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THE STRUCTURE AND HABITS OF PHYSALIA.

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THE last number of the INTELLECTUAL OBSERVER contained a summary of the researches of the older writers on Physalia, from the time of Alexander when it was first noticed by Aristotle as occurring in the Mediterranean, to the year 1843, in which we find it described by M. Lesson in his *Histoire Naturelle des Acalephes*. But, although the more obvious portions of the Physalian structure had already been described at the date of the last-named memoir, it remained for our distinguished countryman Professor Huxley, to advance our previous knowledge of the Oceanic Hydrozoa generally, and to correct many of those erroneous views regarding their organization and morphological relations which were due to the statements of De Blainville, Lesson, and others.

It is the object of the present paper to adduce what further information has thus been rendered available, and, at the same time, to put the reader in possession of some apparently novel facts bearing on the history of Physalia which have fallen under the writer's immediate observation.

Professor Huxley's first memoir on Physalia was forwarded by him in 1847, from the Australian Seas, to the Linnean Society; the more detailed account appearing, however, in his admirable work on *The Oceanic Hydrozoa*, constituting the volume published by the Ray Society for the year 1858.

We find it there stated that "the body of every hydrozoon is essentially a sac, composed of two membranes," an external and an internal, which have respectively been called the "Ectoderm" and "Endoderm."* This sac contains the nutritive fluid which performs the functions of the blood in the higher animals, and is circulated by means of cilia which generally invest the inner as well as the outer membrane and, aided by the muscular contractility of the body, constitute the only circulatory and respiratory mechanism in the organisms under notice. The two membranes may readily be traced in every part of the structure. In the large bladder (which, by the way, closely resembles the swimming bladder of a medium sized haddock in dimension and general outline) they form an outer sac, or "pneumatophore" as it is technically termed, within which the true air-chamber, or "pneumatocyst," is enclosed; the latter being in reality a secondary introverted sac, having the same structure in its walls, and communicating with the outer world by a minute contractile orifice at the point at which the

* By Professor Allman.

inflexion of the pneumatophore or outer sac takes place. This point corresponds with the apex of the more elongated extremity of the pneumatophore. It will thus be seen that there is no communication between the cavity of the pneumatocyst and the general cavity of the organism; but, on the other hand, that a free communication does exist between the general, or "somatic" cavity as it is called, and the space existing between the walls of the pneumatocyst and pneumatophore.

According to Eichwald* and Von Olfers,† the crest is formed of a series of vertical cæcal folds of the pneumatocyst, invested exteriorly, in common with the rest of that body, by the two membranes of the pneumatophore. It is extremely doubtful whether the Physalidæ possess the power of expelling the air from the air-chamber as asserted by some writers. The only reliable evidence of this process is adduced by Eschscholtz,‡ who describes having seen the air voluntarily expelled from a young specimen of Physalia only five lines in length, so that it immediately sank to the bottom of the glass vessel in which it was placed for observation. In the nearly-allied families of Rhizophoridæ and Physophoridæ, in which the pneumatocyst consists only of a minute spherical or pyriform vesicle, I have repeatedly seen the creatures suddenly sink to the bottom of the glass on being irritated, but without any appearance of collapse of the air-cell. In the young Physalidæ the character of the air-cell ("pneumatocyst") is identical with that of the adult Physophora and Rhizophora, but no amount of irritation ever caused the specimens to contract the air-cell or sink, although their polypites and tentacles exhibited sensibility to the slightest touch, or even vibration of the glass, by becoming instantly coiled up close to the body.

During the long-continued calms at the equator, extending sometimes over several days, when the surface of the sea is literally as smooth as a mirror and as pellucid as crystal, I have had ample opportunity of watching Physalia, and have in no instance observed the float collapse, or the creature sink beneath the surface. Under the above conditions it becomes manifest that the creature is wholly devoid of power to move to and fro; the individuals remaining, as it were, fixed in the same spot, and evincing no signs of vitality beyond a partial collapse of the crest, occasional abrupt changes in the direction of the axis of the pneumatophore after the fashion recorded by M. de Quatrefages§ and Professor Huxley (*loc. cit*), a gentle dip over on one side—probably with a view to moisten the surface

* *Mem. de l'Acad. Imp. des Sciences de St. Petersbourg*, 1824.
† *Abhandlungen de Kön. Akad. de Wissenschaften zu Berlin*, 1831.
‡ *System du Acalephen*, 1829.
§ *Annales des Sciences Naturelles*, 1853.

which must become more or less parched by the fierce rays of the tropical sun,—or a few lazy oscillations in answer to the never-ceasing swell of the ocean. These are the only movements which present themselves during calms, but a far more remarkable phenomenon has repeatedly been noticed by me in moderate weather when the ship is passing along at a speed of not more than three or four knots an hour, and its impetus is sufficient to transmit delicate undulations for some distance along the surface of the water, although there is not sufficient wave-action to interrupt observation. Under these circumstances, each Physalia, as it comes abreast of the ship, even when at a distance of from thirty to sixty yards, gently inclines its pneumatophore and crest to one side so as to rest laterally on the water, and only regains its original posture when the ship has advanced far enough to prevent the transmission of the undulations. That the sensibility to the mechanical disturbance thus produced at the surface of the sea must be intensely acute is evident, inasmuch as the effect is visible far beyond the range of any surface disturbance observable by the eye. Hence it would seem to be aroused, not by the ordinary wave-action by which the creature happens to be surrounded, but by the subtle abnormal character imparted to that action by the passage of the ship. It is hardly necessary to state that, since no nervous system can be detected in the Physalidæ, there are, at present, no data even for speculation on the physiological aspect of this highly curious phenomenon; and it must be obvious that any attempt to account for it on the supposition that the acts in question are the result of direct mechanical irritation, is simply substituting one unexplained fact for another. At present, therefore, I have only to record the act of the "Portuguese man-of-war" as one of very frequent occurrence, leaving it to more imaginative minds to trace back the existing mode of salutation between vessels at sea designated "dipping the colours," to this primæval source.

According to my own experience, the Physalidæ never sink below the surface as has been asserted, but merely become lost to sight in the wave-disturbance when the weather is stormy; their peculiar colour and bubble-like aspect causing them to be undistinguishable from the element by which they are surrounded when at any distance from the observer's eye. This view derives confirmation, moreover, from the fact that they are frequently entrapped by the towing-net when not a single specimen can be seen, owing to the reason assigned.

The inclination to one side and re-erection of the pneumatophore, to which reference has been made, is slowly performed, (each operation occupying from three to five seconds) and would seem to be effected by the contraction of the muscular wall on the side towards which the inclination takes place. Besides this, the creature has the power of raising up, into a nearly vertical position at times, the free extremity of the pneumatophore. Even when taken out of the water, and placed on any hard surface, this portion of the creature continues to move, thus indicating that the act is due to muscular contractibility of the walls of the air-chamber, and not to the mere change of axis, alluded to by M. de Quatrefages, which is due to the sudden contraction of the tentacular appendages now about to be described.

On the inferior surface of Physalia there exists what appears, at first sight, to be only a confused mass of tentacular and suctorial organs. This mass consists of a duplicature of the general substance of the body, termed the cænosarc by Professor Huxley, from which three kinds of organs are given off, namely, the "Polypites," the "Tentacles," and the "Hydrocysts." The first are variable in number and size, and, according to the author just named, constitute the "principal organs of alimentation." In outline they are somewhat pyriform or flask-shaped, and during the life of the creature are in continual motion; the broad open discoidal end being that which is dependent, whilst the short pedunculate extremity is that by which they are attached to, and communicate with, the cavity of the cænosarc. Although these organs serve the purpose of stomachs, they also possess the prehensile power imputed to them, as may readily be seen in specimens placed in confinement. The interior of the polypite is furnished with villous projections, by means of which digestion and absorption are said to be effected, and the nutritive products conveyed into the general cavity of the body. The hydrocysts, which differ in no aspect from the polypites, save in being completely closed externally, have been regarded by Professor Huxley as "young stomachs."

The tentacles, in like manner with the polypites, are variable in number and length, one being, however, generally much longer than the rest. Each one is furnished at its point of attachment with a jelly-bag-shaped sac, the mouth of which communicates with the general cavity, and, along its upper half, with that tentacle to the side of which it is adherent. The tentacles in their contracted state are only a few inches in length, whilst, in their extended condition, they often attain a length of from four to six feet. They are formed of longitudinal highly contractible fibres, each of which averages from $\frac{1}{2500}$th to $\frac{1}{1700}$th of an inch in diameter; the united fibres, when extended, constituting a flattened band somewhat thicker on one side than on the other, along which are attached at intervals, crescentic masses composed almost wholly of thread capsules.

These masses do not embrace the entire circumference of the band, but only three sides as it were; the fourth being left free along its whole length. It is in the thread capsules that the peculiarly acute stinging power of the Physalidæ resides; although, as yet, both the chemical composition and the mode of secretion of the poisonous fluid with which the threads are embued, is altogether unknown. It is almost certain, however, that the extension and contraction of the tentacles is attributable to its own muscular structure, and not to the injection of the poisonous fluid supposed by Lesson and others to be a secretion of the basal saccular appendage already referred to.

The extensile quality of the tentacle is very remarkable. Thus I have repeatedly succeeded in winding it on a card by merely placing the animal on a board during the operation, and reeling off the thread, which, by this means, is reduced in thickness to that of fine silk, and may be continuously wound until it attains a length of eight or ten yards. This filament, when dried in the sun, will keep for any length of time, and forms a beautiful object for the microscope; the fibrillæ of the muscular band and the crescentic bundles of thread-cells being admirably seen, whilst their original colour is in nowise destroyed.

My endeavours to preserve the pneumatophore by drying in the sun, were invariably unsuccessful for, although it remained distended and its upper and lateral portions acquired the tough consistence of a dry membrane, the setting in of decomposition along the inferior fleshy portion always ended in its rupture. Small specimens of the allied family of Velella, however, which were preserved on glass slides by a similar process of drying, in 1857, are still in my possession, together with the delicate tentacles of Physalia just alluded to.

Although there cannot be a doubt that nutritive organisms, probably consisting of minute Entomostraca, Infusoria, or Rhizopoda, are seized after having been paralysed by the urticating organs of the tentacles and polypites (for these bodies also occur in the latter appendage), there is, I think, good reason to suspect that Mr. Bennett, who describes the process of fish capture by a Physalia, must have been misled as to the cause and effect of what he witnessed, for the following reasons: In a great number of cases the Physalia is accompanied by one or more small fishes, precisely in the same manner that the pilot-fish accompanies the shark. These fishes swim round and round and through the depending tentacles without inconvenience, and their association with Physalia is undoubtedly one of choice, being in all likelihood due to the quest of some kind of food which is attracted towards it, or furnished through its excretions. I have so repeatedly witnessed this association, and captured both Physalia and fish in the small hoop casting-net I was in the habit of using, that I can confidently state there is no hostility between them under ordinary circumstances, and that the mere contact of the fish with the tentacles of the former does not result in any observable inconvenience to either animal. The fish (according to Dr. Günther, who very kindly examined my sketch and favoured me with his opinion) is probably either a young form of one of the Scombridæ, or, if mature, a member of some unknown genus. It is curious, however, that the specimens captured by me over a wide area of the Atlantic, invariably belonged to the same species, and were, as nearly as possible, of one size; that is to say, from two to three inches in length; the colour on the back being a deep blue, identical with that of the cænosarc and body of the polypites of Physalia. Nor was this fish the only attendant on it; for, crawling about within the mass of polypites and tentacles, I as often found several Isopod crustaceans, from a quarter to three-quarters of an inch in length, evidently parasitic in this position. The same species was also observed by me frequently on the float of Ianthina, and on floating epiphytic Lepadidæ. Here, again, it is clear that the urticating organs are innocuous, inasmuch as partially devoured or dead specimens were never met with.

Lastly, I have not observed the marked iridescent quality which has been stated to accompany the brilliant tints of the Physalidæ. The colours themselves are extremely rich, the contrast afforded by the roseate pink of the upper margin of the crest, and the graduated tints of blue, commencing with the faintest opalescence on the upper surface of the pneumatophore, to the deep and almost full-toned indigo of the cænosarc and appendages, being very striking. Intermixed with these colours are the greenish streaks which mark the outlines of the cæcal chambers of the crest, and the root-like continuations of the velvety dark-coloured mass beneath. The minute mammiliform protuberance at one extremity of the pneumatophore is also of bluish green, whilst the walls of the air cavity itself, although almost colourless, reflect the images and tints of passing objects in the same manner as a soap-bubble, but without any greater amount of iridescence than is perceptible in ligament.

Of the mode of development of the embryo and of the air-chamber in the Physophoridæ generally, nothing is at present known; the young Physalia having only been seen when already so far advanced in growth as to constitute a nearly perfect, though comparatively minute, individual. In like manner we have still much to learn regarding the true basis of specific distinction in this class of organisms; the older authors having adopted distinctions which now-a-days would hardly be admissible as indicative of varieties.

These, then, are the more prominent characters of this remarkable and beautiful genus of Hydrozoa. They have been given somewhat in detail, with a view to incite "those who go down into the sea in ships" to extend our knowledge; and to prove that, at all times and under nearly all circumstances, the voyager may find ample food for the mind, and a far from exhaustible field for the instruction of his fellows.

PROFESSOR LAMONT'S NEW THEORY OF ATMOSPHERIC VAPOUR.

BY ALEXANDER S. HERSCHEL, B.A.

THE experiments of Dr. Dalton on the pressure of vapour rising from the surface of water at different temperatures, in free space and in space enclosing air, led to conclusions which have since been received by the compilers of meteorological tables, but which are questioned by M. Lamont, and shown by his experiments to be in some degree fallacious. The vapour of boiling water, or of water at 100° centigrade, is familiarly known by the vibrations of the lid of a kettle, and by the formation of bubbles upon the surface of the heated water, to have the pressure of the incumbent atmosphere. The bubbles which rise to the surface of water boiling in an open vessel enclose within their pellicle a vapour whose tension or elastic force is exactly equal to that of the equally heated air which surrounds their envelope, and burst so soon as the quantity enclosed exceeds a capacity proportioned to the thickness of the film. The experiments of Dalton proved that the vapour so enclosed was lighter than the air surrounding, in very nearly the proportion of 2 to 3. It follows, by Mariotte's law of equable expansion of gases or vapours by heat, that such vapour and such air exposed to any superior equal temperature, will have to each other the same proportion, in density, of 2 to 3; but a further deduction from the experiments of Dalton is this, that water boiled in a partially exhausted receiver of air, will give rise to bubbles which enclose a vapour having equally a proportion in density of 2 to 3 to the adjacent air. In short, the vapour of water and common air, wherever these subsist at a common temperature and pressure, are always in the proportion in density of 2 to 3 one to the other. We here consider the case of water boiling in air. The pressure of the incumbent air being in this case the exact measure of the elastic force or