

This article was downloaded by: [UQ Library]  
On: 01 February 2015, At: 21:08  
Publisher: Taylor & Francis  
Informa Ltd Registered in England and Wales Registered Number:  
1072954 Registered office: Mortimer House, 37-41 Mortimer Street,  
London W1T 3JH, UK



## Annals and Magazine of Natural History: Series 2

Publication details, including instructions for  
authors and subscription information:

<http://www.tandfonline.com/loi/tnah08>

### XXVI.—On the development of the Cirripedia

C. Spence Bate

Published online: 21 Dec 2009.

To cite this article: C. Spence Bate (1851) XXVI.—On the development of the Cirripedia , Annals and Magazine of Natural History: Series 2, 8:46, 324-332, DOI: [10.1080/03745486109496226](https://doi.org/10.1080/03745486109496226)

To link to this article: <http://dx.doi.org/10.1080/03745486109496226>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

324 Mr. C. Spence Bate on the Development of the Cirripedia.

115. *O. jutlandicum*, Brid. i. p. 296.

*O. phyllanthum*, B. et S.

Common on trees.

Genus 10. *Encalypta*, Schreb.

116. *E. vulgaris*, Hedw.

On the Downs at Hahnaker near Chichester, and on the north wall of St. Nicholas Church, Brighton, Mr. Borrer. On a wall at Storrington, and on a wall between Cocking and Midhurst.

117. *E. streptocarpa*, Hedw.

In many places on the Downs : at Newtimber ; Arundel Park ; Offham near Lewes ; and on tiles near Hurstpierpoint : always barren.

[To be continued.]

---

XXVI.—On the Development of the Cirripedia.

By C. SPENCE BATE.

[With three Plates.]

FEW animals belonging to the European fauna, so very abundant on our shores as the Cirripedia, have had their nature so misunderstood, and so long veiled in mystery. The happy discovery of Mr. J. V. Thomson, so far back as 1826, approximated somewhat to a revelation of their real history ; and the later researches of Burmeister, in his Beiträge zur Naturgeschichte der Rankenfüsser, together with those of Prof. Goodsir, in the Edinburgh New Phil. Journal, July 1843, have further elucidated this interesting inquiry. Although as yet the chain of development between the ovum and the perfect animal has not been successfully observed, the hiatus is not so great but that naturalists are enabled to identify the position of these creatures in the animal kingdom.

Feeling a little curiosity in relation to the subject, and wishing to verify for myself the observations of Mr. Thomson, I took advantage of my residing near the shore where two or three distinct species are common, and have occupied myself a little this summer in endeavouring to observe the animal, as well as the changes through which the larva passes until it assumes the form and characters of the parent. Being desirous to obtain the young, so as to identify it with the species which are the parent of each, I adopted the mode of breaking off the *Balanus* from the rocks and obtaining the embryo in a mature state before it had left the ovum, and of then hatching it ; which was readily accomplished upon its being plunged into sea-water,—a mode which I found

very successful, and which has enabled me to accompany this paper with sketches of the larva of five separate species :—

1. *Balanus balanoides*, Linn.
2. *B. porcatus*, Da Costa. *B. sulcatus*, Brug. *B. Scoticus*, Wood.
3. *B. perforatus*, Brug. *B. communis*, Mont. *B.* (var.) Cranchii, Leach.
4. *Chthamalus depressus* (?), Poli. *Balanus punctatus*, Mont.
5. *Clitia Strömia*, Müller. *Balanus verruca*, Mont.

Upon placing the young as soon as hatched under the microscope, I was interested to find that it differed as much from Mr. Thomson's figure as that given by him does from the adult animal\*, thus showing that the larva must pass through more than one metamorphosis prior to its assuming the figure of the adult.

There is, on the first appearance of the larva of the *Balani*, a single black spot in the centre of what would be termed the head of the animal, appearing like the eye in *Cyclops*, *Canthocamptus*, &c.; but this it cannot be, since the form is not persistent in every individual even of the same species. With what agency this spot may be endowed I am not capable of stating, but it appears to me to be analogous to a similar spot in the larva of *Chirocephalus diaphanus*†, and which, by development, is shown to have no connection with the eyes; so also in an older stage in the larva of the *Balanus*, the eyes, which are absent in the young, become fully developed, but are found to exist distinct from this spot, which has been looked upon as an organ of vision by all previous observers. I think, however, that we are scarcely justified in assuming every black spot in a convenient position to be an eye: and in this instance, when the spot may be seen in the young of the same parent to put on almost every modification of form, I can scarcely bring myself to subscribe to the idea of its being an agent of sight. Moreover, in the pupa state, when the eyes are large and conspicuous, there may be observed a spot (Pl. VIII. fig. 15, 16 b) upon the shell, the same which Mr. Thomson presumes to be the "nucleus of the future attachment," so like to that to which we allude in the larva, that I am inclined to believe

\* When this paper was first written, I was ignorant of the discoveries of either Burmeister or Goodsir; the researches of the former I have only seen since this has been in type; and to both of whom separately is due the merit of the discovery of the great fact of the complex metamorphosis of the Cirripedia; since Mr. J. V. Thomson, although the original discoverer of both stages, did not even conjecture that there was more than a single metamorphosis, although he was aware of the fact in the marine Decapoda, attributing the earlier form or larva to the pedunculated division, and the latter or pupa to the sessile division of the Cirripedia.

† Vide figures by Dr. Baird in the 'Hist. of British Entomostraca.'

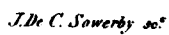
them, particularly if the homologies as pointed out by Burmeister be correct, to be identical; an idea which receives support from the gradual receding of the spot from the anterior edge, near which it may be observed in the larva previous to the first moult; whereas in the next it is further back, and in the third, as given in Pl. VI. fig. 3 *b*, the only specimen of which I have had an opportunity of observing, it has considerably receded, being in a line with the extremity of the probosciform organ. Therefore, presuming such to be the case, I can scarcely appreciate the idea advanced by this latter author, that the two large eyes in the pupa are formed by the splitting into halves of this central spot; or, to translate his own words, "that the single eye is compounded of two halves, which, by degrees, separate more and more until in the following period they are divided by a considerable space."

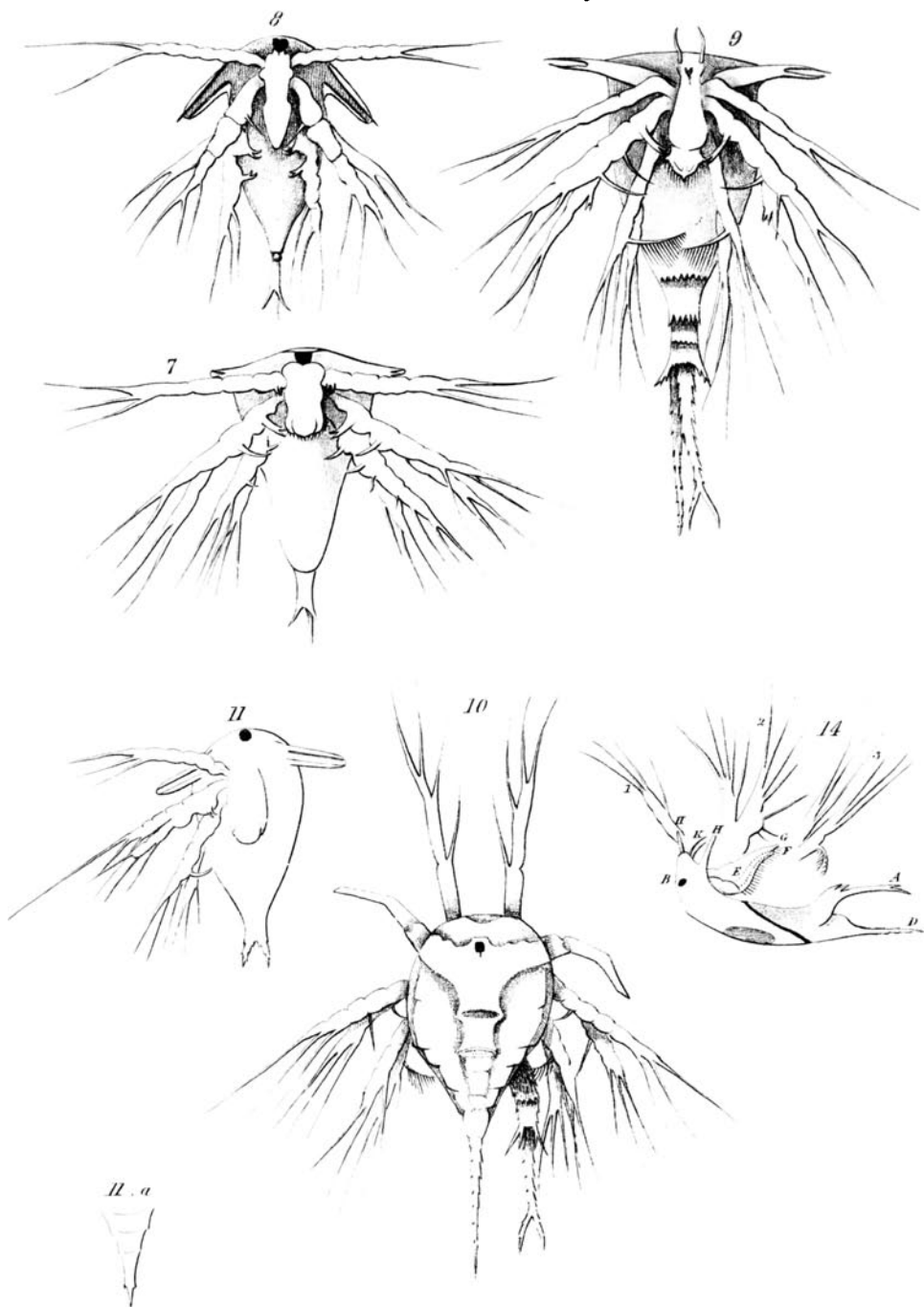
In this description their development is not analogous to that of the eyes in the larva of the Entomostraca, which certainly in this stage must be considered as its nearest ally. For instance, in the larva of *Chirocephalus diaphanus* the two lateral organs of vision are apparent previous to the disappearance of the "central eye," plainly showing that the real eyes are not developed from the central spot, whatever it may be.

Among the more peculiar features of the larvæ of these animals is the presence of an elongated forked process of the abdomen, forming to all outward appearance a second caudal appendage, and which has been confounded with the tail in Prof. Goodsir's figure and description of the larva previous to the first moult, where he says, "the last segment is armed with three sharp strong spines which project backwards." After the first moult this appendage increases in length, greater or less in different species, by the addition of another ring proceeding from the extremity of the last, and like it terminating in a similarly forked extremity. Of its uses in the larva, or its homology in the adult animal, I have not been able to satisfy myself; but it is a feature in a more or less modified form (as far as I have observed) universally present in this early stage of their development.

In *Balanus perforatus*, *Clitia Strömia*, and *Chthamalus depressus*, the growth of the caudal appendages increases at the first moult to a length much greater in proportion than the same organs do in *Balanus balanoides*.

Another organ equally constant and peculiar to the early larval stage of these animals is, that which for convenience of communication I shall call a proboscis. This, the animal has the power of raising and lowering at pleasure, as its uses may require. At its extremity appears to be an oral-like aperture which is closed by a valve or upper lip. This organ, as far as my knowledge goes, has no analogous representation among Crustacea, it





being a feature peculiar to this stage of the larva of the Cirripedia, among which it differs in length and size according to the species; like the caudal appendages, it increases in length, together with the natatory legs, with each of the earlier successive moults. At the base of this organ I have observed an irregular pulsation, and consequently presume it to be the seat of the heart.

At the shoulders of the anterior extremity extends right and left a small process, which under a one-fourth of an inch object-glass appears to terminate most commonly in a bifid extremity; but through the assistance of a higher power than I have used, I am informed by Mr. Darwin that this appearance is shown to be erroneous, it being seen to terminate always in a point: these are attached to the lower surface of the shield, and after the first moult appear to consist of two articulations; they may differ in dimensions in respective species, but, as far as I have had an opportunity of observing, are universally present in the sessile division of the Cirripedia; and judging from the figure given by Burmeister in his memoir upon the pedunculated Cirripedia, and those by Mr. Thomson upon the same division, they appear to be constant throughout the whole class, and probably are, as stated by Burmeister, homologous with the antennæ; and if so, they must represent the external or superior pair; but in watching the habits of these young creatures I have seen nothing which can induce me to accept the idea that they are made use of by the animal, as he presumes, for the purpose of climbing or holding itself in contact with any foreign body. In order to fulfill these conditions the more perfectly, they each terminate with a hook in Burmeister's figure; but this, not being represented in Thomson's, whose observations, in most essentials, coincide with those which opportunity has placed within my reach, induces me to receive the former author's drawing of these antennæ with caution, although it is probable that he may be correct when he presumes that they become the perambulatory feet in the pupa; and if so, we have an interesting exemplification of the assumed fact, that the antennæ among animals are but less modified in order to fulfill certain peculiar conditions; thus they represent in one stage organs of sense, whereas in the next they fulfill the conditions of true feet. Besides these horns or outer antennæ, the larva is endowed with a smaller pair of simple structure, more typical of those organs in Crustacea, and which, therefore, must represent the internal or inferior pair; but these I have not been able to observe previous to the shedding of the first exuviae, though Mr. Darwin has been so kind as to inform me that he has seen them at that early period in the larva of *Scapellum vulgare*, and Prof. Goodsir has also figured them from the larva of *Balanus tintinnabulum*; therefore from



analogy it may be assumed, as most probable, that they exist in a more or less rudimentary form in all.

The natatory legs are at this period three on each side, the anterior pair being single and formed of three or four articulations, the terminating one being armed with three or four long spines, one of which also is generally attached to each of the two preceding joints. The two posterior pairs of legs become duplicates after the basal joint, which is large, and generally armed with a process covered with sharp spines pointing towards the animal: each of the joints of the larger division of the double extremities of both the posterior pairs is furnished with similar spines, some of which are in different species more or less fringed with fine ciliated processes. The spine upon the penultimate joint of the posterior pair of legs is in *Balanus perforatus*, *Chthamalus depressus* and *Clitia Strömia* curved inwards as well as ciliated; each of the extremities likewise is supplied with long spines or hair-like processes, similar to those which exist attached to the cirrhi in the adult.

It is since these observations have been made that I have become aware of Prof. Goodsir's paper in the 'Edin. New Phil. Journal,' by which I perceive that his observations do not exactly coincide with my own; but I think that much of the difference may depend upon the circumstance of his having viewed the animal from the dorsal surface only; since, if he had seen the animal from beneath, he would have observed that the anterior legs originate from a similar position with the rest, that is, near the centre of the animal. Of the "large segment which (he says) has originated at the anterior part of the body after the first moult," I have not been enabled to convince myself. That a line across may sometimes be seen in the *dead* animals, I am aware; but the fact of its position being not always persistent has induced me to attribute the appearance to an accidental fold in the tunic of the animal, originating in the roughness of manipulation in mounting the specimens.

Again, in Prof. Goodsir's figure the whole extremity of the leg consists of but a single articulation, whereas it has appeared to me to be, like the others, made up of several. The large basal process of the second pair of legs is not given in the same figure; this, together with his not having observed the abdominal process, is but the natural result of the drawing being made of the dorsal surface only.

Unfortunately, from the period of the larva having obtained its second form, which, according to my own experience, takes place on the second and not the eighth day, as stated by Prof. Goodsir,—and this I found invariably to be the case in every species which I have observed,—I have not been able, even with the

greatest care and watchfulness, to preserve the young creature alive, so as to have the successive forms through which it passes, between the figure given as the earlier form with this paper, and that by Mr. J. V. Thomson in his 'Zoological Researches' upon Cirripedes; consequently there is a blank existing which imagination will scarcely venture to supply; so very unlike each other is the form in the earlier stage, to that which the larva or rather pupa assumes immediately prior to its adopting the character of a fixed animal.

I am aware that almost as great a difference exists between the very young larva of the decapod marine Crustacea and the one into which it is transformed, and that many moultings of the tunic must take place before the larva has arrived to the size to which it must, ere it can put on its more permanent form; so likewise it *may be* with the Cirripedia, that the larva shall so increase without change of form or undergoing a fresh metamorphosis prior to the one figured by Mr. Thomson and my own observation. That these animals sensibly increase in size during fifteen days (which is the longest period that I have been enabled to keep them alive) seems to lend assistance to this supposition; yet, notwithstanding, I can scarcely suppress the notion that some unrecognized form, possessing somewhat of the characters of each, will be found to be an intermediate stage of the creature's existence.

It was at the latter period of its existence as a free animal that it was observed by Mr. Thomson, from whose figure the one given with this paper in some slight detail differs, which probably has arisen from the greater or less transparency of the shells belonging to the respective specimens examined.

At this period the animal approximates much more nearly to its permanent character than it had done previously, as the natatory legs, which have increased to six pairs, together with the caudal appendage, form, with the soft parts of the animal, as seen through the transparent shell, a near resemblance to similar parts, only less developed, which belong to the adult animal: one slight exception exists in the natatory legs folding in the larva first anteriorly and then posteriorly, somewhat in the form of a compressed letter Z, from the last joint of which a strong spine projects which remains erect after the members are folded and at rest. Although six is the recognized normal number of pairs of legs in this stage of the young animal's existence, yet I was only capable of counting five pairs in the specimen from which this drawing is taken;—a circumstance, which might lend assistance to establish the truth of the intermediate stage given by Burmeister, which is figured and described as having only three pairs similar to that of the larva in its earliest period; and

induces the idea that it adds a pair of legs with each successive moult; but this link in the history of the young creature's development is yet to be made clear.

At the anterior base of these organs an opaque spot exists (fig. 15 *a*), which I presume to be the stomach.

Two larger and darker spots, situated a little higher and anterior, are pronounced to be organs of vision; near these are inserted two long slender members which are supplied with a sucker and hooks to each limb; with these the animal has the power of attaching itself to any object, and, by using them alternately, of perambulating on the surface of any hard substance; thus the young creature is in the middle stage endowed with the power of walking as well as swimming.

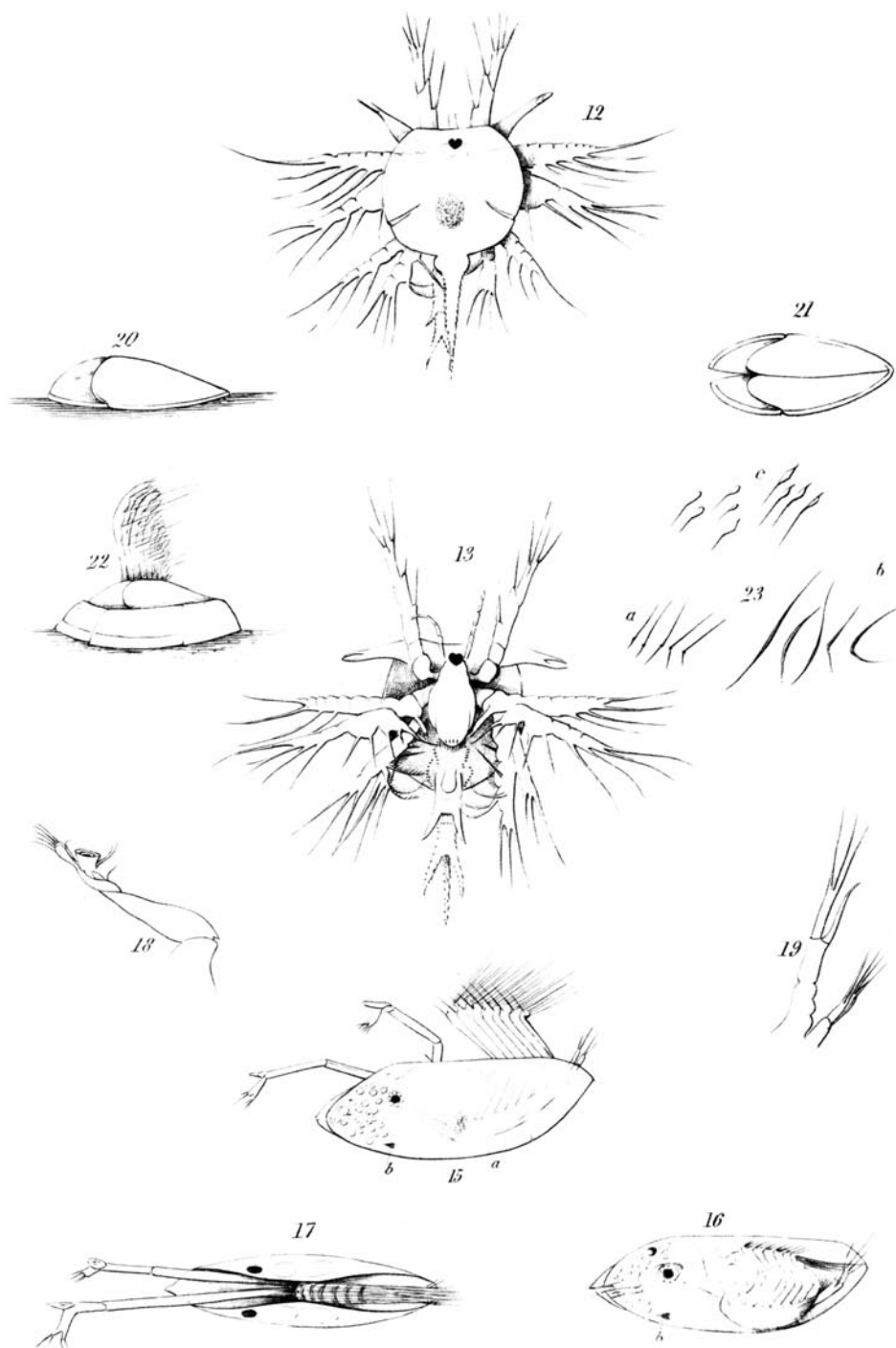
Here I cannot help remarking upon the gradually changing habits of the creature, which in its early state swims about at its own will and pleasure, using, as all aquatic creatures do, its long tail as a rudder, by which it is enabled to direct and control its own movements; whereas in the latter stage of its larval existence the tail is gone, and consequently the creature is most excentric in its movements through the water, apparently being unable to swim direct to any fixed point. Thus it appears that before it becomes a sedentary animal it has been partially rendered incapable of fully enjoying its existence as a swimming creature, and thus the path is softened in the change of habits from an active to a stationary existence; for an animal not having power to control its movements in its natural element could scarcely be supposed to enjoy its own existence: thus, under these circumstances, to become stationary is to become more happy.

It is I believe generally understood that at this stage the larva has two valves, one on either side, a right and left, united at their posterior margin by a hinge similar to that of a bivalve among Mollusks.

Of the correctness of this I was far from being able to convince myself, insomuch that I could neither observe the hinge nor the separation of the valves *beyond a certain point* at which the two appeared to me to unite; nor could I observe any opening or shutting, the two sides appearing to me to be continually the same, and the whole together formed a shelly cell such as I have endeavoured to figure (Pl. VIII. fig. 17).

At this period the larva may be presumed to represent the adult animal, and the shells of the operculum, but without the accessory valves.

Thus it is to be remarked, that this animal in its growth from embryo to adult puts on several distinct characters, all of which are indicative of the Crustacea in different forms.



First, it assimilates to the appearance of the larva of certain Entomostraca, being liberated from the ovum like them without eyes; after which it next approaches in character towards the adult Entomostraca, bearing an external resemblance to the bivalve Crustacea, and like these perfected animals possesses organs of sight, from which period they pass out of recognized tribes, and comprise a family peculiar to themselves. These observations tend to corroborate the now generally received opinion that they are true Crustacea, and among this class they appear to fill up a vacancy which alone was wanting throughout the whole range of the Invertebrata,—I mean a sedentary family, one or more of which exists among each successive race of animals.

The Polyp, from its analogy to the larva of the Medusa, may be looked upon as representing the sedentary family among the Acalephæ,—the fossil Encrinites and the larva of the Comatula as representing the same position among the Asteriæ. The Tunicata among Mollusks and the Serpulæ among Annelides appear to hold a similar relation, each to their separate class, as that which the Cirripedia occupy in relation to the Crustacea; and these last, by the different forms which they pass through in their individual development, may be said to represent the type of those separate forms in the sedentary character.

It would scarcely be just for me to close this paper without alluding to how much I am indebted to my friend Mr. Jeffreys both for specimens and a knowledge of the different species, his cabinet being as rich in this department of natural history as in that of British Mollusca; or without expressing my thanks to Mr. Darwin, but for whose kindness I should have been guilty of publishing more than a single error.

#### EXPLANATION OF PLATES VI. VII. VIII.

Fig. 1. *Balanus balanoides* as it appears when first liberated from the ovum.

- 2. The same after the first moult; 2 a, abdominal appendage.
- 3. The same after the second moult; 3 a, abdominal appendage.
- 4. The same, lateral view.
- 5. *Balanus perforatus* just liberated from the ovum; abdominal view.
- 6. The same after the first moult; abdominal view.
  - B. The (*so-called*) eye.
  - C. Abdominal appendage.
  - D. Caudal termination.
  - E. Proboscis.
  - F. Supposed oral aperture which is protected by the lip or valve G.
  - H. H. Horns or outer antennæ.
  - K. K. True or interior antennæ.
  - 1. First pair of natatory legs.
  - 2. Second ditto.
  - 3. Third ditto.

These letters also refer to fig. 14.

- Fig. 7. *Balanus porcatus*, abdominal view, just liberated from the ovum.  
 — 8. *Clitia Strömia*, do. do. do.  
 — 9. The same after the first moult; abdominal aspect.  
 — 10. The same after the first moult; dorsal aspect.  
 — 11. *Chthamalus depressus*, first form, abdominal view; 11 a, caudal extremity.  
 — 12. The same after first moult; dorsal aspect.  
 — 13. The same after first moult; abdominal view.  
 — 14. The same, lateral view.  
 — 15. *Balanus balanoides*: the pupa, or stage of the larva immediately previous to its becoming a fixed animal, in a state of activity.  
 — 16. The same at rest.  
 — 17. The same, viewed in front.  
 — 18. The same, anterior member with sucker and hooks.  
 — 19. The same, posterior natatory leg and caudal appendage.  
 — 20. The same, soon after its becoming fixed.  
 — 21. The same, do. seen from above.  
 — 22. The same, a little older.  
 — 23. a, Spermatozoa of *Balanus balanoides*.  
       b, do. do. *Balanus perforatus*.  
       c, do. do. *Clitia Strömia*.

XXVII.—*A Catalogue of British Spiders, including remarks on their Structure, Functions, Economy and Systematic Arrangement.* By JOHN BLACKWALL, F.L.S.

[Continued from p. 102.]

77. *Agelena celans*.

*Agelena celans*, Blackw. Linn. Trans. vol. xviii. p. 624.

*Argus celans*, Walck. Hist. Nat. des Insect. Apt. t. iv. p. 504.

This scarce species may occasionally be met with running upon the ground or concealed under stones in woods about Llanrwst. The palpal organs of the male are developed in August. Though intimately allied to the *Agelena*, yet M. Walckenaer has included this spider in the genus *Argus*.

Genus *TEGENARIA*, Walck.

78. *Tegenaria domestica*.

*Tegenaria domestica*, Walck. Hist. Nat. des Insect. Apt. t. ii. p. 2. pl. 16. fig. 2; Koch, Die Arachn. B. viii. p. 25. tab. 260. fig. 607, 608; Blackw. Linn. Trans. vol. xix. p. 117.

— *petrensis*, Koch, Die Arachn. B. viii. p. 27. tab. 260. fig. 609.

*Aranea domestica*, Latr. Gen. Crust. et Insect. tom. i. p. 96.

*Agelena domestica*, Sund. Vet. Acad. Handl. 1831, p. 125.

*Philoica domestica*, Koch, Uebers. des Arachn. Syst. erstes Heft, p. 13.

I have received specimens of *Tegenaria domestica* from Cambridgeshire, Oxfordshire and Middlesex; but I have not ob-