, here seen in profile. *adr. tb.* Adradial tube. *ga. tb.* Stomach tube arising from the funnel (*Sph.*). *i.r.tb.* Internal radial tube. *n.*^{2}, *n.*^{3} Nerves. *n.c.* Nervous centre. *ta.* Tentacle. *ta. tb.* A tube, which passes directly to the tentacle from the funnel. *tb.*^{2} A blindly ending, meridional tube under a row of vibratile flappers. *η.*^{4} Row of flappers. *lb.* Rudimentary lobes.

8. View of a Cydippe-like larva of *Chiaja* (*Eucharis*) from the actinal pole. *adr. tb.* Adradial tube. *ex.*,^{1} *ex.*^{2} Excretionary (?) opening. *ga.* Stomach. *n.* Nerve. *tb.–tb.*^{8} Chymiferous tubes. *per. cn.* Canal arising from the base of the funnel before its division into the interradial tubes. *ta.* Tentacle.

9. Somewhat older larva from the actinal pole, in which the chymiferous tubes have joined in the bell-walls. *adr. tb.* Adradial tube. *aur.*^{1}–*aur.*^{4} Auricles. *ex. l. tb.* Tube skirting the lobe of the body, outside the internal tube (*il. tb.*). *ga.* Stomach. *ga. sch.* Magengefässschenkel. *ga. tb.* Gastric tube seen in section. *i.r.tb.* Internal radial tube. *ta.* Tentacle. *z.*^{1}–*z.*^{4} Point of bifurcation of the tube which skirts the auricle.

10. The same seen from the side. *adr. tb.* Adradial tube. *aur.*^{1}, *aur.*^{2} Auricles. *ex.l. tb.* External tube of the body lobe. *ga.* Stomach. *ga. sch.* "Magengefässschenkel." *g w.* Sac-like appendage to the stomach. *i. r. tb.* Internal radial tube. *lb.* Body lobe. *my. w.* Medial gelatinous elevation near the otocyst. *n.* Nerve. *ocy.* Otocyst. *ta.* Tentacle. *ta. tb.* Tentacular tube. *y.*^{2}, *y.*^{3} Inner wall of the body lobe, seen in profile. *η.*^{3}–*η.*^{6} Rows of vibratile flappers.

11–17. Development of *Cestus Veneris*.

11. Young larva of *Cestus*, seen from one side. *ga.* Stomach. *ga. tb.* Tubes one on each side of the stomach. *n.*^{1}–*n.*^{4} Nerves. *or.* Mouth. *sph. tb.* Tube of the funnel. *tb.*^{1}–*tb.*^{4} Chymiferous tubes. *η.* Vibratile flapper.

12. View of the "Cydippe-formed larva" from the actinal pole. *ga.* Stomach. *ga. tb.* Stomach tube. *i.r. tb.* Internal radial tube. *n.*^{1}–*n.*^{8} Nerves. *mu.* Muscles. *ol.* Otolith. *per. cn.* First division of the chymiferous tubes. *ta.* Tentacle. *tb.*^{1}–*tb.*^{8} Chymiferous tubes.

13. Still older larva ("Cydippe form"). *ga. tb.* Stomach chymiferous tubes. *mu. crc.* Circular muscles. *n.*^{1}–*n.*^{4} Nerves. *ocy.* Otocyst. *or.* Mouth. *sph.* Funnel. *sph. tb.* Tube of the funnel. *ta.* Tentacle. *tb.*^{1}–*tb.*^{4} Chymiferous tubes below the flappers. These have begun to extend downward, but in this stage are blind ending.

14. Larva of "Cydippe form" in which the tubes (*tb.*) have grown downward towards the oral pole. (View at right angles to fig. 13.)
adr. tb. Adradial tube. *ga.* Stomach. *ga. tb.* Gastric tube. *ga. cn.* Beginning of a bifurcation of the extremity of the gastric tube. *n. c.* Nervous centre. *sph.* Funnel. *ta.* Tentacle. *sph. tb.* Tube passing from the funnel to the otocyst. *tb.*, *tb.*^{4}–*tb.*^{6} Chymiferous tubes, extending meridionally in the bell-walls. *η.*^{5}, *η.*^{6} Vibratile flappers.

15. Older larva than that known as the "Cydippe form" (seen in the same plane as fig. 14). *ga.* Stomach. *ga. tb.* Gastric tube. *ga.* Sac-like appendage to the stomach. *m.ga.* Gelatinous elevation near the otocyst. *n.* Nerve. *ocy.* otocyst. *tb.*^{3} Chymiferous tube formed by the junction of two opposite tubes (*tb.*, and *tb.*^{6}, fig. 14). *tb.*^{4}, *tb.*^{5} Two chymiferous tubes.

16. An older stage in the development in which the chymiferous tubes (*tb.*^{4}, *tb.*^{5}) have joined *tb.*^{3} at *x.*^{2}, *x.*^{3} *ga.* Stomach. *i.r.tb.* Internal radial tube. *sph. tb.* Tube of the funnel.

17. Older embryo, in which the larva has become more elongated and band-shaped.

18, 19, *Thoë paradoxa*, Chun.

18. Larva (?) of *Lampetia pancerina*, Chun, with single tentacle (view showing the tentacle on one side). *ga.* Stomach. *n c.* Nervous centre. *sch.* Tentacular sheath. *η.*^{1}–*η.*^{4} Rows of vibratile flappers. *tb.*^{3}, *tb.*^{1} chymiferous tubes under flappers *η.*^{3} and *η.*^{4}

19. The same larva seen at right angles to the plane of the last. *ga.* Stomach. *ga. w.* sac-like gastral appendage. *n c.* Nerve center. *sph.* Funnel. *sch.* Tentacular sheath. *ta.* Tentacle. *ta. sac.* Tentacular sac.

20. Larva of *Cyroë crystallina* Rang, from Fewkes, Notes on Acalephs from the Tortugas, with a Description of New Genera and Species. *Bull. Mus. Comp. Zool.* Vol. IX. No. 7. Pl. 1. fig. 2. *adr. tb.* Adradial tube. *aur.*,[1] *aur.*[2] Auricles. *ex.l.tb.* External lateral tube. *ga.* Stomach. *ga. tb.* Gastric tube. *i.l.tb.* Internal lateral tube. *lb.* Lobe of the body out-stretched. *l.mu.* Muscles. *ocy.* Otocyst. *or.* Mouth. *sph. tb.* Tube extending from the funnel to the otocyst. *η.* Vibratile flapper.

PLATE XI.

Development of Zoantharia (Actininæ). *Figures from* Henri de Lacaze-Duthiers, A. O. Kowalevsky, Étienne Jourdan, Oscar Hertwig und Richard Hertwig, *and* Angelo Andres.

bl d.	Blastoderm.	*om.*	Ovum.
cil.	Cilia.	*or.*	Mouth.
cc.	Ectoderm.	*pes.*	Foot.
cn.	Entoderm.	*phx.*	Pharynx.
g.	Germ.	*phx. sac.*	Pharyngeal sac.
g. vs.	Germinative vesicle.	*phx. sul.*	Pharyngeal groove.
lg. mu.	Longitudinal muscles.	*sg. cav.*	Segmentation cavity.
mb. pa.	Membrana propria.	*ta.*	Tentacle.
m nt.	Mesenteries.	*te. cap.*	Testicular capsule.

Arabic numerals are used to indicate the order of appearance of the mesenteries.

The Greek letters show the order of the formation of mesenterial chambers and the order of the succession of the tentacles up to the stage with 12.

1–25. *Actinia mesembryanthemum.* From Lacaze-Duthiers, Développement des Coralliaires. Premier mémoire. Actiniaires sans polypier. Arch. de Zool. exp. et gén., Tom. I. 1872. Plates XI.–XIII.

1. A portion of an exclusively female mesenterial fold or septum, showing eggs with the germinative vesicle, and also dark, deeply colored germs no longer possessing a germinative vesicle.

   Note.—In the original, more extensive, figure the eggs are shown to be often arranged in series. In the opinion of the author, this appears indicative of their common origin.

2. A highly magnified spermatozoön.

2ª. Cells from the interior of a testicular capsule, in the condition in which they are found when they are mingled with mature spermatozoa.

3. One of the reniform testicular capsules from a male mesenterial fold, rupturing and allowing the escape of a stream of spermatozoa. $\frac{5}{1}\frac{0}{0}$.

4. A germ at the time of its escape from the ovary. It appears bristling with prickles, which it afterwards loses.

4ª. Portion of the external layer of the same, more highly magnified. $\frac{5}{1}\frac{0}{0}$.

5. (At the bottom of the plate near the middle.) A germ in which there is a central deeply-stained mass (entoderm), and a peripheral layer (ectoderm) scarcely rose-colored. The depression which will be the mouth is indicated by *or*. The cilia are more strongly developed at the aboral pole. The striate appearance of the outer layer is caused by the presence of nematocysts which have begun to be developed in it, as well as by the cilia. About $\frac{1}{1}\frac{5}{5}$.

6. An embryo seen in profile, and already presenting one partition (septum) indicated by a vertical line.

7. The same as the last; view of the oral pole. The mouth is elongated in the manner of a button-hole, the long diameter of which is perpendicular to the two septa, marked 1, which have divided the central mass of the embryo into unequal portions, α and α′.

8. A slightly more advanced embryo seen from the side. The partitions, and especially the œsophageal prolongation, cause the appearance at this point of the transversely oval cavity.

9. A more advanced embryo, in which a second pair of partitions, 2, are visible.

10. Embryo showing plainly the division into four compartments. The chamber α′ is already removed from the partition, I, which gave origin to it; the chambers β, β form with α′ a group of three lobes representing the greater of the two original chambers.

11. The same as fig. 10, seen in profile. The œsophagus (pharyngeal sac) descending from the mouth is already well formed, and the chambers to the number of four are also well limited.
12. An embryo much larger than the preceding. The small compartment (α) is divided into three by the pair of partitions, 3. The compartment β of fig. 10 is also divided already into two (β and δ) by the appearance of the partition, 4. Of the 8 septa thus acquired, the pairs numbered 1 and 2 are always more developed than the others.

    NOTE. — The order of development of the "septa" 2 and 4 is claimed by the brothers Hertwig to have been interchanged, so that the true order of their appearance would be indicated by the numbers in parentheses. Compare explanations of figs. 31, 35, and 36.
13. Profile view of the preceding, showing the mouth surrounded by 8 compartments with rounded bases.
14. The same as in the two preceding figures, but the progress of the partitions being more considerable, the division into 8 compartments is more distinct; the partitions, 1, are still much more advanced; they already reach the central pad surrounding the mouth (peristome), and consequently begin to indicate the primitive division into halves.
15. An embryo in which the 8 complete partitions have reached the peristome.
16. Embryo with 8 divisions showing the partitions, 5, well advanced, and the beginning of the partitions, 6, in the lobe γ. The two new chambers thus formed are respectively ϵ and ζ.
17. One of the various forms which the embryos assume when in motion.
18. The same as fig. 17. It has been compressed a little to show the "septa" or mesenterial folds (*m nt.*). Only two of the latter (1, 1) present the beginnings of the craspeda, or mesenterial filaments; they are the primary folds. $\frac{7}{1}^{5}$.
19. An embryo represented with the form which it assumes when it swims rapidly. The tuft of cilia at the pedal pole is considerably elongated. $\frac{7}{1}^{5}$.
20. Profile view of an embryo. The mouth is supported on a snout-like prolongation, and the primitive chamber α' has begun to send forth a tentacle. 1, Primary fold with mesenterial filament slightly developed. $\frac{7}{1}^{5}$.
21. Embryo further developed than the preceding, exhibiting already eight tubercles, which are the beginnings of the tentacles of the eight chambers first formed. $\frac{7}{1}^{5}$.
22. Oral aspect of a young actinia already approaching the form of the adult. The 12 tentacles of the first formation are already produced. The period of equalization in sixes, taken alternately, is in process of accomplishment and transforms the special embryonic form into one with regularly radial symmetry. The two cycles already begin to appear. The group of 7 lobes which has as its centre the tentacle α' is always distinguishable by the size of the latter, and by the development of the mesenterial folds. 1. $\frac{2}{1}^{0}$.
23. Young actinia with two well-pronounced cycles. The limits of the pedal disk are well marked, although the movements of the animal are still very lively, and the tuft of pedal cilia is very long. $\frac{2}{1}^{0}$.
24. Young actinia already attached, viewed from the oral pole. In the intervals between the tentacles of the first cycle ($\alpha - \zeta$, $\zeta - \epsilon$ ($\zeta - \delta$?), $\delta - \alpha'$) there begin to be formed six new pairs of young tentacles, which increase the total number to twenty-four.

    NOTE.— Of the three tentacles occupying each of the intervals ($\alpha - \zeta$, $\zeta - \delta$, etc.) the *middle* one out-strips the other two, replacing (in size) γ, ϵ, β, etc., and thus the middle ones come to constitute the *second* cycle. The third cycle is then composed of the remaining 12 (smallest) tentacles, which occupy the intervals between those of the first two cycles, thus regularly alternating with them. The subsequent increase in the number of chambers — and later, in that of the corresponding tentacles — is accomplished by the production of a *pair* of elements (mesenteries) in each of the 12 chambers above which are placed the smallest tentacles; and by a process of substitution similar to that just described the middle ones of the three compartments (tentacles) thus formed comes to constitute the third cycle, while the two on either side of it become members of the fourth cycle. The fifth cycle is formed in a similar manner. "Since after the formation of each fresh cycle, the arrangement of the tentacles again becomes symmetrical (in sixes), it is obvious that all the equal-sized cycles except the first are formed of tentacles entirely heterogeneous as to age."
25. Face view — from the side of the seven-chambered group — of a young actinia with twenty-four tentacles, showing the relative development of the three pairs of mesenterial folds, 2, 4, and 5. $\frac{2}{1}^{0}$.

26–31. *Actinia* (sp. ?). From A. O. Kowalevsky, Observations on the development of the Cœlenterata. From the Publications of the Imperial Society of Friends of Natural Sciences, Anthropology, and Ethnography. Moscow: Katkov, 1873. 4to, 36 pp., 8 pl. (Russian.) Pl. IV. figs. 1–5, 7.

26. The egg after its segmentation.
27. Infolding of the blastoderm.
28. Invagination completed.
29. Later stage in which the mouth-opening appears as a narrow slit and the first pair of mesenterial partitions has arisen.
30. Radial section of the germ which is represented in fig. 29.

31. Radial section of a more advanced germ. The pairs numbered (2) and (3) constitute the second series of mesenterial septa, the single septum, (4), arising later; a corresponding single septum (not shown in the figure) arises diametrically opposite (4).

    NOTE. — The numbers in parentheses indicate the order in which the brothers Hertwig claim that the septa must have arisen, the septum numbered (1) being in their opinion really a pair of septa. Compare figures 35 and 36.

32–34. *Actinia equina*. From Étienne Jourdan, Recherches zoologiques et histologiques sur les Zoanthaires du Golfe de Marseille. Ann. sci. nat., sér. 6, zool., Tom. X., Art. no. 1. Oct. 1880. Pl. XVI. figs. 117, 118, 120.

32. Longitudinal section, showing the secondary infolding to form the œsophageal tube (*phx*). $\frac{2}{1}\frac{3}{0}\frac{2}{0}$.

33. Transverse section of a stage with eight partitions (*m nt.*), of which the *membrana propria* forms the axes. $\frac{8}{1}\frac{0}{0}$.

34. Larva with small tentacles, *ta.*; *ed*, ectoderm of the œsophageal tube. $\frac{1}{2}\frac{1}{5}$. (Longitudinal section.)

35, 36. *Adamsia diaphana*. From Oscar Hertwig und Richard Hertwig, Die Actinien anatomisch und histologisch mit besonderer Berücksichtigung des Nervenmuskelsystems untersucht. Jena: Gustav Fischer, 1879. Taf. 1. figs. 3, 4.

35. Cross section of a young Adamsia in which the fifth and the sixth pairs of "septa" are still destitute of muscle fibres.

36. Cross section of an Adamsia somewhat older than the preceding. The fifth and sixth pairs of septa, although exhibiting muscles, have not yet joined the pharyngeal tube.

    The Roman numerals indicate the ultimate grouping of the septa into pairs in the adult animal.

    The Arabic numerals are used to indicate the supposed order of appearance of the 6 primary pairs of septa, the 5th and 6th appearing, however, at the same time.

    The pairs numbered 3, 3, and 4, 4 are called "direction septa" by the Hertwigs.

37. Thirteen figures illustrating the scissiparity of *Aiptasia lacerata*. From A. Andres, Intorno alla scissiparità delle attinie. Mittheilungen a. d. Zoolog. Station zu Neapel, Bd. III., Heft 1. 9 Dec. 1881. Taf. VII.

    The letters correspond to the successive epochs of observation, as follows: *A.* 7 Nov. 9 A. M.; *B.* 7 Nov. 12 M.; *C.* 7 Nov. 12 : 20 P. M.; *D.* 7 Nov. 12 : 30 P. M.; *E.* 7 Nov. 12 : 40 P. M.; *F.* 7 Nov. 12 : 50 P. M.; *G.* 7 Nov. 1 P. M.; *H.* 11 Nov. 3 P. M.; *I.* 12 Nov. 3 P. M.; *J.* 19 Nov. 10 A. M.; *K.* 25 Nov. 3 P. M.

    The unaccented letters belong to figures giving the general aspect in profile. *B*, *D*, and *G* are natural size; *I* and *K*, magnified two diameters, represent only the newly-formed individual. The letters with a single accent pertain to figures exhibiting the appearance of the base, and those with a double accent to figures of *radial* sections. *C'*, *E'*, and *G'* are magnified between 2 and 3 diameters; *H'* 5 diam.; *J'*, and *K'*, 6 diam.; *C''*, and *K''*, 15 diam.

    The parent has 96 mesenteries. Of the intermesenterial chambers the 12 primary are designated by the odd numbers from 1 to 23, the 12 secondary by the even numbers from 2 to 24, the 24 tertiary by the accented numbers 1′, 2′, 3′, etc. (not reproduced here), and the 48 quaternary, or spurious, mesenteries are not numbered. Neither of the gonidial chambers is involved in the changes.

    At stage *B* the disk of the foot exhibits a gibbosity which is opaque at the margin. A radial longitudinal section shows in this stage, as also in the next (compare *C''*), that it is due principally to a thickening of the entoderm, which soon occupies all the available space in the chambers. (The ectoderm in *C''* has been drawn relatively too thick.) The region embraced in the gibbosity is embraced between the numbers 1 and 9.

    In the next stage (*C'* and *C''*) the gibbosity is distinguished from the rest of the periphery by two angles, which correspond to the two chambers 1′ and 8′.

    In stage *D* the angles correspond to the chambers 2 and 8. The laceration of the mesenteries embraced between 3 and 7 now begins.

    In the succeeding stage (*E'*) upon the base the laceration is completed in the median space, and is also extended to the chambers 4 and 8, nearly isolating the gibbosity, which now remains attached by only two delicate cords, — remnants of 3′ and 8′. The ragged edges contract toward the principal mass, whether of the parent or the off-shoot, gradually determining the contour.

    The final separation (*G''*) is effected at points corresponding to 2′ and 8′. The process thus far has occupied only one hour.

    Four days later (*H'*) the basal portion of the parent shows the arrangement of restored mesenteries and chambers, and the contour shows that the scar is healed. The off-shoot is thickened and rounded; the mesenteries at its extremes are fused together into a uniform obscure mass. The chambers which persist are 3, 3′, 4, 4′, 5, 5′, and 6, together with the intervening ones. A sagittal section perpendicular to the plane of separation shows that the off-shoot has an opening where its continuity with the parent was severed. This opening is restricted by the margins of the internal parts, which tend to curve inward at all points and,

being more pronounced below than above, carry the aperture obliquely upward (compare K''). Some of the mesenteries are clearly prolonged from the curved portion of the periphery across to the straight — or chord — portion corresponding to the line of separation. The latter side subsequently assumes the appearance of a hilus.

A view of the base eight days later (J') shows it almost completely rounded, and in the region of the former hilus the formation of two new chambers is confusedly indicated. It is to be seen upon sagittal sections that in the region of the hilus some of the mesenteries are certainly formed by the development of the distal portion of the central mesenteries of the opposite or curved side, others by the regular growth of the mesenteries occupying the folded ends of the off-shoot, and still others by a new local origin; also that the infolded portions previously mentioned gradually come to form the pharynx.

At length, after six days more (K', K''), the off-shoot is developed into a minute young actinia with nearly central mouth and twelve tentacles. Upon the base are readily recognized six primary chambers (1–6), — of which 4 are old and 2 are new, — 6 secondary, and 12 spurious chambers. The gonidial chambers correspond to 1 and 4.

A few days later it had become quite regular, and showed traces of craspedi (mesenterial filaments) on the gonidial mesenteries.

PLATE XII.

Development of Zoantharia *and* Alcyonaria. *Figures from* A. O. Kowalevsky, Étienne Jourdan, Wilhelm Busch, Alexander Agassiz, Edward L. Mark *and* Carl Claus.

an. po.	Anal pore.	*lg. mu'.*	Longitudinal muscles of mesenteries.
bl d.	Blastoderm.	*mb. pa.*	Membrana propria.
cam.	Artificial chamber between *ec.* and *en.*	*m nt.*	Mesenteries.
cil.	Cilia.	*m nt. fil.*	Mesenterial filaments.
d.	Dorsum, and dorsal mesenteries.	*mso d.*	Mesoderm.
d.–l.	Dorso-lateral mesenteries.	*or.*	Mouth.
dx.	Dextral.	*or. ta.*	Oral tentacles.
ec.	Ectoderm.	*phx.*	Pharynx.
en.	Entoderm.	*s.*	Sinistral.
en'.	Intermesenterial ridges of *en.*	*sg. cav.*	Segmentation cavity.
gtt. ol.	Oil globules.	*ta.*	Tentacle.
lab.	Oral lips.	*v.*	Ventrum, and ventral mesenteries.
lg. mu.	Longitudinal muscles.	*v.–l.*	Ventro-lateral mesenteries.

1–9. *Cerianthus membranaceus.* 1–6, 8, 9, from A. O. Kowalevsky, Observations on the development of the Cœlenterata. From the Publications of the Imperial Society of Friends of Natural Sciences, Anthropology, and Ethnography. Moscow: Katkov. 1873. (Russian.) Pl. VI.

1. Egg after the segmentation is completed. $\frac{3}{4}^{0}$. The blastoderm, of a single layer of uniform columnar cells, embraces a comparatively large segmentation cavity.
2. Stage showing the invagination of one half of the blastoderm into the other half. At the bottom of the cavity are seen fat globules (*gtt. ol.*) which came out through the invaginated cells, *en.*
3. A farther developed stage, already slightly elongated.
4. The edges surrounding the mouth-opening have been infolded to form the beginning of the stomach, *phx.* Note. — This infolding affects principally only two opposing sides, whereby the cavity thus formed is bounded on two sides, as shown in this figure, by both layers (*ec.* and *en.*) of the infolded wall, whereas at the two remaining sides the infolded portion of the ectoderm is in immediate contact with the superficial layer, the entoderm not being involved in the folding. The upper part of the entodermic cavity is thus divided into two lateral pockets. Compare fig. 9.
5. A still more developed stage, in which four tentacles (*ta.*) have appeared. The rim or lip which surrounds the mouth-opening is seen through the substance of a tentacle at *lab.*
6. A swimming larva of Cerianthus, which shows, beside the four tentacles, a pair of oral tentacles (*or. ta.*), a pair of mesenterial filaments, and an indication of the so-called anal pore at the aboral end.
7. Longitudinal section of a larva of Cerianthus membranaceus. $\frac{3}{4}^{0}$. From Étienne Jourdan, Recherches zoologiques et histologiques sur les Zoanthaires du Golfe de Marseille. Ann. sci. nat., sér. 6, zool., Tom. X., Art. no. 1. Pl. XVI. fig. 121.
8. Transverse section through the posterior end of the larva represented in fig. 5. The longitudinal muscles of the wall, lying on the outer margin of the membrana propria, are shown cut across at *lg. mu.* These are believed to have originated from the ectoderm. The cut ends of the longitudinal muscles on both sides the mesenteries are seen at *lg. mu'.*
9. Transverse section through the upper end of the same larva.

10–15. *Cerianthus? (Dianthea nobilis* Busch). From Wilhelm Busch, Beobachtungen über Anatomie und Entwickelung einiger wirbellosen Seethiere. Berlin: A. Hirschwald, 1851. Taf. XVII. figs. 1, 2, 4, 5, 7, 8.

10. Young larva, uniformly ciliate; too opaque to show internal structure.

11. More advanced stage of the same individual. To the two rudiments of tentacles which made their appearance 24 hours earlier, is now added a third, which is soon to be followed by a fourth. In swimming, the end opposite the tentacles is in advance.
12. Beside the four tentacles there is a pair of oral elevations. Compare *or. ta.*, fig. 13.
13. Oral aspect of a six-tentacle stage. The two new tentacles are *ta'.*, *ta''*.
14. A seven-tentacle stage, much contracted. The fifth tentacle (5) has reached the length of the four older ones. The sixth and seventh have both appeared in the same intertentacular space, namely, the one adjacent to the space occupied by the fifth. The oral lips show a maximum protrusion. Two of the clavate organs are pedunculate; two, attached near the bases of the sixth and seventh tentacles, are still sessile.

    Note.—The tentacle marked "5" is stated by the author to be the fifth, which at this stage reaches the size of the first four. One would naturally infer that *ta'.* of fig. 13, being the larger, would be the new tentacle first to attain the size of the other four; such however cannot be the case, since in fig. 14 the *relative position* of the fifth as compared with the sixth and seventh does not admit this conclusion.
15. Stage—about 30 days older than that of fig. 10—with seven tentacles of equal length and four pedunculated club-shaped organs, *m ut. fil.*

16–23. *Edwardsia* (sp.?). 16–22. From Alexander Agassiz, On Arachnactis brachiolata, a species of floating Actinia found at Nahant, Massachusetts. Boston Jour. Nat. Hist., Vol. VII., pp. 525–531 and 5 woodcuts; and from drawings by Alexander Agassiz at Nahant, Sept., 1862.

    Note.—The natural attitude of the animal while swimming is with the tentacles down, the younger tentacles, however, being on the side nearest the surface.
16. The young larva with only four marginal tentacles, seen from the side (dorsal?) bearing the youngest pair. The two in the distance are the large pair of tentacles at the opposite extremity of the mouth-slit. The slit and the folds from which are formed the labial tentacles are seen edgewise, and there are already indications of the existence of mesenterial filaments. The large polygonal "yolk-cells" form a central mass, which slowly revolves, and is reduced in size as the larva increases in age.
17. Oral view of a larva with three pairs of tentacles, beside the odd tentacle which lies in the axis of the oral elongation and in this figure is placed below. The disk should have been represented more strongly compressed laterally. *d?* (dorsum?) The region of the formation of new tentacles. The oral tentacles are as yet simple thickenings of the walls around the mouth, and project straight up as seen in fig. 16.
18. A later stage, seen from the edge (ventral?) which bears the odd tentacle, and showing the labial tentacles directly above the latter. A pair of mesenterial filaments and the sphere of yolk-cells are seen through the wall of the body.
19. Oral aspect of the same stage as that of fig. 18. The odd tentacle (ventral edge?) down. The paired tentacles decrease in size toward the dorsum (*d?*).
20. Much later stage with 13 tentacles, seen from the (dorsal?) edge which bears the youngest tentacles. The outline of the oral lips seen through the tentacles; the odd tentacle in the distance. The mesenteries are symmetrically arranged and proportional in size to the corresponding tentacles, and the sphere of yolk-cells is much reduced in proportion to the size of the cavity.
21. View of the same from the ventral (?) edge, only one-half of the oral end being shown; the large pair of oral tentacles quite prominent.
22. A stage less advanced than the last, seen from the left (?) side, the labial tentacles seen through the marginal ones. The "digitate appendages" (mesenterial filaments) have their convexities turned away from the odd tentacle of the ventral (?) margin.
23. From a drawing of an *Edwardsia* with 16 tentacles which was raised from "Arachnactis" and drawn by Alexander Agassiz at Newport, R. I., Sept. 1872. One pair of the mesenterial filaments is much more developed than the remaining pairs. Seen from the ventral (?) side.

24–33. From drawings illustrating an unpublished paper by E. L. Mark, on the development of an *Edwardsia* parasitic in its earlier stages in Mnemiopsis Leidyi, perhaps *Edwardsia lineata* Verrill. Figures 26 and 33 were drawn from living specimens toward the end of October 1882, the others, either at Newport, R. I., in August 1882, or from material collected at that time.

24. Outline of Mnemiopsis showing numbers of the parasites of various sizes grouped about the infundibulum and the beginnings of the radial canals. Many stages, and often in greater numbers, are usually to be found in a single jelly-fish. They are more or less translucent and of a delicate pinkish color.
25. One of the larger parasitic individuals, removed from the jelly-fish. $\frac{2}{1}$. The pharyngeal sac is very short and may be seen projecting inward from the truncate oral end for a little distance. The eight mesenteries, which are already formed, are not shown in the drawing. On separating from its host, the parasite contracts, though slowly, to such an extent that its proportions are about the same as those of the Cerianthus larva shown in fig. 10. In this condition it leads a free life. It swims like actinia larvæ with the aboral end foremost.

26. A later, balloon-shaped, free stage as seen swimming. The positions of the mesenteries are marked by superficial longitudinal depressions. Eight tentacles have already appeared. The cilia which cover the whole body are relatively too short to be reproduced. $\frac{1}{1}^{5}$.

27. Ventral aspect of a young parasitic stage, showing the latero-ventral mesenterial folds, which are the first to be developed. $\frac{7}{1}^{2}$. The right latero-ventral mesentery ends somewhat abruptly before reaching the aboral pole. The other mesenteries are only feebly indicated in

28. Posterior face of a cross section of the same larva near the middle of the anterior half (a, fig. 27). Depressions in the surface of the entoderm show the places where the mesenteries will appear. In this section the depressions corresponding to the dorso-lateral mesenteries (*d.-l.*) are most evident, those of the ventral pair (*v.*) less distinct, and those of the dorsal pair (*d.*) not indicated. The ventro-lateral mesenterial folds are strongly ciliate, but cilia cannot, in the sections, be seen on other parts of the internal wall. The cells of these folds are wedge-shaped-columnar in form, whereas all the rest of the inner cell-layer is of a spongy or reticulated appearance and the cell boundaries are not distinguishable. $\frac{1}{1}^{5}$.

29. A parasitic stage somewhat older than the preceding, stained, made transparent in clove-oil, and seen from the dorsal side; magnified about 20 diameters. The edges of the ventro-lateral mesenteries are seen to be continuous with the ectodermic lining of the pharyngeal sac, and may be traced to the middle of the posterior half of the body, where they *appear* in the drawing to meet by convergence. The ectoderm is thick at both ends, but much thinner along the sides of the larva. An artificial (?) separation between ectoderm and entoderm at the oral end leaves a series of arched spaces (*cam.*) around the front end of the pharyngeal sac.

30. Cross section through the pharyngeal sac of a stage near the preceding. $\frac{7}{1}^{2}$. Although drawn from the anterior face of the section, the lithographer has reversed it, so that the effect is as though it were a view of the posterior face. The ectoderm is rather diagrammatic, the unshaded portions being intended to represent the gland-cells. The row of dots at the deep surface of the ectoderm indicates diagrammatically the enlargement of the basal ends of ectodermic cells. Similar rows of dots on one side of each of the mesenteries represent the cut ends of the longitudinal muscles of the mesenteries and are somewhat too strongly marked. The muscles are only feebly developed at this stage. Spindle-shaped nucleated cellular elements are scantily present in the homogeneous sub-ectodermal layer, as at *cl.*

31. Anterior face of the fourth section below the free end of the pharyngeal sac, from the same individual as the preceding figure. $\frac{7}{1}^{2}$. The ventro-lateral mesenterial filaments are cut obliquely, especially the one of the left side. The vacuolated nature of the entoderm is particularly noticeable when it projects, as is often the case, in thick longitudinal ridges into the common cavity of the body. These thickenings (*en'.*), although constantly occurring in all the interspaces between mesenteries, are very irregular in their dimensions. Compare figure 33, where, as is always the case with later stages, they are more conspicuous than the mesenteries themselves.

32. Anterior face of a cross section near the aboral end, from another specimen of about the same age as the preceding. $\frac{7}{1}^{2}$. The entodermic ingrowths nearly fill the digestive space, and have a peculiar zig-zag course, not well reproduced by the lithographer. This peculiar appearance results from the fact that the section is so near the aboral end as to approach the condition of a *tangential* section. The middle half of the ventro-lateral mesenteries, as well as the inter-mesenterial protrusions (*en'.*), are so thoroughly vacuolated as to present a very porous and spongy appearance which makes the histological distinction between the thickened free margins of these mesenteries (the mesenterial filaments) and the more peripheral parts of the mesenteric folds very conspicuous. This difference is intensified by the deep stain which the marginal band takes.

NOTE.—On account of the small size of the drawing neither the vacuolation nor the structure of the mesenterial bands have been well reproduced by the lithographer.

33. Ventral aspect of a living specimen possessing sixteen tentacles arranged in two cycles of eight each, the smaller alternating regularly with the larger; magnified about 7 diameters. The transparency of the animal allows one to see the short pharyngeal sac and the mesenteries of the opposite wall, although, to avoid confusion, the latter have not been drawn. The animal is very changeable in form, the aboral end being often much more dilated than in this figure. The mantle of amorphous matter (β) surrounding the column is the product of ectodermic secretions, and forms a loose tube within which the animal may retire.

34. *Edwardsia?* From C. Claus, Bemerkungen über Ctenophoren und Medusen. Zeitschr. f. wiss. Zool., Bd. XIV. Taf. XXXVII. fig. 7. A spheroidal larva from Messina magnified about 25 diameters. The walls consist of a small-celled ciliated entoderm and an ectoderm of large cells, the two cell-layers being separated by an intervening layer of clear homogeneous substance. Two of the twelve (8?) meridional rows of large orange-yellow fat-globules are indicated by *gtt. ol.* There are four coiled tentacle-like arms (mesenterial filaments?) which may be protruded through the mouth opening.

NOTE.— It is probable from the statements of the brothers Hertwig (*op. cit.* pp. 126, 127) that this is the young either of an *Edwardsia* or a nearly related unknown form, since it has four pairs of mesenteries with well developed muscular bands, which have exactly the same arrangement around the pharyngeal sac as in *Edwardsia*.

35, 36. *Edwardsia?* (*Kalliphobe appendiculata* Busch.) From Wilhelm Busch, Beobachtungen über Anatomie, etc. (cited above), pp. 130–132, Taf. XIV. figs. 8, 10. Magnified about 100 diam.

35. Larva with oral end down. Into the general cavity two club-shaped organs (*m nt. fil.?*) project. At the aboral pole there is a tuft of cilia, half as long as the body, which is only partially represented in this figure.
36. The same larva as that last figured with the club-shaped organs protruded through the mouth. The latter are ciliate, and armed with nettle-cells like the ectoderm.

37–43. *Alcyonium digitatum* Lam. From A. O. Kowalevsky, Observations on the Development of Cœlenterata (cited above). pp. 16–23. Taf. IV B. and V.

NOTE. — *Three of the earliest stages are figured at the bottom of Plate XII. figs.* 57–59.

37. The central, as well as the outer, layer has broken up into nucleated cells.
38. The larva is already formed. The limits of the inner cells and their nuclei are only very indistinctly visible.
39. (Erroneously numbered 30.) An advanced stage of a free swimming larva. The entodermic cavity is nearly filled with yolk substance (*vt.*), containing at one pole transparent vacuoles.
40. A larva which has become attached.
41. Around the infolding which was formed at the upper end there have grown out eight rounded protuberances.
42. A cross section of the preceding stage, showing the pharyngeal sac (*ph.c.*), the continuous layer of sub-ectodermic cells, — the middle layer (*ms d.*), — and the walls of the mesenteries surrounding still persistent masses of yolk.
43. Cross section of a more advanced stage than the preceding. The remnant of the yolk (*vt.*) lines the inner surface of the entoderm, and the mesoderm (*ms d.*) is composed of a double layer of spindle-shaped cells. The membrana propria is seen between the entodermic walls of the mesenteries.

PLATE XIII.

Development of Zoantharia *and* Alcyonaria *continued. Figures from* Henri de Lacaze-Duthiers, Étienne Jourdan, A. O. Kowalevsky, G. von Koch, Edmund B. Wilson, *and* R. v. Willemoes-Suhm.

cap.	Capsule.
cil.	Cilia.
coll.	Columella.
cr.	Calcareous concretions.
d.	Dorsum ; dorsal mesenteries.
d.-l.	Dorso-lateral mesenteries.
ec.	Ectoderm.
en.	Entoderm.
en'.	Thickening of *en* corresponding to the calcareous septa.
en''.	Inner layer of *en*.
e the.	Epitheca.
gtt. ol.	Oil globules.
mb. pa.	Membrana propria.
m nt.	Mesentery.
mur.	"Wall" of the calcareous cup.
ms d.	Mesoderm.
nl.	Nucleus.
nl'.	Clear space in the region of the germinative vesicle.
nll.	Germinative spot.
or.	Mouth.
pes.	Foot.
phx.	Pharynx.
ppl.	protoplasm.
py.	Primary polypite.
rch.	Rachis.
rud.	Rudimentary zoöids.
scp.	Calcareous septa.
spc.	Spiculum.
te.	Tentacle.
te'.	Short *te* ; beginning of *te*.
tc.	Testis.
v.	Ventral.
vit.	Vitellus.
z d.	Zoöid.
z d'.	Median (or "Haupt") zoöid.

1–11. *Astroïdes calycularis.* From Lacaze-Duthiers, Développement des Coralliaires. Deuxième mémoire. Actiniaires à polypiers. Arch. de Zool. exp. et gén., Tom. II. 1873. Pls. XII–XV.

Note. — The sequence of the stages is indicated by the following order of the figures : 1, 6, 9, 5, 7, 2, 3, 4, 10, 11, 8.

1. A free-swimming larva with strongly expressed spiral form, which it assumes when in motion. The arrow indicates the direction of the motion, the aboral end being in advance.
2. Oral aspect of a larva with 12 mesenteries. The twelve lobes thus formed are divided by the first pair of mesenteries, as in Actinia (see Plate XI. figs. 12–16), into two groups of 7 and 5 respectively. The order of succession of the mesenteries is the same as for Actinia.

   Note. — It will be seen by comparison that the 5th and 6th are transposed, as compared with Actinia !
3. Oblique view of the aboral end of the same larva.
4. A more advanced larva than the preceding. After having begun, while in the free state, the formation of calcareous nodules in its tissues, it is now attached, and tentacles have made their appearance.
5. The embryo begins to undergo a modification of form. The mouth (*or.*) is seen at the summit of an elevation surrounded by the peristome ; the foot is relatively reduced in size.
6. The same larva as seen in figure 1. Granules are seen escaping from the mouth, which is placed above.
7. Side view of an embryo which has attached itself to the microscopic slide.
8. View of the base of a specimen in which the calcareous septa are forked at their peripheral ends, the tines of the forks being short. The mural (epithecal ?) layer (*e the.*) is already formed, but the septa are not yet joined to it.
9. An embryo slightly compressed ; before compression the surface showed no trace of a striation, although the walls of the body had advanced into the cavity and very young mesenteries were already developed. The distinction between the inner and outer layers is evident.

10. A young polyp perfectly developed, having two cycles of tentacles. At the base the wall (*c the.*) limiting the cup of the young polyp has already become very evident.
11. The internal (entoderm) and external (ectoderm) layers are sharply marked. The elongated calcareous nodules indicate the points of origin of the septa. The three centres of deposit for each septum are located not in the external but in the internal (entodermic) layer. (Compare Koch's results, below, figs. 18–28.)

12–15. *Balanophyllia regia*. From É. Jourdan, Recherches zoologiques et histologiques sur les Zoanthaires du Golfe de Marseille. Ann. sci. nat., sér. 6, zool., Tom. X., Art. no. 1. Pl. XVII. figs. 123, 124, 126, 127.

12. Vermiform larva. $\frac{9}{1}$.
13. A more advanced larva. $\frac{9}{1}$.
14. Longitudinal section of a larva of the same stage as the preceding.
15. Transverse section of a larva having six mesenterial plates. *ms d.* The mesoderm in process of formation. $\frac{30}{1}$.
16. Note. — Figures 16 and 45 have been transposed by the lithographer. For the explanation of figure 16 see below.

45, 17. *Astræa* (sp.?). From A. O. Kowalevsky, Observations on the development of the Cœlenterata. From the Publications of the Imperial Society of Friends of Natural Sciences, Anthropology, and Ethnography. Moscow: 1873. (Russian.) Plate V. figs. 15, 17.

45. Longitudinal section of the large, ciliated, brick-red larva. The central mass (*vt.*), evidently derived from cells, is now composed only of nuclei (*nl.*) and oil globules (*gtt. ol.*). The entoderm (*en.*) of the present stage forms only *a part* of the many-layered entoderm of the fully developed polyp, the balance being derived from this central mass.

    Note. — The dotted line from *en* should not have been carried as far as the central mass, but should have ended in the layer of columnar cells separating the ectoderm from the central mass.

17. View of the larva from the oral end after it has become attached and flattened. *ta'.* The rudiment of a tentacle. The radial or internesenterial chambers (*r. cam.*) appear as transparent cavities.

    Note. — The central ends of the mesenteries bounding all the chambers except two are grouped in pairs, and in such a way as to make the whole appear symmetrically divided by the line η. That this line cannot, however, represent the projection of the plane of bilateral symmetry, is very evident from the studies of other observers.

18–28. *Asteroides calycularis*. From G. von Koch, Ueber die Entwicklung des Kalkskeletes von Asteroides calycularis und dessen morphologischer Bedeutung. Mittheilungen aus der Zoologischen Station zu Neapel, Bd. III. 1882. Taf. XX., XXI.

18. Somewhat more than one-half of a radial section of a young larva, killed the last of June, which had attached itself to cork (θ). The first trace of the skeleton lies between ectoderm and cork in the form of small, more or less fused, calcareous concrements, *cx.* The section along the floor passes longitudinally through the entodermic thickening (*en'.*) corresponding to the place subsequently occupied by the calcareous septa (compare figs. 19 and 20, *en'.*, *sep.*). $\frac{4}{1}$.
19. Portion of a section from the same individual, parallel to the preceding section, but distant from the centre. Three mesenteries (*m nt.*) and two of the entodermic thickenings (*en'.*) are cut transversely. The beginning of the skeleton (*cx.*) is also to be seen below the ectoderm. $\frac{4}{1}$.
20. Portion of a section similar to the preceding, through an older individual. One mesentery with a median layer of connective substance (mesoderm, *m sd.*), flanked on either side by entoderm, is cut across, as are also two calcareous septa (*sep.*), continuous with the floor-skeleton. $\frac{75}{1}$.
21. Marginal portion of a section from an individual killed in the middle of July. To show the formation of the epitheca (*cx.*). $\frac{14}{1}$.
22. A small portion of the base from the section shown in fig. 18, more highly magnified. The entoderm is vacuolated and contains nuclei. The mesodermic connective tissue is scarcely discernible (not well reproduced in the lithograph). The ectodermic cells are nucleated and have sharp contours, especially at their free ends. The calcareous concretions (*cx.*) are very small spheroids and double spheroids which lie between the free ends of the ectodermic cells and the cork.
23. A portion of the preceding still more magnified, and giving a better idea of the form of the concretions and their relations to individual cells.
24. The cells of the ectoderm from another part of the same section, together with a calcareous concretion.
25. A stage somewhat older than that (compare figure 8) in which the septa remain separate. The latter have acquired by their lateral outgrowths a complicated form. A portion of them have fused with each other at the periphery to form the first trace of the mural layer (*mur.*); in the centre also several have joined their fellows. A narrow rim of epitheca (*c the.*) is already formed, but remains distinct from the mural layer.

26. The oldest stage raised artificially; near the end of October. Six of the calcareous septa overtop the other six, and a new series of 12 additional septa is faintly indicated; the columella (*coll.*) is already formed. This individual is distinguished by a very considerable development of the epitheca. $\frac{3}{4}$.
27. A much further developed stage, nearly 2 mm. high. There are 24 septa which fall into three orders according to their relative sizes. The epitheca is not visible, as it does not reach to the margin of the cup. $\frac{3}{4}$.
28. Almost fully developed single individual with 48 septa, 12 of which overtop the others.

    Subsequently 48 new septa, alternating with those already formed, make their appearance, and the main septa are at the same time increased in number from 12 to 24.

29–42. *Corallium rubrum*. From Lacaze-Duthiers, Histoire naturelle du Corail, etc. Paris: 1864. Pls. I., II., XI., XIV., XV., XVII–XIX.

29. One of the many forms assumed by the ciliate larva in its natural position, with the mouth-end downwards.
30. Another, more worm-like form of the ciliated larva (compare corresponding stage of Astroides, fig. 1).
31. One of the stages of transformation from the worm-like to the disk-like form. The aboral region becomes enlarged, and the oral end sinks in.
32. An expanded "oözoite" (animal developed from an *egg*) attached to a rock; the latter not reproduced here.
33. An oözoite still older than the preceding, though still simple. Expanded and seen from the oral side.
34. The same oözoite seen in fig. 32, but in a contracted condition.
35. One of the tentacular arms of the adult, seen in profile. In this position the barbules are seen to be directed obliquely from above downward, and from within outward.
36. Oral view of a larva several days after its metamorphosis. The central part around the mouth (*i*) is already elevated and forms a *bourrelet;* the base is not so regularly circular as it was at first, since it commences to spread itself over the body to which it is attached.
37. Extremity of a barbule from a tentacle of an adult, magnified 250 diam. *ec.* External cell-layer. *en.* Large cells forming a network and bearing vibratile cilia.
38. Spicules which are exposed on tearing away the epidermis from the adult.
39. Nematocysts from the adult; one with the mother-cell still surrounding the nematocyst — or internal capsule — with its spiral filament.
40. Portion of a radial fold (mesentery, *m nt*) bearing (1) at *ov.* an egg, the capsule (*cap.*) of which has in part fallen away, and the vitellus (*vit.*) of which presents a very distinct clear spot (*nl'*), corresponding to the transparent (germinative) vesicle, in the middle of which are to be seen the germinative spots (*nll.*); (2) at *te.* a capsule in process of development, remarkable on account of an apparently empty space (λ) surrounded by a cellular band (κ) which lines the capsule; this is a testicle.
41. A small rock to which are attached three zoanthodemes, the polyps of 2 and 3 having been destroyed. 3. The beginning of the corallum; a plate with irregular sides covered here and there with small projecting corpuscles bristling with points. 2. Exhibits an early form of the corallum. It consists of an irregular plate, curved into the shape of a horse-shoe, formed of masses of agglomerated spicules. The general cavity of the body of the polyp occupies the interior of this curve, and consequently the solid plate is formed, as may be seen at 1, in the midst of the sarcosoma between the external and the internal surfaces.
42. Zoanthodeme composed of one oözoite (1), and three "blastozoites" (budded individuals), 2, 3, 4.

43, 44, 46. *Gorgonia verrucosa*. From G. von Koch, Vorläufige Mittheilungen über die Gorgonien (Alcyonaria axifera) von Neapel und über die Entwicklung von Gorgonia verrucosa. Mittheilungen aus der Zoologischen Station zu Neapel, Bd. III. 1882. Figs. 10, 13, 15.

43. Section through an egg before the segmentation spheres have been differentiated into distinct layers. The outer cells are somewhat smaller than the inner, and all possess distinct nuclei. The latter appear to be wanting in some of the cells simply because lying outside the plane of section.
44. Longitudinal section of an attached individual, showing the thin layer of ectoderm infolded to form the pharyngeal sac which opens into the entodermic cavity below.
45. Note. — Figures 45 and 16 have been accidentally transposed by the lithographer. For explanation of 45 see above.
46. *Gorgonia verrucosa*. From A. O. Kowalevsky, Observations on the development of the Coelentrata (cited above). Taf. V. fig. 19. Ciliated larva. There are to be distinguished two layers in the entoderm. The peripheral layer (*en.*) is striate, indicating its composition out of cylindrical cells, with irregularly arranged nuclei; this merges into the inner layer (*en'.*) which is granular, filled with highly refractive spherules, and is ciliate. (The cilia are not figured by the author.) The latter is considered equivalent to the yolk-mass of Alcyonium and of Astræa.
46. Four cells of the ectoderm, one of which has migrated into the underlying mesodermic layer (*Zwischensubstanz*) and shows at one side of its nucleus the cross section of a spiculum which is being formed within it. The same cell somewhat more enlarged is figured near by.

47–52. *Renilla reniformis* Cuv. From E. B. Wilson, The Early Stages of Renilla. American Journal of Science, ser. 3, Vol. XX. 1880. Pl. VII.

47. Young, bilaterally symmetrical, ciliated, free-swimming polyp with the first pair of zoöids (*z d.*). Of the septa (mesenteries), the dorsal pair (*d.*) extends back as far as the zoöids, the dorso-lateral (*d.-l.*) pair reaches the posterior end of the body, the ventro-lateral is somewhat longer than the dorsal, and the ventral pair is the shortest of all.

48. Later stage with 8 pinnate tentacles, probably about 2 weeks after the abandonment of the free mode of life. A third zoöid (*z d'.*) has appeared in the median line on the dorsum, in front of the two first zoöids. It is the "*Hauptzooid*" of the German writers.

49. A much later stage. The first pair of lateral zoöids (1.) now have well-developed tentacles. The order of appearance of the paired zoöids, which develop into sexual zoöids, is indicated by Arabic numerals. There are, in addition, three (usually there are 2 pairs) rudimentary zoöids opposite the bases of the first pair.

50. A much later stage than the preceding, in a state of contraction. The primary polypite (*py.*) has its oral extremity at the edge of the disk, and not yet turned upward. Subsequently this and all the marginal zoöids are forced upward and made to occupy the upper surface of the disk by the union, behind (below) them, of the younger zoöids which bud out from the angles between them and increase in size. The rudimentary zoöids bud in a similar manner, each group becoming a kind of miniature of the whole colony.

51. An enlarged view of one of the simple zoöids of fig. 50. The small ventral chamber is always turned toward the centre of the disk, that is, *away* from the oral extremity of the sexual zoöid on which it is situated.

51ª. A more advanced condition than that of the previously figured zoöid. The rudiment of a new zooid (*z d'.*) has appeared on the upper side.

52. This new zoöid is fully developed, and two lateral zoöids (1, 1) have appeared.

53–56. *Umbellularia* (sp.?). From R. v. Willemoes-Suhm, Notes on some Young Stages of Umbellularia, and on its Geographical Distribution. Annals and Magazine of Natural History, ser. 4, Vol. XV. 1875. Pl. XVIII A.

53. Young stage seen from the ventral side. The terminal polypite (*py.*) probably comes out first, as it exceeds the others in length. In this and succeeding figures the order of the appearance of the polypites is indicated by Arabic numerals. The rachis is shown as seen in a specimen rendered transparent. Reduced to one half natural size.

54. Another and older specimen seen from the dorsal side. A fourth polypite has appeared by the side of the original terminal polypite and has overtaken it in size, so that there are now two terminal polypites of equal size but different age, and two lateral polypites (1, 1) behind them. In addition, a fifth (3) has made its appearance in the middle of the dorsum. The zoöids appear first on the ventral side as seen in

55. A ventral view of the same specimen as the preceding, the zooids being indicated by dots.

56. Dorsal aspect of a larger specimen in which the primary polypite (*py.*) is supplemented by another terminal one. The author does not distinguish between them, but the figures seem to warrant the interpretation given by the lettering here adopted. There is a median line along the dorsum which is destitute of zoöids.

57–59. *Alcyonium digitatum* Lam. From A. O. Kowalevsky, Observations on the development of Cœlenterata (cited above). Taf. IV B. Figs. 1, 3, 4.

57. Section of the egg, in which may be distinguished a peripheral layer of finely granular protoplasm (*p pl.*) and a central mass containing yolk spherules (*vl.*).

58. Protuberances of the finely granular protoplasm of variable size appear as the first indication of segmentation. These are gradually constricted off from the central mass which they then envelop as an irregular layer.

59. This peripheral layer of cells undergoes further division. Some of the cells contain two nuclei (*nl.*), and a deep layer (*en.*) begins to be formed. Gradually there is formed from the outer layer a continuous envelope of ectodermic cells, and the whole central mass breaks up into larger nucleated cells, as seen in fig. 37, Pl. XII., which, with succeeding figures, continues the illustration of the development of Alcyonium.

INDEX.

PAGE

Acraspeda, Development of, Pls. V., 26; VIII. 19, 29–31
Actinia equina, Pl. XI., 32–34 40
Actinia mesembranthemum, Pl. XI., 1–25 . 38, 39
Actinia sp.? Pl. XI., 26–31 . . . . 39, 40
Actinina, Development of, Pl. XI. . . 38–41
Actinula, Pl. V., 11 18
Adamsia diaphana, Pl. XI., 35, 36 . . . 40
Ægalma elegans, Pl. VII., *passim* . . . 25, 26
Ægalma Sarsii, Pl. VII., *passim* . . . 24–26
Ægalmopsis pictum, Pl. VI., 19 22
Aglaophenia pluma, Pl. V., 25ª, 25ᵇ . . . 19
Aiptasia lacerata, Scissiparity of, Pl. XI., 37 . 40, 41
Alcyonaria, Development of, Pls. XII., 37–43; XIII., 29–59 . . . . . 45, 48, 49
Alcyonium digitatum, Pls. XII., 37–43; XIII., 57–59 . . . . . 45, 49
Anthozoa, Development of, Pls. XI.–XIII. . 38–49
Asteroides calycularis, Pl. XIII., 1–11, 18–28 . 46–48
Astræa sp.? Pl. XIII., 17, 45 47
Astroides sp.? (See *Asteroides.*)
Aurelia flavidula, Pl. VIII., 1–9, 20–49 . . 29–31

Balanophyllia regia, Pl. XIII., 12–15 . . . 47
Beroë Forskalii, Pl. IX., 42, 44, 47 . . . 33, 34
Beroë roscola, Pl. IX., 1–9, 10–13 . . . 32, 34
Bougainvillia fruticosa, Pl. V., 13–15 . . 18

Callianira bialata, Pl. IX., 38–40 33
Candelabrum phrygium, Pl. I., 12–22 . . 8
Cerianthus membranaceus, Pl. XII., 1–9 . . 42
Cerianthus? Pl. XII., 10–15 . . . . 42, 43
Cestus Veneris, Pl. X., 11–17 36
Chiaja multicornis, Pls. IX., 41; X., 1–10 . 33–36
Clavatella prolifera, Pl. V., 11 18
Clytia poterium, Pl. III., 6–11 12
Corallium rubrum, Pl. XIII., 29–42 . . . 48
Coryne mirabilis, Pl. II., 1–16 . . . . 9, 10
Ctenophora, Development of, Pls. IX., X. . 32–37
Cunina octonaria, Pl. IV., 14–17 . . . 15
Cunina rhododactyla, Pl. IV., 11–13, 18–20 . . 15
Cyanea Arctica, Pls. V., 26; VIII. . . 19, 29–31

Dianthea nobilis, Pl. XII., 10–15 . . . 42, 43
Dicoryne conferta, Pl. V., 8, 9 18

PAGE

Diphyes Sieboldii, Pl. VI., 26–28 22
Diplophysa inermis, Pl. VI., 25 22
Discoidea, Development of, Pl. VI., 2–9 . . 20, 21

Edwardsia lineata? Pl. XII., 24–33 . . . 43, 44
Edwardsia sp.? Pl. XII., 16–23 43
Edwardsia? Pl. XII., 34–36 . . . . 44, 45
Ephyra, Pl. VIII., 40–49 . . . . 30, 31
Epibulia aurantiaca, Pl. VI., 10–15 . . . 21
Eucope polystyla, Pl. III., 19, 20 13
Eudoxia Lessonii, Pl. VI., 28 22

Geryonia eurybia, Pl. IV., 21–36 . . 15, 16, 17
Gleba hippopus, Pl. VI., 16, 17 21
Glossocodon eurybia, Pl. V., 1–3 19
Glossocodon tenuirostris, Pl. V., 4–7 . . . 17
Goryonia verrucosa, Pl. XIII., 16, 43, 44, 46 . . 48

Halistemma rubrum, Pl. VI., 18 . . . 21
Hormiphora plumosa, Pl. IX., 43 34
Hybocodon prolifer, Pl. II., 17–23 . . . 10, 11
Hydra aurantiaca, Pl. I., 1–6, 8–11 . . . 7
Hydroida, Development of, Pls. I., II., III. . 7–13

Kalliphobe appendiculata, Pl. XII., 35, 36 . . 45

Lampetia pancerina, Pl. X., 18, 19 . . . 36, 37
Laomedea amphora, Pl. III. 17, 18 . . . 13
Laomedea flexuosa, Pl. III., 12–15 . . . 12, 13
Lizzia octopunctata, Pl. V. 20 18
Lucernaria? Pl. V., 23, 23ª 18

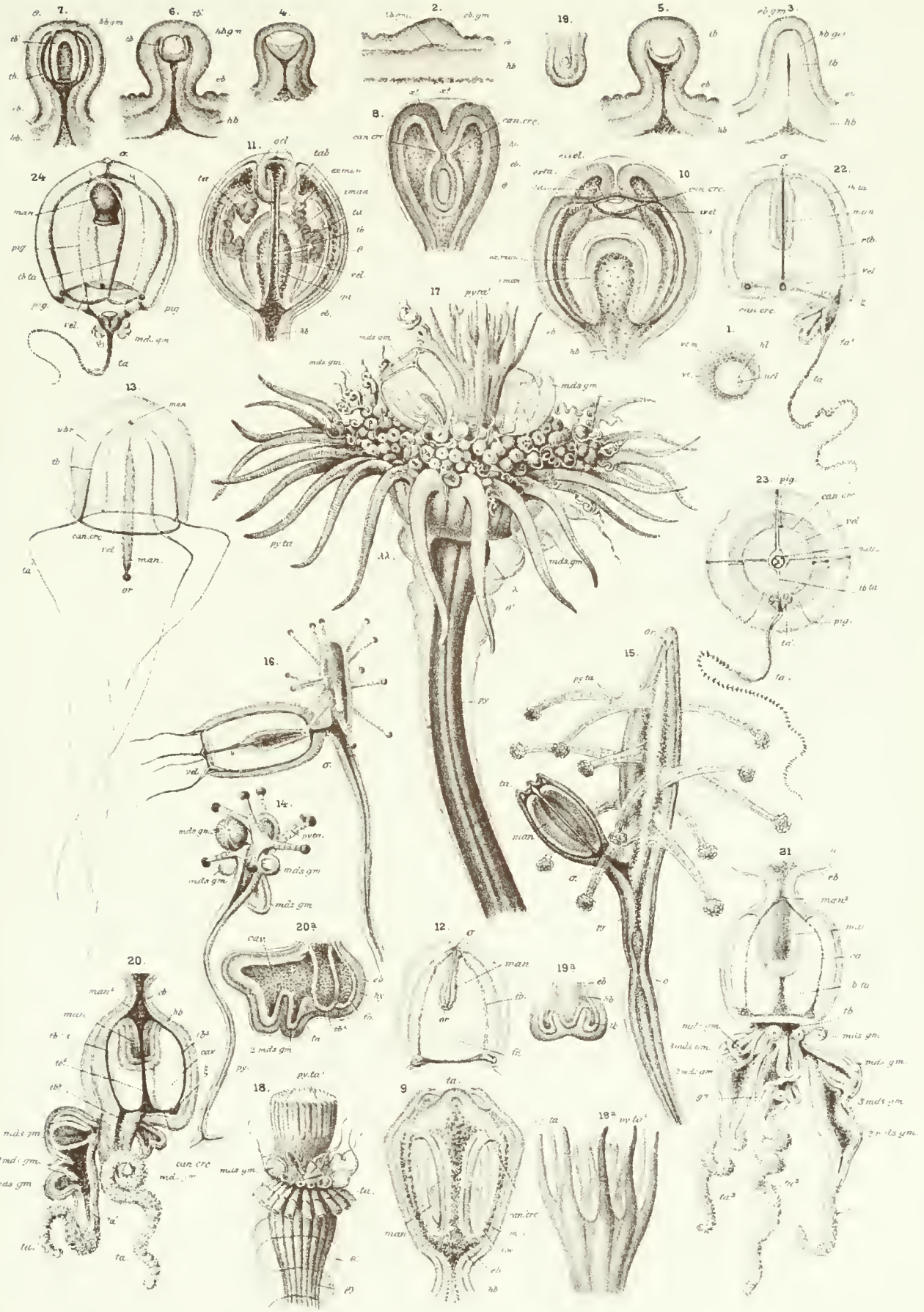
Monophyes primoidialis, Pl. VI., 29, 30 . . 22, 23
Muggiaea, Pl. VI., 31 23
(Myriothela) phrygia, Pl. I., 12–22 8

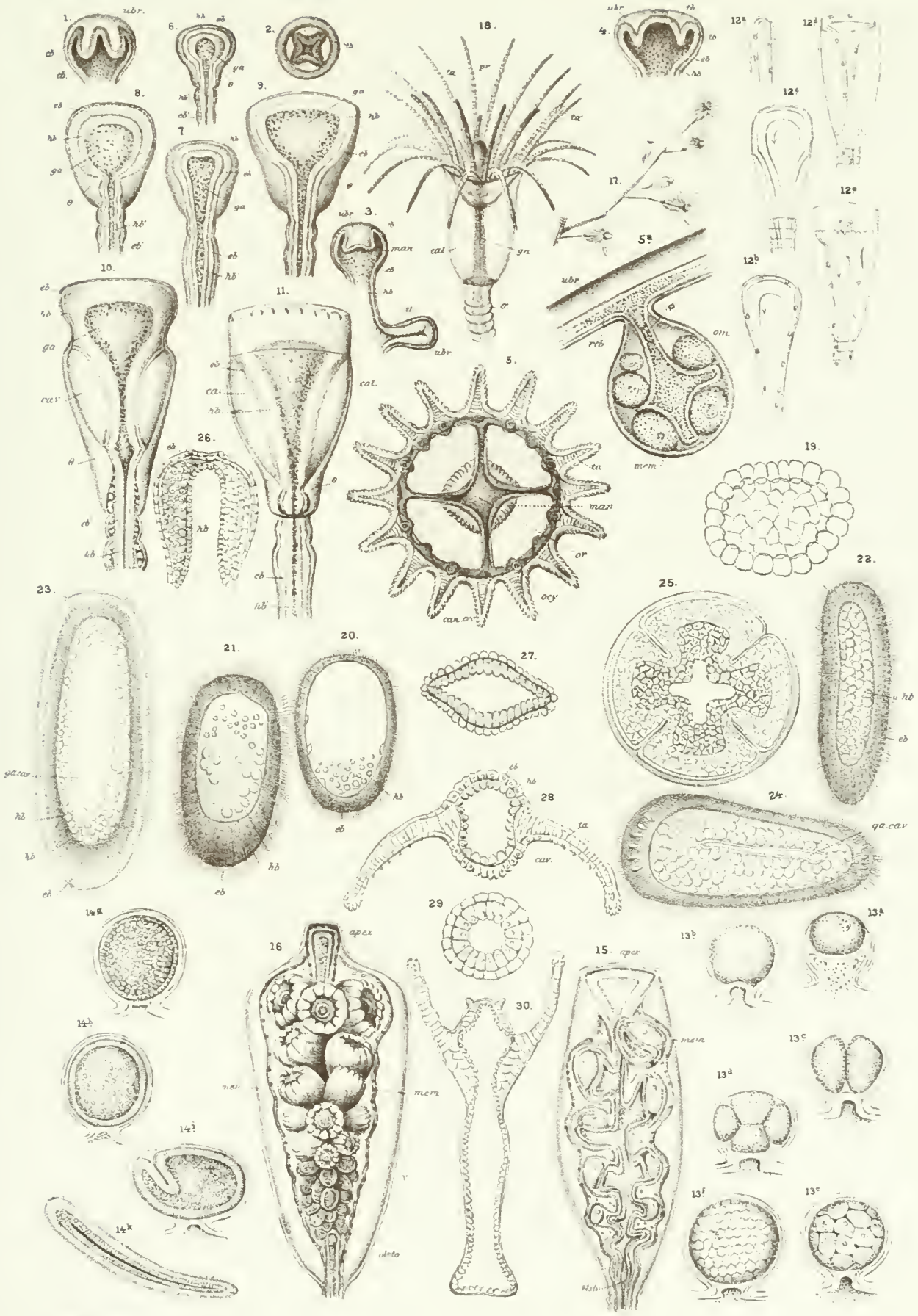
Obelia commissuralis, Pl. III., 1–5 . . . 12
Obelia geniculata, Pl. III., 16 . . . 12, 13
Occania languida, Pl. V., 16 18
Oceyroë crystallina, Pl. X., 20 37

Perigonemus vestitus, Pl. V., 12 18
Physalia Arethusa, Pl. VI., 1 20
Physophora hydrostatica, Pl. VII., 26–29 . . 26

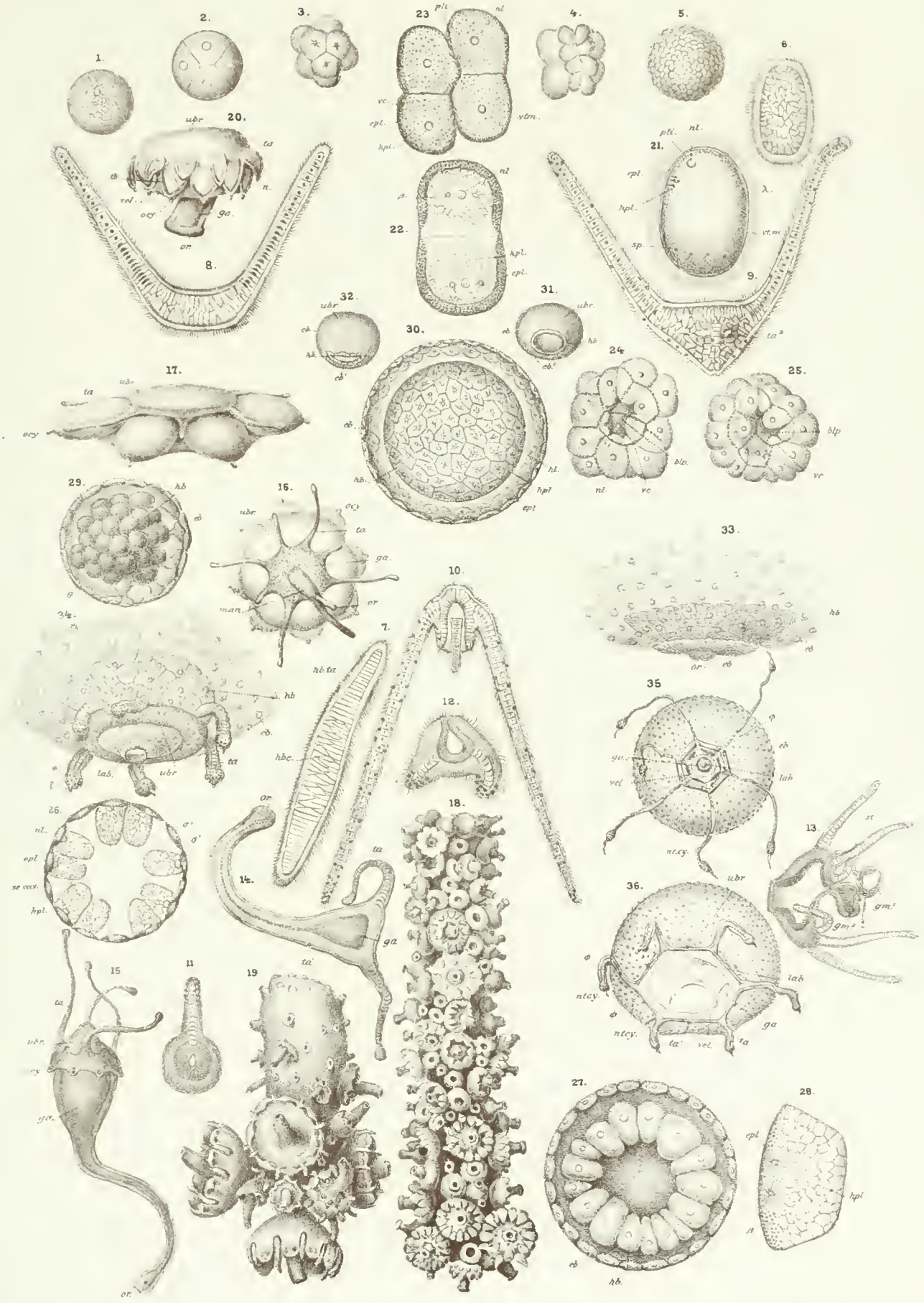
	PAGE
Physophora magnifica, Pl. VI., 20–23	22
Pleurobrachia rhododactyla, Pl. IX., 8, 9, 14–37	32, 33
Polyxenia leucostyla, Pl. IV., 1–10	14
Porpita, Pl. VI., 8	21
Praya, Pl. VI., 24	21
Rataria, Pl. VI., 5–7	20, 21
Renilla reniformis, Pl. XIII., 47–52	49
Schizocladium ramosum, Pl. V., 24	18, 19
Scyphostoma, Pl. VIII., 27–33	30
Siphonophora, Development of, Pls. VI., VII.	20–26
Strobila, Pl. VIII., 34–39	30
Thoë paradoxa, Pl. X., 18, 19	36, 37
Tubularia indivisa, Pl. V., 10	18
Tubularia larynx, Pl. III., 26–30	13
Umbellularia sp.? Pl. XIII., 53–56	49
Velella mutica, Pl. VI., 2–4, 9	20, 21
Willia ornata, Pl. V., 19	18
Zoantharia, Development of, Pls. XI., 1–37; XII., 1–36; XIII., 1–28	38–48
Zygodactyla Groenlandica, Pl. V., 17, 18	18


1.
2.
mb
nl.
3.
om
4.
5.
6.
7.
ga
cs
ers.
8.
hb
eb
9.
10.
11.
12.
eb
hb
μ
13.
14.
15.
16.
car
hb
mb
17.
cp
18.
19.
ta
20.
ta'
21.
22.
ta
ta'

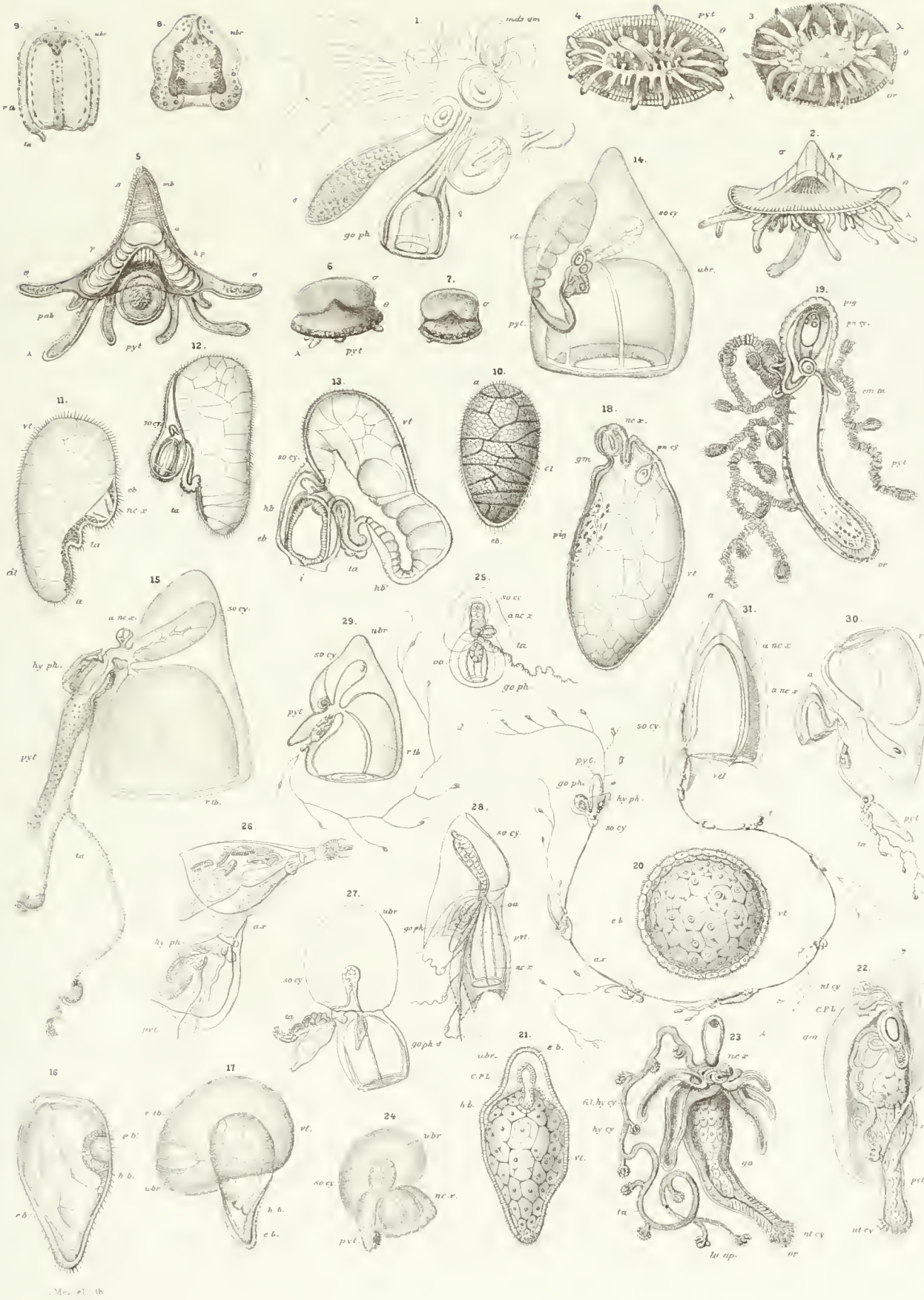




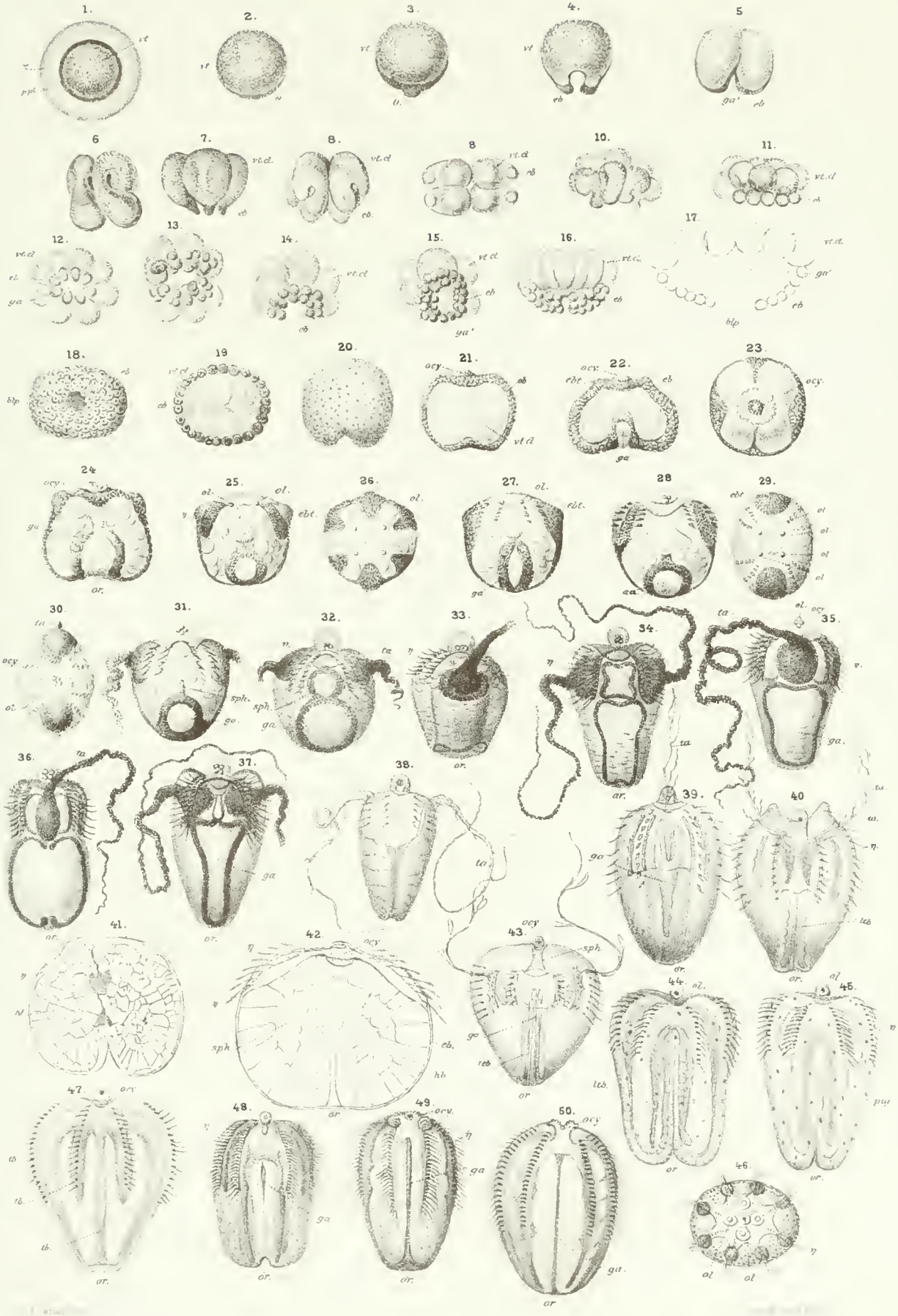
Printed by A.M...

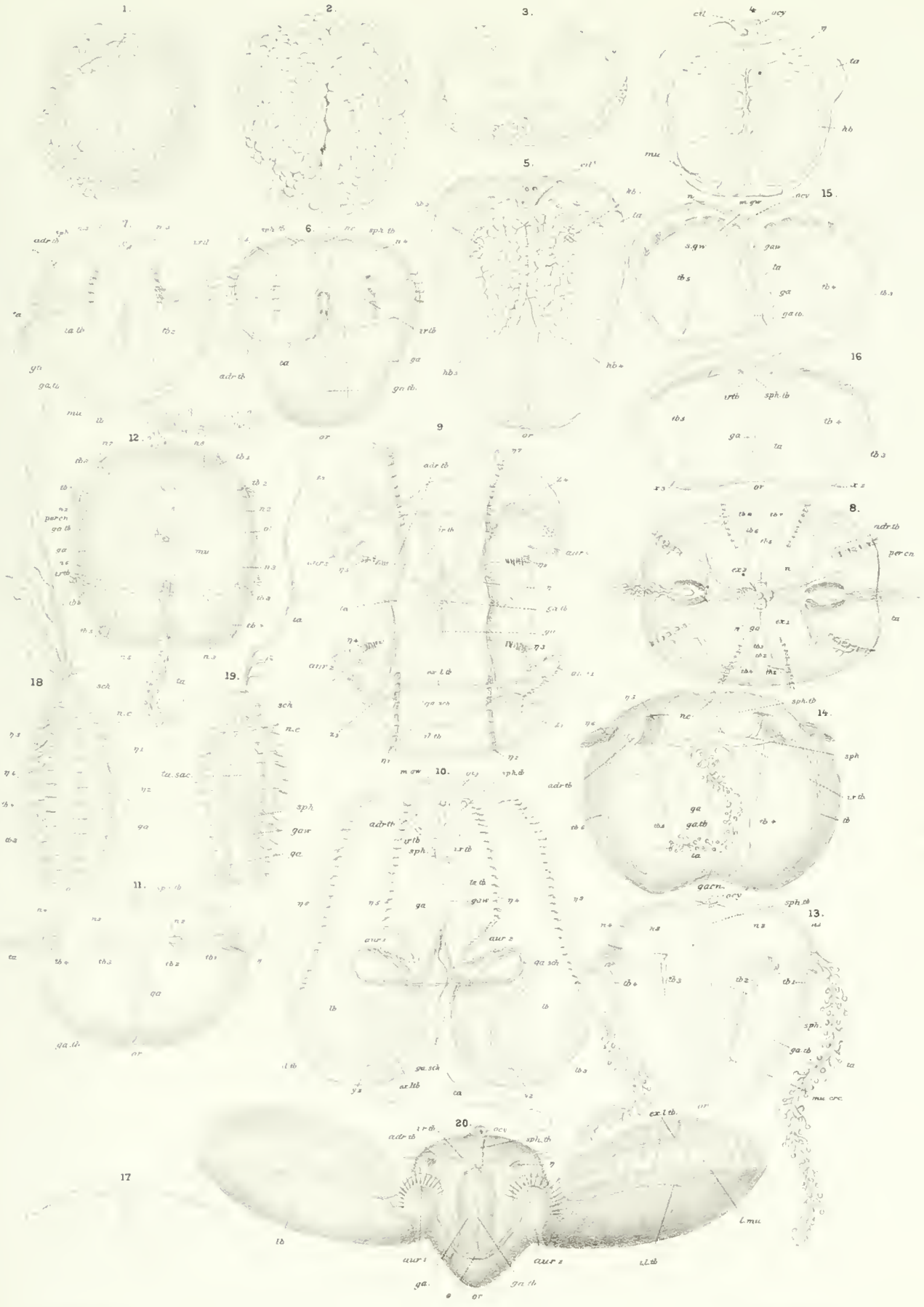

1.
2.
3.
23
4.
5.
6.
20.
8.
22.
21.
9.
32.
31.
30.
24
25.
17.
29.
16.
33.
10.
7.
12.
35
18.
26.
13.
36.
15
11
19
27.
28.

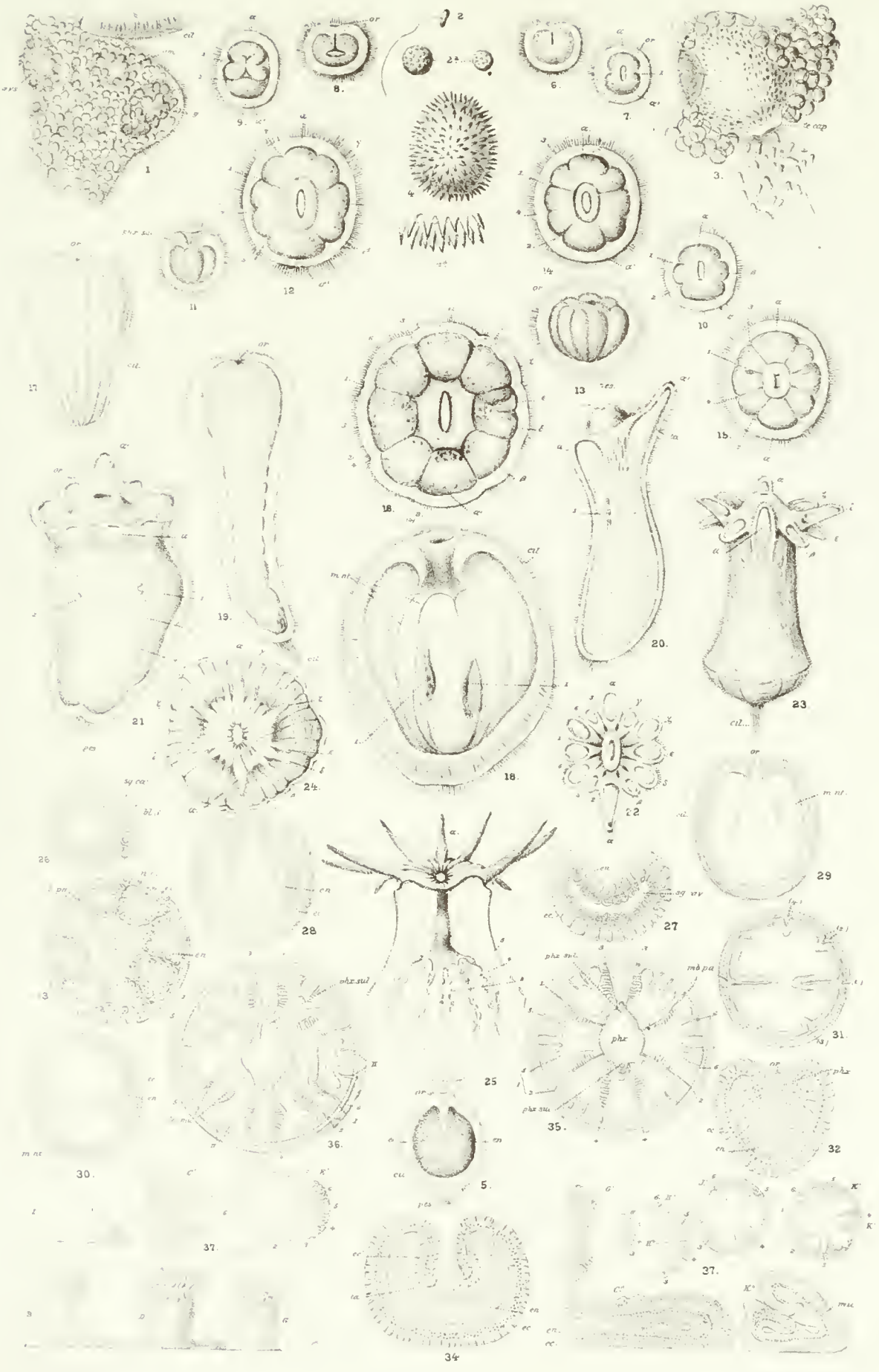

26.
3
2.
1
9.
8
11.
10.
7.
15.
5.
4
17.
12.
20.
16
18.
13
6.
19
14
23.
23a
24a
24b
25c
25d
25b
21.
22.
25a
24d
24c


9.
ubr
ta
8.
ubr
1.
mds qm
go ph
4.
pyt
3.
or
2.
hp
5
mb
hp
pab
pyt
6
pyt
7.
14.
so cy
vt
ubr
pyt
19.
pig
pn cy
cm ta
pyt
or
12.
so cy
ta
11.
vt
eb
nc x
ta
dt
a
13.
vt
so cy
hb
eb
i
ta
hb'
10.
a
cl
eb
18.
nc x
pn cy
gm
pig
vt
15
a nc x
so cy
hy ph
pyt
vt
ta
25.
so cy
a nc x
ta
oa
go ph
29.
ubr
so cy
pyt
r th
31.
a nc x
a nc x
vel
30.
r th
a
p nc x
pyt
ta
26.
a x
hy ph
pyt
28.
so cy
oa
pyt
nc x
27.
ubr
go ph
so cy
ta
go ph
20
e b
vt
a x
21.
e b
ubr
C P L
h b
vt
23
nc x
fil, hy cy
hy cy
ga
ta
lo sp
nt cy
or
22.
nt cy
C P L
gm
m b
h b
pn cy
vt
cm ta
pyt
nt cy
16
r th
e b
h b
ubr
eb
17
r th
vt
h b
e b
24
ubr
so cy
nc x
pyt


1
eb.
vt.
2
eb
h b
3.
C.P.L.
eb.
4.
h b
eb
5
C.P.L.
pig
ml.
cl.
6.
mx b.
e b
eb'
ζ
7.
C.P.L.
h b.
pn cy
eb.
8.
C.P.L.
pr hy ph
pn cy
9
C.P.L.
pr hy ph
vt.
10.
pn cy
pr hy ph
11.
C.P.L
ser hy ph.
pr hy ph
pig
pn cy.
e b.
h b
pig
12.
pn cy
ser hy ph
vt.
13.
pr hy ph
pn cy.
vt
ser hy ph
14.
pap
pn ph
C.P.L
ser hy ph.
vt
15
ser hy ph
pn cy
cl.
vt.
or
16.
pn cy.
C.P.L
ser hy ph.
17.
pn cy
ser hy ph.
ga
pvt
or
18
C.P.L
α
pn cy
β
γ
ga.
or
19
C.P.L
pr hy ph
ta
γ.
pig
pn ph
ga
γ
nt cy
22.
pn ph.
ne x'
ne x
ne s.
tb
hy cy
py
py s
pvt
hy cy
fil. hy cy
fil. hy cy
em. tu.
23
24.
21.
pn ph
ne x.
as
r tb.
em. tu
ser hy ph
25
P
v
a
a
26.
27.
θ
λ
l vs
28
l vs
i. v.
sac
29
ch
λ
30.
pyr.
ser hy ph
pn ph
vt
γ
em. tu


1.
2.
3.
4.
5
6
7.
8.
8
10.
11.
12.
13.
14.
15.
16.
17.
18.
19
20.
21.
22.
23.
24
25.
26.
27.
28
29.
30.
31.
32.
33.
34.
35.
36.
37.
38.
39.
40
41.
42.
43.
44.
45.
46.
47.
48.
49.
50.


1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.
20.


1
8.
9.
6.
7.
3.
12
11
14
10
13
15.
18.
19.
20.
23.
21
24.
18.
22
29
28
27
31.
25
35.
36.
32
30.
5.
37.
34


1.
2.
3.
4.
5
6.
7
8.
9.
10.
11
12.
13.
14.
15
16
17
18
19
20.
21.
22.
23
24.
25.
26
27.
28.
29
30.
31.
32.
33.
34.
35.
36.
37.
38
40
41.
42.
43

F. Puetter lith.