THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

" ..... per litora spargite muscum,
Naiades, et circùm vitreos considite fontes :
Pollice virgineo teneros hìc carpite flores :
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Craterides, ite sub undas ;
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchylia succo."
Parthenii Ecl. 1.

No. 81. JANUARY 1844.

I.—*Observations on the Structure and Propagation of the genus* Sagitta. By Charles Darwin, F.R.S., V.P.G.S.

[With a Plate.]

THE species of this genus are remarkable from the simplicity of their structure, the obscurity of their affinities, and from abounding in infinite numbers over the intra-tropical and temperate seas. The genus was founded by MM. Quoy and Gaimard*; three species have been figured and described by M. A. d'Orbigny, and lately Prof. E. Forbes has added a species to the British fauna, and has given many particulars regarding the structure of the genus. Scarcely any pelagic animal is more abundant: I found it in lat. 21° N. in the Atlantic, and again off the coast of Brazil in 18° S.; between latitudes 37° and 40° S., the sea, especially during the night, swarmed with them. They generally appear to swim near the surface; but in the Pacific, off the coast of Chile, I obtained specimens from a depth of four feet. They are not confined exclusively to the open ocean, as supposed by M. d'Orbigny; for near the shore of Patagonia, where the water was only ten fathoms in depth, they were very numerous.

All the individuals which I caught had two pair of lateral fins,

* Annales des Sciences Naturelles, tom. x. p. 232. M. d'Orbigny's observations are given in his grand work (Mollusques, p. 140). Prof. E. Forbes four years since made his first communication on this genus before the Wernerian Society, and a second one at the Meeting of the British Association for the present year.

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but I do not suppose that they all belong to the same species: those obtained in lat. 37° to 40° S. appear certainly to be the *S. exaptera* of D'Orbigny; and the few following observations, which relate chiefly to their propagation, apply, when not otherwise stated, to this species. M. d'Orbigny and Prof. Forbes have provisionally placed this genus amongst the nucleo-branch mollusca; but the evidence is hardly conclusive.

Head.—The linear-lanceolate head, which is of a transparent, gelatinous and adhesive texture, is separated from the body by a distinct neck. The head when not in action is slightly flattened and of a truncate-conical shape; when in action its basal part assumes a semilunar or horse-shoe form, in the concavity of which lies the longitudinally-folded mouth. On each arm of the fleshy horse-shoe, a comb, formed of eight strong, curved, slightly hooked claws or teeth, is attached. The animal when lively is constantly clasping these bristle-like teeth together, over its mouth; when clasped together, and the head in a state of inaction, they appear to be situated much nearer to the mouth than when their fleshy bases are expanded in action. The middle teeth are the longest; besides their clasping action and the power of movement in their fleshy bases, each separate tooth can move itself laterally further from or nearer to the adjoining ones. The mouth opens on the oblique surface of a part projecting up, between the two fleshy arms. Close to the mouth there are two other rows of exceedingly minute teeth, which have not been noticed by other observers, and which I discovered only with a lens of high power. These two rows of little teeth project inwards and transversely to the two great upright combs of teeth; so that when these latter are clasped over the mouth the minute teeth cross them, thus effectually preventing any object from escaping which might be caught by the longer curved teeth. I could not see any vestige of eyes or of tentacula.

Locomotive organs.—The animal moves quickly by starts, bending its body. The two pair of lateral fins and that on the tail lie in the same horizontal plane: viewed with a lens of small power they appear formed of a delicate membrane, but under a lens of $\frac{1}{20}$th of an inch focal distance they appear to consist of excessively fine transparent rays, touching each other, like the barbs of a feather, but not, as it appeared to me, actually united by a membrane. The tail, besides being used as a locomotive organ, serves as a means of attachment; for the animal when placed in a basin of water sometimes adhered by its tail so firmly to the smooth sides, that it could not be detached by a considerable agitation of the water. Out of the innumerable specimens which I procured, I never saw one fastened by its teeth to the ova

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of pelagic animals, or to other bodies, as M. d'Orbigny has observed in some of his species.

Internal viscera.—Within the body, in the same plane with the longitudinally folded mouth, there is a flattened tube or cavity, which in the specimens obtained in lat. 18° S. I observed had the power of contracting and enlarging itself in different parts, and within it there was a distinct peristaltic movement. Within this cavity in the *S. exaptera* I could clearly discern in the posterior half of the body a delicate vessel, which I presume is the intestine, for it appeared to terminate on one side of the body at the base of the tail. I could discover no vestige of a nucleus, of branchiæ, of a liver, or of a heart. In some exceedingly young specimens, however, just liberated from the egg, there was a distinct pulsating organ (as will hereafter be mentioned) in the anterior part of the body.

Propagation.—The state of the reproductive system varies much in animals caught at the same time. Taking a specimen with this system in a high state of development, the tail, or the tapering part of the body into which the intestinal tube does not penetrate, is seen to be longitudinally divided by an exceedingly delicate partition, and to be filled with a pulpy finely-granular matter. The column of matter on each side of the central division also *appears* (but whether really so I do not know) to be divided, making altogether four columns, as is shown in the diagram. The whole of this matter is in a state of steady and regular circulation, something like that of the fluid in the stems of the *Chara*. The matter flowed upwards in the two outer columns, and downwards towards the point of the tail in the two middle columns. The circulation in the up-flowing columns was most vigorous on their outer sides; and in the down-flowing columns on their insides, that is, on each side of the central partition: this would be accounted for, if we might suppose that the two surfaces of the central partition were covered with cilia, vibrating in a direction opposite to that in which other cilia situated on the inside of the membrane forming the tail were also vibrating. The stationary condition of the granular matter between the two streams, travelling in opposite directions, perhaps gives the appearance of the partition on each side of the central one. The circulation at the base of the tail was twice as rapid as it was near the apex: where most rapid I found that a granule travelled over the $\frac{1}{230}$th of an inch on the micrometer in five seconds; allowing for the slower rate in other parts, I calculated that in an individual, the tail of which was $\frac{5}{20}$ths of an inch in length, a granule performed its entire circuit in about six minutes. I could distinctly follow the granules descending one column, turning the angle, and again ascending. In specimens with the reproductive

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system in a lesser stage of development, the tail contained very little granular matter; and in proportion as this was less in quantity, so was the circulation less and less vigorous: in some specimens no granular matter, and perhaps, consequently, no circulation, was visible.

When the tail is filled with vigorously circulating matter two large *cul-de-sacs* or gut-shaped ovaries are invariably present, extending, as represented (*o o*) in the diagram, from the base of the tail along each side of the intestinal tube. These are filled with ova, which in the same animal are in different stages of development, and vary in length from $\frac{1}{100}$th to $\frac{1}{30}$th of an inch; their shape is pointed oval (Plate I. fig. B), and they are attached by the pointed end in rows to the sides of the ovaries: those of full size are detached by a very slight touch. When the ovaries contain many eggs nearly perfect (but not at other times), a small conical and apparently perforated protuberance can be seen on each side (A A) of the body, through which without doubt the eggs are expelled. In different individuals the ovaries are of different sizes and the eggs in different stages of development: before any of the eggs are perfected the ovaries are merely filled with granular matter; but this is invariably of a coarser texture than that within the tail. The ovaries when not containing granular matter are contracted into a very small size* (B). In great numbers of specimens taken in latitude 18° S. and between 37° and 40° S., I invariably observed that there existed a close relationship between the quantity of circulating matter within the tail and the size of the ovaries; from this circumstance, and from the similarity of the granular matter in the ovaries, before any of the eggs are perfected, with that in the tail, except that the granules are in this latter part of less size, I think it almost certain that the granular matter is first formed within the tail, and that it then passes into the ovaries, where it is gradually developed into ova. I could not, however, trace any opening from the one part into the other, but at the bottom of each ovary there was a space, where a closed orifice might have been situated.

A well-developed egg presents, when liberated by a touch from a torn open ovary, the appearance represented at (B) in the diagram. The egg is transparent, and contains within it an exceedingly minute globule. Twice on one day and once again a week afterwards, I clearly observed the following curious phænomenon take place: the apex of the egg, a few minutes after having been liberated from its attachment, began and continued to

* I also remark in my MS. notes, that the granular matter within the tail is sometimes contracted into small kidney-shaped bodies; I cannot help suspecting that I ought in every case to have written that the ovaries were contracted into this form.

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swell, and soon assumed the form shown by (C). Whilst this was going on, the small internal globule also appeared to be swelling, and at the same time the transparent fluid with which the ovum and its enlarged apex were charged, became more and more opake and granular. The apex continued enlarging until it became of nearly the same size with the ovum from which it proceeded; and as this took place, all the granular matter was slowly expelled from the original capsule into the newly-formed one, in a manner which seemed to show that it was effected by the contraction of a lining membrane as represented at (D). Directly that this was completed the two balls slowly separated; one being left a mere empty husk, and the other consisting of a spherical mass of granular matter, within which a minute globule could be discovered. I presume that this was the same globule as seen within the egg in its first state (as at B), and that the appearance of its swelling was caused by the transparent fluid round it being first converted into granular matter. I have reason to suppose from what follows that this little globule contains only air. The whole phænomenon was effected in about ten minutes; and in one case I watched the entire process without taking my eye from the microscope.

On the 27th and 29th of September 1832, we passed* through the same tract of sea (off Bahia Blanca on the coast of northern Patagonia) where twenty-five days previously I had observed such great numbers of the *S. exaptera* with their ovaries distended with eggs, and I now found infinitely numerous ova floating on the surface. They were in different states of maturity; those least developed presented a sphere of granular matter contained within a larger spherical case. In the next stage the granular matter collects in a linear manner on one side of the inner sphere, and projects slightly beyond its outline; it then soon forms a distinct prominent rim, extending round two-thirds of the circumference of the inner sphere. This prominent rim is the young animal; a fine vessel is seen extending within its entire length, and one extremity enlarges into a head: the tail is first liberated from its attachment on the surface of the inner sphere, and lastly the head: the young animal, when thus released, lies in a curved position within the outer case, with the inner sphere, on the circumference of which it was developed, pushed on one side, and its function apparently ended. The central intestinal vessel is now much more distinct: an excessively fine membrane-like fin is discernible round the end of the tail; and the young animal being liberated from the outer spherical capsule, progresses by a

* I may add, that in the beginning of April, off the Abrolhos, on the coast of Brazil, in lat. 18° S., numerous specimens of a four-finned *Sagitta* had their ovaries filled with eggs apparently ready to be expelled.

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starting movement like that of a full-grown *Sagitta*. At the anterior extremity, near the head, a pulsating organ can be distinctly seen. The ovum in all these stages contains a minute globule, which causes it to float on the surface of the water, and apparently is formed of air: I presume that it is the same globule with that seen in the egg, when first released from the ovary. The change in the floating ova from the state in which the inner sphere consists of granular matter without any trace of a young animal to the succeeding states must be rapid; for on the 27th of September all the ova were in this first state, whilst on the 29th the majority contained partially developed young ones. These floating ova were $\frac{1}{14}$th of an inch in diameter, whereas the spherical balls of granular matter which I saw expelled from their pointed oval cases were barely the $\frac{1}{30}$th of an inch in diameter; but as the eggs within the ovaries were of different sizes, according to their states of maturity, we might expect that their growth would continue after having been expelled from them. I will conclude by expressing a hope that these few observations on the propagation of this curious genus may aid more competent judges than myself in ascertaining its true affinities.

EXPLANATION OF PLATE I.

I. Intestinal tube.
o o. Ovaries.
A A. Apertures of the ovaries, and lateral fins.
T T. Tail divided into four columns of circulating granular matter, the course of which is shown by the arrows.
B. Egg just liberated from the ovary.
C. Egg in first state of change.
D. Egg in a succeeding state.

II.—*On the Marine Algæ of the vicinity of Aberdeen.* By G. Dickie, M.D., Lecturer on Botany in the University and King's College of Aberdeen.

[With a Plate.]

In the present and subsequent communications it is proposed to enumerate the marine Algæ which have been found in the vicinity of Aberdeen, and also to record such observations on their structure as may seem of most interest.

Although no great merit attaches to mere local lists, still such are not to be entirely rejected as useless, more especially when we consider their utility to those whose attention is directed to the geographical distribution of plants, a very interesting and important branch of their history.

All the species to be mentioned have been collected on the Kincardineshire coast, the southern part of the Aberdeenshire

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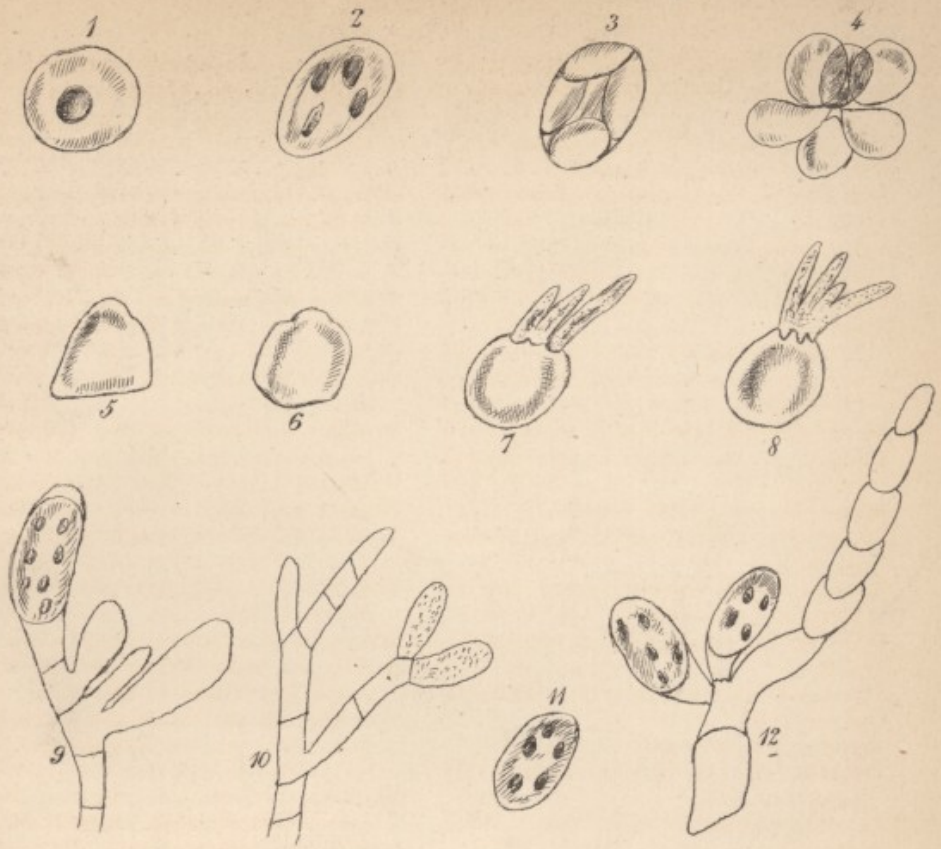
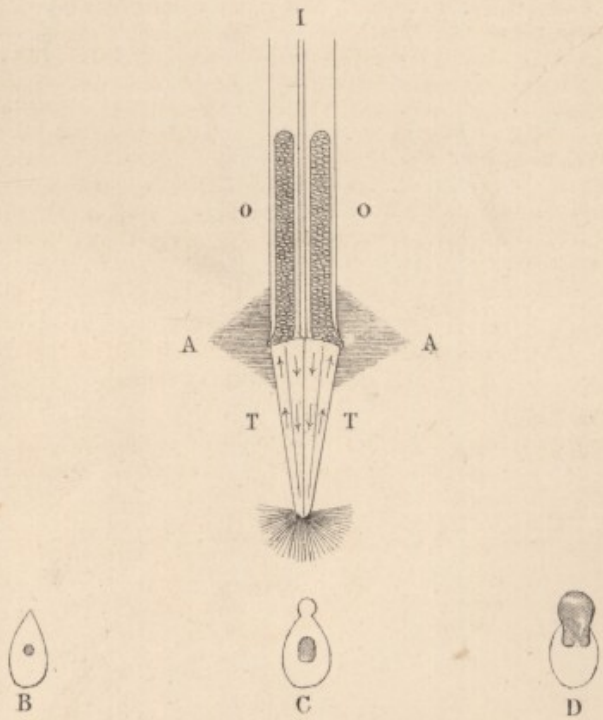


Marine Algæ.



Structure of Sagitta.

prel. lith. Linn. imp.
8. King William St. Strand.

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