1844

Memoir on the Development of Asteroids. A translation of Sars, M. 1844. *Mémoire sur le développement des Astéries, Annales des sciences naturelles, Zoology. Sér 3. Vol. II, Pp. 190-199*

M. Sars

John Lawrence
University of South Florida, lawr@usf.edu

Follow this and additional works at: https://digitalcommons.usf.edu/bin_books

---

Recommended Citation

Sars, M. (2021). Memoir on the Development of Asteroids. A translation of Sars, M. 1844. *Mémoire sur le développement des Astéries, Annales des sciences naturelles, Zoology. Sér 3. Vol. II, Pp. 190-199* (J. M. Lawrence, Trans.). Herizos Press, Tampa.

This Book is brought to you for free and open access by the Integrative Biology at Digital Commons @ University of South Florida. It has been accepted for inclusion in Integrative Biology Books by an authorized administrator of Digital Commons @ University of South Florida. For more information, please contact digitalcommons@usf.edu.

Sars, M. 1844. Memoir on the development of asteroids. A translation of *Sars, M. 1844. Mémoire sur le développement des Astéries, Annales des sciences naturelles, Zoology. Sér 3. Vol. II, Pp. 190-199.* (J. M. Lawrence, Trans.).

© J. M. Lawrence. 2021. Herizos Press, Tampa.

Translator's note:

See also: Sars, M. 1844. Über die Entwicklung der Seesterne. Archiv für Naturgeschichte. Volume 10. Issue 1. Pages 169–178.

I thank Janessa Fletcher for preparing the figure.

MEMOIR ON THE DEVELOPMENT OF ASTEROIDS

By M. SARS¹

(Extracted by the author from his still unpublished work on the Faune de la Norwège.)

As the publications of the works in which are found recorded all my observations on the animals that are the subject of this memoir have experienced an unexpected delay, I believe it is necessary to communicate here the principal results of my investigations on the development of *Echinaster sanguinolentus*, Nob.² (*Asterias sanguinolenta* O. F. Müller), and *Asteracanthion Mülleri* Nob., a new species very close to *A. glacialis*³.

I. In the asteroids, the male organs and the female organs are in distinct individuals. The reproductive activity is in the spring. The eggs form in the ovary and have the Purkinje vesicle in which is enclosed the vesicle of Wagner (Pl. 13 A, fig 3, 4, 5 and 6). They are released in several broods in diverse seasons of the year. Probably they are expelled by special openings located on the ventral surface after being detached from the ovary and fall into the body cavity. Until now, I have not been able to show this fact in a positive way.

Note: To conclude that the eggs of released in successive broods and at diverse seasons of the year, we can rely on the fact that we find eggs in the ovaries at different periods (fig. 4 and 5) and on the simultaneous existence of eggs and unequally developed young in the incubatory chamber of the mother.

II. Independently of the chorion, the spawned eggs (fig. 7) are composed of yolk and a little albumen. The yolk soon has the ordinary phenomenon of furrowing, shown in the great majority of classes of the animal kingdom (fig. 8, 9 and 10). These eggs are not abandoned in the water. They are received into a chamber prepared by the mother, using the ventral surface of the disk and bringing the arms together (fig. 1 and 2). It is, in a way, a kind of external womb, analogous, up to a certain point, to the marsupial chamber. This is where the eggs hatch and where the young stay for the duration of their development. This incubatory chamber, hermetically closed during the spawning of the eggs, and until the moment when the organs of attachment are completely developed in the young. It is probable that, during all this time, the mother eats no food, because the incubatory chamber, closed below, completely interrupts all communication between the mouth and the exterior. In fact, the asteroids that are in this brooding state remain curved in the

---

¹ *Archiv für Naturgeschichte*, in-8, 1844, p. 169.

² It is, without any doubt, *Echinaster Sarsii* Müller Trosch, described on page 179 of this volume (*Archiv für Naturgeschichte*, 1844) and whose incubatory pouch still contained young that I received from Christie, Canon of Bergen. *Asterias sanguinolenta* of Retz (*Diss.*, p. 22) is, according to examination of the very individual that served for his work, *Echinaster sepositus* of Müller and Troschel (*Syst. der Asteriden*, additions, p. 126). We cannot determine in an absolute way to which species *A. sanguinolenta* of O. F. Müller belongs because there are three *Echinaster* of this color in the sea of the North.

(*Note from J. Müller.*)

³ The facts reported in this memoir are not common to all asteroids. It appears that in the diverse species, even in those that are most closely related and that have been united in fewer number in small groups, the phenomena of reproduction are subordinated to the phenomena of animal life.

position that we just described (fig. 2), nearly motionless and without leaving the place where they are found for at least eleven days. It is a remarkable example of protective care for the young in animals placed in the last degree of the scale of life.

Notes: We know, in lower animals, several other examples of eggs that require incubation in order to hatch. Thus, in the medusae, the eggs pass from the ovaries into a chamber located in the four large buccal arms. In river bivalves (*Unio*, *Anodonta*), they are received in the external brachial lamellae. In crustaceans, they are held under the belly or under the tail for incubation for a certain period of time⁴. But there does not exist, to my knowledge, any other example of an incubatory chamber formed voluntarily by these animals by means of a part of their body. The instinct of the asteroid is unique in this regard. The starvation of this animal during this incubation, recalls a similar phenomenon in several other animals, in the serpents, for example, that, according to the observation of Valentine, the python does not eat for the fifty-six days that incubation of the eggs lasts⁵.

III. The yolk is completely transformed into a fetus. When the egg is released, it has an ovoid or subspherical form (fig. 11), without external organs and swims freely in the water that surrounds it by means of an immense number of cilia that cover the body. The form of infusorians and those of young medusae, of corynes and of alcyons that are just born, greatly resembles it. This is the first state, the infusorian-form state of the asteroid. After a few days, at the end of the body located on the extreme forward position while swimming, it develops organs (fig. 12, *a,a*) that will serve later to attach these animals. These organs of attachment appear in the form of eminences. One first on one side (fig. 12, then two smaller ones on the other (fig.13, *13b, a,a*). Later, the first subdivides into two others in a way that we see then four of these eminences as clubs having nearly the same size (fig. 14, 15 and 16, *a,a*). In their midst appears another smaller eminence (fig. 14, 15, 16, *b*). It is by means of this organ that the young attach to the wall of the incubatory chamber. The body of the young flattens little by little, rounds (fig. 14, 15, 16 and 17), and, on one of its surfaces, that we recognize thus for the ventral surface, it develops tentacles in the form of globular protuberances arranged in two concentric rows that are each composed of two of these protuberances, alternatively nearer or further from each other (fig. 14, *c,c*). If we detach the young from the place where it is attached, it still swims in the environmental water by means of the cilia, always with the organ of attachment directed forward. If we do not detach it, it remains still in nearly complete immobility in the place where it is attached. I give this second state the name crinoidean, because I cannot better compare this to what we see in the crinoids, the only echinoderms that are attached, at least at the young age. At this time, the young asteroid is still bilateral because, in its movements, the organ of attachment is always directed forward and its two sides are not perfectly alike (fig. 14, 15 *a,a*). We thus can recognize an interior end and a posterior end, a right side and a left side. The dorsal surface and the ventral surface are already made distinct by the tentacles. But, little by little, this bilateral form takes the radial form that characterizes the third state, the complete asteroid state. Then the body becomes pentagonal, edge develops in a way to form very short and obtuse arms (fig. 18 and 19). The tentacles, with a sucker at their end, extend as cylindrical tubes (fig. 20, *c,c*) and function for crawling. We note at the end of the arm the organ that Ehrenberg considers an eye (fig. 18, *b*). The mouth appears in the center of the ventral surface. Numerous spines (fig. 19, 20) are produced on the surface of the body and the

---

⁴ According to Joly (Mémorial on the Caridian *Desmarestii*: *Annales des Sciences naturelles*, 2^o série, t. XIX, p. 61, 1843), it is not possible, until a determined period, to remove crustacean eggs from maternal care without death being the consequence of the separation.

⁵ *Annales de Sciences naturelles*. 2^o série, t. XVI, p. 65.

arms. Finally, the organ of attachment begins to decrease in volume (fig. 20, *a,a*) and ends, little by little, in disappearing completely. The animal can no longer swim by means of the cilia. These organs no longer exist. The young asteroid becomes now perfectly radial (fig. 21 and 22), crawling freely with the aid of its tentacles that are very long in relation to the body (fig. 22, *c,c*). This development is complete in six to seven weeks. However, the young sea star, at least in one of the species that I have studied (*Asteracanthion Mülleri*) extends its stay in the incubatory chamber and thus is transported from place to place by its mother. I have found the young of another species, *Echinaster sanguinolenta* in the radial form in the interior of the incubatory chamber, but I have not been able to learn by observation either if the young continue to stay in the chamber, or at what time they leave it.

IV. Asteroids may or may not undergo metamorphosis according to the meaning of the word. If, by metamorphosis, we mean, as some naturalists do, and not understood transition from one state to different states as occurs in the development of insects that leave their original state to pass to the larva, to the nymph, and finally to the complete insect, no. Asteroids have no metamorphosis. But if we understand this word in the usual sense, such as Lamarck defined it⁶: “I call metamorphosis this singular peculiarity of the insect either not being born with the form or with all the parts that it must have in the last state” one must accept that there is metamorphosis in asteroids because its form, in the first two states that we have described is bilateral instead of being radial. It comes into the world without any trace of any of the organs that will be the most important in the last state, such as the mouth, the arm, the tentacles and that appear only later. In addition, the animals, when young, have parts that completely disappear later, like the organ of attachment that we have referred to so often and that functions only in the first periods of life. In regard to the latter, their metamorphosis can be considered as a kind retrograde progression and can be called, after Rathke, “retrograde metamorphosis by dissolution”⁷. The reason for the disappearance of the organ of attachment is that the tentacles, organs of a new form of locomotion, are then developing and make, by this fact, the first is absolutely useless⁸.

Note: We just followed as long as we could, the very recognizable trace of the organ of attachment, persisting in the form of two very small, warty eminences located side by side and that always seem to retract more and more from the dorsal surface of the disk. I am presently convinced, although I still do not have definitive proof, of this act, that the plates that we call madreporic and that exist in adult asteroids are nothing other than these two eminences fused into only one, the remains of the organ of attachment. J. Müller and Troschel, in speaking of the madreporite plates, whose nature has been so difficult to discern, express themselves in the following way⁹: “We see at first glance that there is an analogy, when we compare the madreporite plates of the asteroid to those of the urchin with the bouton of comatulids, this like the stalk of other crinoids corresponds to the latter. The madreporite plate can also be compared to this stalk. Its eccentric position cannot be considered a valid objection because, in clypeasters, it is at the dorsal pole. However, the constant existence of the madreporite plates in multiple number in some asteroid species reduces the exactness of this point of view and perhaps the history of the development of these beings can

⁶ *Histoire naturelle des animaux sans vertebrae*. T. III, p. 277.

⁷ Rathke, “*Reisebemerkungen aus Scandinavien*”, appendix, p. 123. — I must make the remark, on this occasion, that Rathke has misunderstood me when, in this work that I just cited, he accepts, according to my memoir inserted in *Archives* of Wiegmann for 1837, p. 122, that “the asteroids have, in their extreme young age, a thin stalk on the dorsal surface and functions to fix it to other bodies.”

⁸ *System der Asteriden*, p. 134.

⁹ *Archive für Naturgeschichte*. 1841; heft I, t. VI, p. 321.

clarify the nature of these organs. According to the observation of Sars, the asteroids are free at a young age and not fixed to the substratum”.

If my supposition is valid, if the madreporite plates are nothing other than the remains of the organ of attachment. We can compare them correctly with the boutons of comatulids and to the stalks of other crinoids. And, although the authors I just cited have believed that my observations, reported in the *Archives* of Wiegmann for 1837, are contrary to this point of view, I myself think they are instead of the nature to give weight to this comparison. In fact, the organs of attachment fill in young asteroids the same function as the stalks in crinoids, i.e., that they serve to attach the young.

My hypothesis on the madreporite plates, considered to be the remains of the organ of attachment, is supported in the most remarkable and most unexpected way by the admirable description of the bilateral type of echinoderms that we owe to Agassiz. Because not only is the position of the organ of attachment in the interradius at a point such that the longitudinal axis of asteroids crosses it, but still the point of view of Agassiz concerning the determination of the anterior end and the posterior end is confirmed. That which fixes the body of the young asteroid must be regarded as the posterior end. It is true that, at a young age, the asteroid directs this end forward and that one, consequently, can consider it anterior. It is still in this sense that we are talking about it. But the analogy with the medusae, according to my observations¹⁰ and those of Milne-Edwards¹¹, we demonstrate that the end directed forward during swimming is that which is fixed later and that ultimately becomes posterior.

As for the asteroids with several madreporite plates, we can confirm nothing for certain. Perhaps these species have, at a young age, multiple organs of attachment.

To end, I repeat what I have said above, that it is necessary to be very reserved when it is a matter of making generalities. Regarding reproduction, there is probably between the genera and species of asteroids a greater difference than we first assumed. *Echinaster sanguinolentus*, whose openings of the genital organs are found on the ventral surface, differs essentially from *Asteracanthion rubens*, in which this same opening is located, according to Müller and Troschel, on the dorsal surface so that its eggs fall into the sea and are abandoned to themselves. It is, in all probability, to this circumstance that I must, despite the most active investigations undertaken in all seasons of the year, not have encountered a single indication of maternal care by this species. However, another species of the same genus, *Asteracanthion Mülleri* Nob., resembles, as have already seen, reproduction in *Echinaster sanguinolentus*. There are more anomalies still in the development of others. The animal I called *Bipinnaria asterigera*¹² is probably, according to new investigations that I shall make known on another occasion, an asteroid in developing, having a large apparatus for swimming.

Finally, I cannot omit noting here that the development of asteroids, as far as we can judge now, has considerable differences from those of other radial animals (polyps, aculephs), among which a large number has particular forms at the young age, forms designated in Germany under the name *Generations-wechsels* (reproductive changes). The asteroids hatch, develop and acquire their typical characteristics without having reproductive changes. In this, they have some relation with vertebrates and annelids, to which they seem to have some tendencies, not only in the articulated calcareous skeleton that is peculiar to them, but also by the remarkable instinct with which they care for their progeny.

---

¹⁰ *Archiv für Naturgeschichte*. 1841.heft I (*Annales des Sciences Naturelles*, 2° série, t. XVI, p. 321).

¹¹ *Observations sur les Ascides des côtes de la Manche*.

¹² *Beskrivelser og Jagthajeler*, etc.

EXPLANATION OF THE FIGURES

PLATE 13 A

- Fig. 1. *Echinaster sanguinolentus* of natural size, seen by the ventral surface. The incubatory chamber is semi-open and we see bright red young in its interior.
- Fig. 2. The same animal seen in profile, attached and humped, having its incubatory cavity completely formed. — *a*, madreporite plate.
- Fig. 3. Ovary of a small individual examined 22 February.
- Fig. 4. The same organ, enlarged. We see eggs at various stages of development.
- Fig. 5. A pocket of the same organ, even more enlarged.
- Fig. 6. One of the smallest eggs taken from the pocket, having the vesicle of Purkinje and that of Wagner.
- Fig. 7. An egg that was just spawned (7 March). The chorion is colorless. The yolk is smooth and bright red. Between the two, the albumen is limpid like water.
- Fig. 8, 9, 10. Furrowing of the yolk on the same egg. — fig. 8, 9 March in the morning. — fig. 9, the same day in the evening, — fig. 10, the next day, 10 March, in the evening.
- Fig. 11. The young, come out from the egg, found 17 March in the incubatory chamber. The young is spherical, with visible external organs and covered with cilia. It is the first state, the infusorian state of asteroids.
- Fig. 12 to 20. Second state of development, the crinoidean state of asteroids.
- Fig. 12 and 13. Young found in the incubatory chamber, 17 March, having developing organs of attachment, *a,a*, — In figure 12, the individual, very slightly depressed and still nearly spheroidal, has rudiments of the organs of attachment in the form of two eminences, *a,a*, of which one is more protruding than the other. The young cannot use them for attachment. — In figure 13, one of the eminences is already subdivided into two others and all three attach the young animal. — Fig. 13 *b*. The same young, seen by its anterior end. — Fig. 13'. Its natural size.
- Fig. 14 to 17. Young found, 3 April, in the incubatory chamber. They are rather flat, with four perfectly developed organs of attachment in the form of clubs, *a,a*, and one smaller eminence, *b*, in the middle of the four others. By means of this organ, the young is attached to the wall of in the incubatory chamber. — Fig. 14. Young seen by its ventral surface, where we see the tentacles, *c,c*, growing in the form of very small eminences, arranged in ten radiating series from the center of the body, two for each series, alternating closer and further. — Fig. 15. The same young seen by its dorsal surface. — Fig. 16. The same seen by its anterior end. — Fig. 17. A young, with an organ of attachment with three clubs, seen by its anterior end.
- Fig. 18, 19 and 20. Transition of the young from their bilateral state to their third or radial state.
- Fig. 18. One of the young drawn with figures 14, 15 and 16, reaching a more advanced state of development (15 April). It is seen by the ventral surface. The body is pentagonal, the corners placed in the intervals of the thick arms and bent inwards. The tentacles have become more voluminous and more marked and, at the end of each arm, is a small round eminence that Ehrenberg considers an eye.

Fig. 19. The same young, seen by the dorsal surface. We note the round disk, separated from the arm by a groove. The skin has a large number of spines. — Fig. 19'. The same animal at natural size.

Fig. 20. The same young, eight days later (23 April). Seen by its dorsal surface. The tentacles, *c,c*, are elongated in the form of a tube and function at this time for crawling. The organs of attachment, *a,a*, begin to decrease in volume.

Fig. 21. The same young (4 May) seen by the dorsal surface.

Fig. 22. The same, seen by the ventral surface. The mouth is visible. The organ of attachment has disappeared. The young, now completely radial, crawls with the aid of the tentacle. — Fig. 22'. The same, natural size.

At the end of May, the arms are more elongated and become slenderer. The number of tentacles increases to five in each of the rows of the ten series etc.

A.

A. Développement des Astéries

N. Rémond. inv.