

Nat. Hist. 1849, p. 339. pl. 13. f. 5, and which he also found in the valves of *Placuna sella*.

At the Scientific Congress held at Lucca (1843), Dr. Nardo proposed a new classification of the *Spongiadae*, dividing them into five families, under the names of Corneo-spongia, Silico-spongia, Calci-spongia, Corneo-silici-spongia, Corneo-calci-spongia, these families containing thirty genera*.

XXVI.—On the Branchial Currents of the Bivalve Mollusca.

By JOSHUA ALDER, Esq.

To Richard Taylor, Esq.

DEAR SIR,

Newcastle-upon-Tyne, 16th August 1849.

It was not my intention again to have troubled you concerning those points in the œconomy of the Bivalves about which Mr. Clark and I are at variance, but the concluding paragraph of that gentleman's letter, in which he claims to have set at rest the use of the anterior siphon in the genus *Kellia*, demands a few words from me, lest my silence should be taken as an acquiescence in such a statement. Perhaps I am also entitled to a reply to the two new arguments by which my opinions are attempted to be disproved.

Mr. Clark has at length given us a distinct statement of his views with respect to the admission of water into the branchial cavity of the bivalves, which he attributes to the opening and closing of the valves alone, and not to the action of cilia. Had this been stated at first, some misunderstanding might have been avoided. Undoubtedly a branchial current entering by a special aperture, whether anterior or posterior, cannot be accounted for by the opening and shutting of the valves. To explain such a current the existence of ciliary action is required; but I was unwilling to believe that a gentleman of Mr. Clark's information could entirely have discarded it. However, instead of arguing this point further, I shall take the liberty of giving the result of some observations made upon two or three species of bivalves since the publication of my last letter.

A small specimen of *Modiola vulgaris*, placed in a glass of sea-water, gradually expanded the margin of the mantle beyond the shell, and protruded the excretory siphon. When these were

* Atti della quinta unione degli Scien. Ital. tenuta in Lucca, 1843, p. 436. The details of this paper have not I believe been published; a short notice however of the three first families appeared about fifteen years ago in Dr. Oken's 'Isis.'

extended to their full length, an action commenced in the surrounding water which was very discernible with a common lens; but for its more careful examination I put the animal under a low power of the microscope, and could then distinctly see that a current of water was passing in at the lower side of the open mantle, partly by the cirriferous portion (as observed by Cuvier and others in the common mussel), but more especially at the part of the mantle just in front of the cirrhi, and between them and the foot. At the same time a very strong current was flowing off by the posterior siphon;—so strong as to communicate a motion in the same direction to the surrounding water and its contents. These two currents continued while the mantle was expanded, but on its withdrawal they ceased, and the animal became quiescent. During the whole of the time the valves remained stationary.

My next experiment was upon *Modiola nigra*, and with exactly the same results. The mantle of this species has the margin perfectly smooth, and is extended in the posterior part of the large opening so as to simulate a second siphon. The current, however, did not go in at the prolonged extremity of this siphonal fold, but at the anterior part of it. The egress-current of the anal siphon was very distinct.

A specimen of *Mactra elliptica* was some time in protruding its siphons, which, as is well known, are long, and united to their extremities. No distinct action of the water could be observed until these were fully extended, and the hyaline valve exerted from the anal siphon. A violent agitation then commenced in the vicinity of the apertures, and, on looking carefully, I could see a current containing floating particles, animalcules, &c. flowing in at the branchial or inhalant siphon; while an ex-current, still more conspicuous, flowed simultaneously from the anal one, sending the water to a considerable distance. At short intervals during this operation a spasmodic contraction of the valves and siphons sent off the water with a squirt; probably at both apertures, but this I could not distinctly make out. At such times only was there any perceptible motion of the valves, which, while the regular branchial currents were flowing, remained stationary and were held a little apart. The water remained motionless opposite the pedal aperture. The strong currents at the extremities of the siphons induce me to attribute a more powerful action to the cilia lining these orifices than I was at first inclined to do, as they are generally much smaller and more difficult to observe than those on the branchiæ.

The only other species I shall here notice is the *Turtonia minuta*. At first the water was observed to pass into the widely open mantle of this little mollusk at all parts of the base of the

shell. This was perhaps owing to the gradual opening of the valves, as afterwards the current appeared to be confined to the posterior portion, and while it was flowing in at that point, I could distinctly see an opposite current passing off at the posterior siphon. This simultaneous action of currents in contrary directions, observed in all the instances mentioned, is surely sufficient to prove the existence of some special motive power distinct from the action of the valves*.

We shall now turn to Mr. Clark's two additional 'proofs,' by which he "proposes to demonstrate" that the water passes into the branchial cavity by *both the posterior siphons, in conjunction with the pedal aperture*, and that it is *expelled indiscriminately in various proportions by all*. The argument is a little obscure, but if admitted in its fullest extent could not demonstrate the whole of this proposition. As far as I can understand it, it is this:—that as "important prehensile organs"—cirrhi and cilia—clothe both the anal and branchial siphons "to entangle and capture the minute animalcules to be conveyed into the branchial cavity," therefore a current of water must pass into *each* siphon to carry them forward to their destination. But the premises are assumptions that require in the first place to be proved. According to my observations, the cirrhi that surround the apertures are not prehensile but only tentacular; their use apparently being to guard the orifices from the intrusion of anything hurtful. The cilia that clothe the interior of the siphons (which I presume are what Mr. Clark alludes to) are neither prehensile nor tentacular, but perform the office usual to these minute organs in assisting to create a current. But why should the food be seized and detained by these organs at so great a distance from the mouth, when it could (and does) flow freely into the branchial siphon by means of the same current that brought it to the aperture? The hyaline valve of the anal siphon would obstruct the performance of such a function by the cirrhi of that aperture. This argument, therefore, instead of being 'irrefragable,' appears to me to prove nothing.

The next argument rests on the literal meaning of the word 'aperture.' In those bivalves whose mantle is entirely open the whole circumference forms only *one* aperture, consequently in these species there cannot be *two apertures* (ingress and egress). True. But there may be nevertheless an ingress- and an egress-current at different points of the open mantle without their interfering with each other: and such is the case in *Anomia*, where a current may be seen to pass in at the anterior base of the shell

* "The respiratory currents are occasioned by the action of cilia, and are not dependent upon the opening and closing of the valves of the shell."—Owen's Lect. Comp. Anat. vol. i. p. 283.

while another flows off posteriorly near the termination of the branchiæ*.

I now come to the most interesting part of Mr. Clark's letter, where he informs us that he has ascertained that *Kellia suborbicularis* is viviparous,—a good discovery: but the supposition that the anterior siphon is only intended as a marsupial pouch for the further development of the ova after their extrusion from the ovarium, is a conjecture not warranted by Mr. Clark's own observations, as he afterwards saw completely testaceous young in the ovarium, thus doing away with the necessity of their being further detained in the open siphon, which is ill-adapted to the office assigned to it. Besides, if such had been the case, it would most likely have been observed before, as from the hyaline transparency of the tube and its wide aperture, it is always easy to see to the bottom of it. That the young escape by this aperture is probable, but this does not prevent its being used for branchial purposes; as in no instance that I am aware of, either in a Bivalve or an Ascidian, is there a separate orifice of the cloak set apart for the extrusion of the ova. All that can therefore be admitted as proved by Mr. Clark's observations, are the viviparous character of the reproduction in *Kellia suborbicularis* and the escape of the young (in one instance at least) by the anterior siphon. May I not add,—it is also proved by equally authentic observations, often repeated,—that both in *Kellia rubra* and *K. suborbicularis*, a special current can be seen to go into this siphon, and at no other part of the circumference of the mantle?

I remain, dear Sir, yours very truly,

JOSHUA ALDER.

P.S. Since writing the above I have had an opportunity of examining the currents in *Pholas crispata*, which I find to correspond entirely with those of the species already mentioned. As however Mr. Garner, in his excellent paper on the *Lamelli-branchiata*, though agreeing in the general existence of ciliary currents received and expelled by separate apertures, yet considers this and some other allied genera to be exceptions, I purpose, with your permission, to treat this part of the subject a little more at large in a separate communication.

* With respect to the range of *Kellia rubra*, Mr. Clark has ascertained that he was right in stating that near Exmouth this species is found beyond ordinary high-water-mark, and often, in calm weather, is only covered by the sea at spring tides. If it has been also ascertained that "thousands of these animals pass their entire existence without perhaps being completely in a condition to receive branchial currents of sea-water," I shall agree that I was mistaken in thinking the account in question overstated. The ordinary range of *Kellia rubra* is within tide-marks.



Alder, Joshua. 1849. "XXVI.—On the branchial currents of the Bivalve Mollusca." *The Annals and magazine of natural history; zoology, botany, and geology* 4, 242–245. <https://doi.org/10.1080/03745486009494825>.

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