

11020
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.

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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 ZOOLOGY,
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.*

<i>a b.</i> Abdomen.	<i>r.</i> Proboscis.
<i>n.</i> Nerve-ganglion.	<i>α.</i> Spine on first segment of first pair of appendages.
<i>o c.</i> Eye.	<i>β.</i> 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 picrocarmine. 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 *Achelina laevis*.
9. Intermediate stage between larva and adult of *Achelina laevis*. 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 oesophagus 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. *n¹ - n⁴*, first to fourth sub-oesophageal 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. *n⁵*, fifth sub-oesophageal nerve-ganglion.
11. Second appendage (palpus) of adult male *Achelina laevis*.
12. Third appendage (ovigerous or accessory) of the same.
13. Second appendage of female.
14. Third appendage of the same.
15. Adult *Achelina laevis*, 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-oesophageal ganglion, and may be homologous with the antennæ of Crustacea. The second and following pairs receive nerves from the sub-oesophageal 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.

<i>h.</i> Dorsal vessel.	<i>ocl.</i> Ocellus.
<i>l.</i> Liver.	<i>a.</i> Inner egg-membrane.
<i>m.</i> Mouth.	VII. Seventh pair of appendages.
<i>mt.</i> Metastoma.	VIII. Eighth " "
<i>n.</i> Nerve-cord.	IX. Ninth " "
<i>oc.</i> Compound eye.	

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. *a*, 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 oesophageal commissure, and are probably homologous with the mandibles of Crustacea. Balfour, moreover, has shown that in the spiders the anterior pair of appendages (chelicerae) in the embryo are innervated from a post-oral ganglion, and are equivalent to the mandibles of insects, rather than to the antennae 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. *oc*, compound eye. *ocl*, 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. *mt*, 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 Entwicklung 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 $\frac{1}{4}$ 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 CIRRIPIEDIA. Figures from FRITZ MÜLLER, W. LILLJEBORG, CHARLES DARWIN, P. P. C. HOEK, CARL CLAUS, ALEXANDER AGASSIZ, and C. SPENCE BATE.

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

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 Entwicklungstufe 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. *cp*, margin of carapace. *lb*, labrum. *ocl*, ocellus. *vt*, 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. *ov*, ovary, *t*, testis. *a*, 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. Exuviae 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. *Balanidae*, 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. I, 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 Entwicklungsgeschichte 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 suckorial 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*, suckorial 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.

<i>a en.</i>	Anterior hypoblast cell.	<i>pn ♂.</i>	Male pronucleus.
<i>an.</i>	Anus.	<i>pn ♀.</i>	Female pronucleus.
<i>cen.</i>	Central hypoblast cell.	<i>t.</i>	Testis.
<i>cr.</i>	Cirri.	<i>vd.</i>	Vas deferens.
<i>ec.</i>	Epiblast.	<i>vm.</i>	Vitelline membrane.
<i>gen.</i>	Beginning of the genital system.	<i>a.</i>	Frontal papilla.
<i>i.</i>	Intestine.	<i>β.</i>	Spiral canal.
<i>lb.</i>	Labrum.	<i>γ.</i>	Gland.
<i>len.</i>	Lateral cells, containing hypoblastic elements.	<i>ε.</i>	Gland.
<i>ms.</i>	Cells containing the elements of the mesoblast.	<i>ζ.</i>	Tactile organ.
<i>mt.</i>	Metastoma or paragnathite.	<i>η.</i>	Cement gland.
<i>n.</i>	Nervous system.	<i>θ.</i>	Receptaculum seminis.
<i>n'.</i>	Secondary supra-oesophageal nerve-ganglion.	<i>λ¹.</i>	Tergum.
<i>nc.</i>	Nucleus.	<i>λ².</i>	Scutum.
<i>oc.</i>	Eye.	<i>λ³.</i>	Carina.
<i>ocl.</i>	Simple eye.	<i>λ⁴.</i>	Carino-lateral compartment.
<i>oes.</i>	Oesophagus.	<i>λ⁵.</i>	Lateral compartment.
<i>ovd.</i>	Oviduct.	<i>λ⁶.</i>	Rostrum.
<i>pc.</i>	Polar cell.	<i>ξ.</i>	Tail.
<i>pm s.</i>	Primitive mesoblast cell.		

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

1 - 5. *Development of CIRRIPIEDIA, 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. *cr*, cirri, representing the swimming-feet of the Cypris stage.
2. Later stage, seen from above. The cirri are retracted within the shell.
3. Still older stage, side view. λ^1 , tergum. λ^2 , scutum.
4. Seen from above, cirri 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*. *ocl*, median eye. *oc*, paired eye. ξ , abdomen. I, prehensile antennæ. From Claus, Die Cypris-ähnliche Larve (Puppe) der Cirripeden. Schriften Gesellsch. Beförd. gesamt. Naturwissensch. Marburg, IX., Suppl. 5, Taf. I. 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. *a*, 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 *lb* 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. *ocl*, 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, *lb*, 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 (*a*) 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. *vd*, 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. *ovd*, oviduct. ζ , tactile organ. *n*, 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. *vm*, vitelline membrane, a product of the yolk. *pc*, second polar cell, the first usually being formed before the vitelline membrane, and hence escaping from the egg. *pnq*, female pronucleus. *pnq*, 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. *nc*, 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 (*anen*) and a large one (*cen*), the other cells being arranged bilaterally with reference to them. The central larger cell (*cen*) 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 (*anen*), too, is a hypoblast cell. The four cells (*len*) lying on each side of the larger and smaller cells, contain hypoblastic and epiblastic elements. The cell (*ms*) 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 (*pc*) 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 (*anen*). 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 (*cen*) 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 *len* in the figure, together with the central (*cen*) and small anterior cell (*anen*), 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 *ms* in Fig. 16, we now have four cells. The two larger, anterior (*pms*), 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 (*anen*) 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.