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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

“..... per litora spargite muscum,
 Naiades, et circum vitreos considite fontes:
 Pollice virgineo teneros hic 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 conchyliis succo.”

N. Parthenii Giannettasii Ecl. 1.

No. 49. JANUARY 1872.

I.—*On the Abyssal Theory of Light, the Protozoic-Absorption Theory, and the Azoic-Mud Theory, propounded in the Reports of H.M.S. ‘Porcupine,’ 1869 and 1870.* By W. C. M’INTOSH.

IN recording the following remarks I must disclaim any intention to cast reflections on the scientific energy or the experience of marine animals of the three excellent naturalists who were chosen by the Royal Society to represent British zoologists in these expeditions. Such would certainly be unworthy, more especially as I had the pleasure of receiving (through the intervention of Mr. Jeffreys) part of the collection of Annelids (all from a depth of less than 500 fathoms) in the first expedition, and the whole of the Annelida of the second. Having made this necessary acknowledgment, I must also admit that certain parts of the reports of my friends struck me at once, on hearing the first read and on perusing the second, as being slightly at variance with my own views on such subjects. Some of the latter, however, are points on which more than one opinion may be held; and the following remarks*, therefore, are intended to be tentative rather than dogmatical.

* These were included for the most part in a paper read before the Royal Society of Edinburgh, on the 1st of May, 1871.

1. *The Abyssal Theory of Light.*

The distinguished dredgers in the expeditions were struck by the luminosity of many of the animals procured from great depths in the Atlantic, such as Alcyonarian Zoophytes, Brittle-stars, and Annelids. In some places, indeed, the mud itself was full of luminous specks*. In their Report on the Dredgings of 1869†, they broach the idea that the abyssal regions might depend solely for their light upon the phosphorescence of their inhabitants, and that this luminosity in the dark abysses of the sea fulfils, in regard to the great object of the supply of food, the functions performed in the upper world by the light of day. In other words, the phosphorescence of an animal would, on the one hand, enable it to see its prey, and, on the other, would discover it to its enemies‡. Moreover, according to the report, since the young of certain starfishes are much more luminous than the adults, it is probable that this is part of the general plan which provides an enormous excess of the young of many species, apparently as a supply of food, their wholesale destruction being necessary for the due restriction of the multiplication of the species, while the breeding individuals, on the other hand, are provided with special appliances for escape or defence.

Now, without entering on the present occasion into the literature of the subject (a labour which has been so ably accomplished by Ehrenberg, De Quatrefages, and other authors), it will be seen, on referring to a single passage in the article on this subject (Todd's *Cyclopædia*) by the late accomplished Dr. Coldstream, that marine zoologists have long been familiar with such notions. "Considering," says Dr. Coldstream, "that in the ocean there is absolute darkness at the depth of 800 or 1000 feet (133-166 fathoms), at least that at such depths the light of the sun ceases to be transmitted, Macculloch has suggested that, in marine animals, their luminousness may be 'a substitute for the light of the sun,' and may be the means of enabling them to discover one another as well as their prey. He remarks, 'It seems to be particularly brilliant in those inferior animals which, from their astonishing powers of reproduction, and from a state of feeling apparently little superior to that of vegetables, appear to have been in a

* We shall suppose that due precautions were taken to prevent the entrance of the myriads of surface-forms.

† Proc. Royal Soc. No. 121 (1870), pp. 431, 432.

‡ Thus a young *Hyas araneus* having dense tufts of *Obelia geniculata* waving from its carapace and limbs, must, on the one hand, like an Indian beauty with her fire-flies, be the cynosure of all (predatory) eyes, and, on the other, be enabled to throw such a flood of light on the food-question as to distance many rivals.

great measure created for the supply and food of the more perfect kinds.'"

Phosphorescence, however, is a feature so broadly and diversely distributed amongst marine animals, not only abyssal, but pelagic and littoral, that, on a careful view of the subject, some objections to such a theory present themselves.

On land the idea that the phosphorescence of certain insects (*Lampyris*, *Elater*, &c.) may guide them to their prey, was early promulgated by entomologists (*e. g.* Kirby and Spence). Further, since the light in *Lampyris* is usually most brilliant in the female, it has been connected with sexual characteristics, especially as these females are wingless; but it must be remembered that both larva, pupa, and male are likewise luminous. The provision, besides, continues after the reproductive season. The luminous myriopods, again, show that the presence or absence of wings has little to do with the matter. Kirby and Spence have also observed that certain insects can control their phosphorescence, in order, as they suppose, to escape being captured by nocturnal birds. On the whole, we can scarcely predicate of such animals, any more than the botanists can with regard to the Fungi, that their luminosity subserves them for the light of day.

Amongst the inhabitants of the ocean, phosphorescence appears in all the invertebrate subkingdoms, from Protozoa to Annulosa. Certain infusorial animalcules (*Ceratium*, *Peridinium*, *Synchaeta*) and the well-known *Noctiluca* are luminous. Of Cœlenterata there are Hydroid Zoophytes, true Medusæ, and Aleyonaria; while *Pyrosoma* and, it may be, others are similarly provided among the mollusks. In the Annulosa, again, there are Brittle-stars, *Planariæ*, Annelids, and Crustacea.

If, as the report says, luminosity subserves the purpose of guiding animals to their prey, or of causing them to be preyed upon (an unfortunate result), or even of illuminating the abysses of the ocean, we should find traces of a general resemblance in habits, structure, or physiology, which would at least indicate the bearings of a provision so important. Thus, for instance, we should look for a similar state of matters in the dark caves of Illyria and Dalmatia, or in those of Kentucky.

On surveying the marine animals possessed of this property of phosphorescence, they are found to live under circumstances so varied that it is truly difficult, not to say hazardous, to attribute the function assigned in the report to the phenomenon. Thus *Noctiluca miliaris* occurs in such swarms as to give the whole surface of the ocean a sparkling appearance. Mere blowing on the surface of sea-water taken at random

in July off many of our shores where *Laminariæ* abound, produces phosphorescence from a vast number of minute medusa-buds. The same takes place most strikingly in vessels in which specimens of *Obelia geniculata* attached to tangle-blades are immersed. On touching the seaweed, a large number of such luminous points appear on the zoophytes, the stems most irritated sending off beautiful flashes, which glitter like a faintly dotted line of fire, the points not being harshly separated, but blending into each other; while the shock imparted by the instrument detaches the minute medusa-buds, which scintillate from the parent stem upwards to the surface of the water. Dr. Allman would therefore have found this a much more interesting species for his observations than *O. dichotoma* *. The immense abundance of these minute phosphorescent organisms (medusa-buds) in some parts of the Zetlandic seas may explain the following fact, reported to me by Mr. Gatherer, the intelligent naturalist of Fort Charlotte, Lerwick. During the prevalence of a south-easterly gale, the late Dr. Cowie, of Lerwick, was riding at night along Deal's (or Dale's) Voe, when, happening to touch his beard, he found both it and his fingers gleam with phosphorescent points; and the same ensued on rubbing his sleeve. The gale had probably swept the spray and thousands of its minute inhabitants landwards, and showered them on the person of the rider.

If *Thaumantias*, or any other phosphorescent Medusa, which, when swimming freely, has its disk-margin shining like a dotted fiery ring of great beauty, be taken from the water and rubbed on a woollen surface, such as a carpet, a considerable luminous area is produced, showing that the entire mass of the animal has this property when thus violently irritated; moreover the surface just mentioned, as well as the fingers, remain in a gleaming condition for some time. I am aware that this view slightly differs from that of so distinguished and so cautious an observer as my friend Mr. Busk, who, along with Dr. Allman and probably Panceri, confines the seat of light to the marginal tentacular bulbs; but I cannot conscientiously say otherwise†. If *Beroë* be treated in the same rough manner, it is found to be less phosphorescent, and the luminosity of the area disappears sooner. It did not signify, in any case observed by me (*Beroë* excepted, as I did not examine it especially on this point), whether the examination were made at

* This author (Proc. Roy. Soc. Edinb. vol. iv. p. 519) is of opinion that *Beroë* and other Ctenophora are among the chief sources of the phosphorescence of the sea in our latitudes.

† The state of matters in *Aphlebia*, where the light gleams along the simple tentacular processes, supports this view.

night or by day in a darkened room or recess ; and this feature of itself would raise a doubt as to such having any connexion physiologically with the capture of prey or of being conspicuous to marauders.

The free gonozoids of many of the Hydroid zoophytes, therefore, and the true Medusæ are pelagic and phosphorescent animals, whose active life is passed at or near the surface of the water, so that they can scarcely be included under the head of abyssal inhabitants, though some descend during quiescence to the bottom. We have no proof that the luminosity of such forms occurs only at night ; for, as before mentioned, I have found various species, like the annelids and the Coleopterous larva recently described by Dr. H. Burmeister*, exhibit this property as vividly during the day as during the night, if taken into a suitable place for observation, and without any previous seclusion in darkness as described by Dr. Allman in *Beroë*. Medusæ, besides, do not, so far as I know, form a common food of other marine animals in our seas (their most notable enemies, perhaps, in this respect being each other), and their habits and structure do not point to their exercising the luminosity for the sake of seizing their prey. Moreover there does not seem to exist the provision mentioned in the report, whereby, in virtue of their lessened phosphorescence, the breeding individuals are preserved. There is nothing in the history of *Pennatula* or *Pavonaria* which would lead us to infer such interpretations of their luminosity ; and though the former sometimes occurs in the stomach of the cod, it must be borne in mind that inconspicuous mollusks and annelids are at least as common, not to mention stones and iron nails.

Phosphorescence could be of little service to the brilliant *Pyrosoma* in capturing prey ; and, to balance the fancy that this was given for the sake of attracting plunderers, we have the fact that the allied and equally palatable *Salpæ* of the British waters are not luminous.

It is asserted that the young of the starfishes emit more light than the adults in order that they may the more readily court destruction ; but it may be asked, are the young of the Hydroid Zoophytes, of *Beroë*, or the young Annelida more luminous than the adults ? Apparently not ; and in some cases rather the reverse. Further, we may inquire as to the facts bearing on this question in those starfishes which are not phosphorescent. The structure of the group and their habits in feeding, again, show that such illumination could only be of service to their enemies. But we have no reliable data to

* Proc. Linn. Soc. (Zool.), vol. xi. no. 54, p. 419.

demonstrate that one marine species which is luminous is more preyed on than another which is not.

Some interesting features are presented by the Annelids. *Chaetopterus norvegicus*, for instance, is a most beautifully phosphorescent form, bright flashes being emitted from the posterior feet; but the most vivid luminosity is at a point on the dorsum between the lateral wings of the tenth segment. Here the copious mucus exuded by the animal can be drawn out as bluish-purple fire of great intensity, which, besides, now and then gleams along the edges of the wing-like processes, at once illuminating the surrounding water and eliciting the admiration of the observer. A very characteristic odour, somewhat resembling that produced by phosphorus in combustion, is given out by the animal during such experiments. The common *Harmothoe imbricata*, again, discharges bright greenish scintillations from the point of attachment of each dorsal scale; and thus, under irritation, the flashes are arranged in pairs along the body, or in a double moniliform line. The separated scales, also, continue to gleam for some time, chiefly at the surfaces of attachment. If severely pinched, the worm wriggles through the water, emitting sparks of green light from the bases of the feet. The same phenomenon is readily produced in a fragment either of the anterior or posterior end of the body. The large *Polynoë scolopendrina* and a Zetlandic *Eunoa* are similarly phosphorescent, the light proceeding from the dorsal surface of the bases of the feet. A *Eusyllis* common under stones and on the blades of tangles is also highly luminous. Under irritation, a fine green light is emitted from the ventral aspect of each foot. The scintillations seem to issue from many minute pores at each space, flash along both sides of the worm posterior to the point of irritation, and then disappear, a faint trace only being visible for a few seconds. On one occasion, after a severe pinch, the animal remained luminous behind the injured part for nearly half a minute, while the surface of granular light on each segment was larger than usual; and in some instances those of opposite sides were connected on the ventral aspect by a few phosphorescent points. Moreover, for some time after, mere shaking of the vessel caused a repetition of the brilliant flashes. The body behind the irritated point had a decidedly paler pinkish hue (under a lens) immediately after the emission of the luminosity. When at rest, a spark appeared here and there at intervals. As in all such marine forms, immersion in spirit elicited the luminosity, a moniliform band of greenish phosphorescence (brightest at the tail) being instantly produced on each side: at the end of five minutes

the body was still faintly luminous, while from the injured points the soft parts protruded. A pale *Aphlebina* (*Polycirrus*), very generally distributed, is so phosphorescent that, on simply blowing on the water of the dissecting-trough or other shallow vessel in which it lies, the most vivid pale bluish luminosity gleams for a moment along every one of the mobile tentacles, which are often elegantly disposed in a stellate manner.

Now, with the exception of *Harmothoe imbricata* and *Eunoea*, all the luminous annelids above-mentioned are inhabitants of tubes of greater or less density. *Chaetopterus* lives under stones between tide-marks, amongst old shells and stones in deep water, or sunk in sand and gravel at low water in tubes resembling thick parchment covered with pebbles, shells, and seaweeds. *Polynoë scolopendrina* frequents the tubes of the speckled *Terebella nebulosa*; indeed I have never found it anywhere else than in these or similar galleries. The latter species is not luminous, while the former is; yet both are placed under the same circumstances, and, of the two, perhaps *P. scolopendrina* has less need for such extraneous aid in procuring nourishment. Many of the Polynoidæ which have similar habits are not phosphorescent, while the succeeding form, which greatly resembles *Terebella* in habits and structure, is luminous. With such a varied history, the only theory that seems feasible is one which would endow the *Polynoë* with the property of attracting prey for the benefit of *Terebella* or itself—a somewhat analogous part to that ascribed by the fancy of the older naturalists to the pea-crab in the horse-mussel! The yellow *Aphlebina*, again, a close ally of *Terebella*, is beautifully phosphorescent. This and the two foregoing are comparatively safe from the attacks of marauding fishes or crabs, the two former in tubes immersed in sand or under stones, and the latter in obscure chinks and fissures of muddy rocks, boulders, and old shells. It will not do to affirm that they are protected because they are luminous, since many species which are not so have exactly the same habits and shelter, while other phosphorescent annelids are without such a safeguard. Lastly, *Eusyllis* occurs in swarms in delicate tubes on Laminarian blades covered with *Obelia*, as well as under ascidians on stones between tide-marks. The effect produced in its former situation may sometimes be seen on a gigantic scale on the West Sands at St. Andrews, after a heavy storm has tossed on shore a bank of tangles and other seaweeds about a mile long. Throughout this extent, wherever the people are engaged at night in securing the valuable mass as manure, countless myriads of minute glittering points cover the seaweeds, carts, and weapons. Whether the phosphorescence be

due to the zoophytes, the annelids, or both, does not signify for our argument. Both are found between tide-marks, and in immense quantities in the Laminarian region immediately beyond, where there is abundance of light. Neither, therefore, supposing it were able to profit by that gift, requires its luminosity to aid it in its search for nourishment; nor do the Nudibranchs which prey on the zoophyte, or the devourers of the annelid, stand in need of this artificial guide to their respective means of support.

The abyssal theory of light thus gains little succour from the Annelids.

It is stated in the report that, since fishes feed principally at night, the phosphorescence of the larvæ on the surface, for instance, is an example of a provision for feeding the herring. The stomachs of cod, haddock, whiting, flounders, and other fishes, however, give no such result in regard to luminous annelids. Even if such were the case in the herring, it would not be a solid basis on which to found the abyssal theory of light.

On the whole, then, the present state of our knowledge does not warrant the supposition that luminosity is given to marine animals for the purpose of preying or being preyed upon; moreover, that the abysses of the ocean are not better supplied with this provision than the littoral region and the shallow Laminarian zone—indeed much less than the surface of the sea itself. It may yet be a question, according to some observers, whether the phosphorescence may not in some cases act a part exactly the reverse of alluring, and so tend to preserve the species from attack. A speculation to this effect could be as easily established as the foregoing. The theory has much of the visionary character of CErsted's scheme as to the occurrence of marine animals in variously coloured strata corresponding to the solar spectrum; and some other explanation must be advanced as to the presence of well-formed eyes in certain animals at great depths in the sea.

2. *The Protozoic-Absorption Theory.*

In regard to the speculation that marine Rhizopoda have the power of absorbing, after the manner of the Entozoa, the organic matter which certain analyses of oceanic water showed to exist therein, some reflections suggest themselves.

In the first place, there does not appear to be any serious difficulty in accounting for the supply of nourishment to the abyssal Rhizopoda, since the whole ocean lies at their command. Minute organisms and minute organic particles of all kinds surely abound, and currents, however slow, must bring a constant supply for even a larger population of such micro-

scopic animals than has yet been discovered*. Besides, the minute jellies and disintegrating particles of their fellows of the deep are not unpalatable, and probably in many cases are preferable to "diffused protoplasm" imbibed by their surfaces.

If the reporters had prefixed to their theory†, which is clearly a modification of Dr. Wallich's‡, a statement of a series of exact scientific experiments proving that the Protozoa in question, or other free animals, lived not upon minute organic particles, as other Rhizopoda do, but upon this invisible "protoplasm" diffused through sea-water, or if they had observed that when disintegrating particles were placed near such Rhizopoda there was no contact, but only a patient expectation till the protoplasm got diffused through sea-water, so as to enter their tissues by absorption, then there would have been a basis for their argument. Such a foundation there would have been, also, if they had stated the fact that the beautiful and highly complex *Eunice norvegica*, an annelid five inches long, provided with intricate dermal, muscular, digestive, nervous, circulatory, branchial, and other systems, can be preserved alive in fifteen ounces of the purest (unchanged) sea-water, in a clean glass vessel§, for three years—that large Nemerteans, like *Lineus marinus*, can be kept for a longer period, and regenerate lost portions of their bodies (though their general bulk diminishes), no trace of nourishment of any kind being visible, nor any change made in the water. Further, they might have drawn upon their experiences in this respect with many other Annelids, Echinoderms, Mollusca, and Coelenterates, and called attention to the remarkable tenacity of life in sea-water, under apparently complete absence of all nourishment; and, reviewing such facts by the light of their discovery of "decomposable organic matter," might have shown that, since animals so highly organized thus sustain life in sea-water, there must be some inherent aliment, capable of absorption, therein, and consequently that there can be no difficulty in believing that vast myriads of animals of the simplest structure live altogether on this pabulum in the ocean-bed.

The mere occurrence of some "decomposable organic matter" (to wit, "dilute protoplasm") in sea-water in general, or any sea-water in particular, it appears to me, cannot be balanced for a moment in such a case against well-ascertained facts as to the mode of nourishment in the Rhizopoda. Be-

* An interesting paper bearing on this question has recently been published by Dr. Karl Möbins, Zeitsch. w. Zool. xxi. Bd. 2. p. 294, and Ann. Nat. Hist. ser. 4. vol. viii.

† Proc. Roy. Soc. No. 121, p. 476 *et seq.*

‡ North-Atlantic Sea-bed, pt. i. p. 131.

§ A jar with a glass cover.

sides, it is well known that a large quantity of organic matter in solution ("diffused protoplasm" be it called) exists in many freshwater lochs and ponds; yet it has not been brought to light that the Rhizopodous faunæ of these ever resort to this old prescription of nutritive baths, after the fashion of the Gregarinæ and other parasites*.

Moreover it does not seem to be a sound inference to assert (and this also is a modified form of Dr. Wallich's argument) that, because the Protozoon has the power of "drawing" from the sea-water "the mineral ingredients of the skeleton it forms," it is nourished by direct absorption of the "dilute protoplasm" so conveniently dissolved in the surrounding medium. So far as our experience of such formations goes, the calcareous and siliceous spicula and the horny fibres of sponges, the tests of Foraminifera, and other such organisms are (of course with the exception of the instances in which foreign bodies are used) as much the peculiar secretions and excretions in virtue of the inherent properties of their tissues as the crystalline styles in the gastric organs of certain mollusks, the stylets in the Nemertean proboscis, and the spicula of the Echinoderms. It is no rough "drawing" of "mineral ingredients" from the sea-water which takes place at all, but a much more intricate vital process; for, just as the primitive layers in the vertebrate embryo form the respective classes of tissues, as each annelid produces its characteristic bristles, each *Synapta* its peculiar anchors and plates, each armed Nemertean its stylets, each mollusk its shell, and each coral-polyp its special mass, so the elementary tissues in the several Rhizopoda as invariably secrete or excrete their peculiar internal or external "skeletons," and that, too, in many cases, as infallibly as though each had inherited the "die" from its ancestor. It is true that in marine animals the surrounding medium is favourable, but this will not of itself affect the main question at issue. The same line of argument used by the reporters may be applied to every other subkingdom of animals inhabiting the ocean, from mammals to cœlenterates; yet it is highly problematical if a minute coral-polyp would rest satisfied with a meal of this "dilute protoplasm" any more than, in our opinion, a Protozoon would. The speculation does not appear to be worthy of confidence.

3. *The Azoic-Mud Theory.*

In the summary of the results of the last cruise of the

* It is a pity the solution of "protoplasm" was not a little stronger; for thereby many marine animals, such as *Arenicola*, would have been saved some trouble.

"Porcupine," Dr. Carpenter, who assumes the entire responsibility of this part of the Report*, has advanced the theory that it is the *turbidity of the bottom-water* which renders the deeper parts of the basin of the Mediterranean barren of life. "All marine animals," he says, "are dependent for the aëration of their fluids on the contact of water either with their external surface or with special (branchial) prolongations of it. Now if this water be charged with suspended particles of extreme fineness, the deposit of these particles upon the respiratory surface will interfere with the aërating process, and will tend to produce asphyxia." He further cites the case of oyster-beds, which cannot be established in situations to which fine mud is carried. He, moreover, points out the important bearing this theory of his will have in regard to the vast azoic deposits of the geologists, who, since the lapse of Prof. E. Forbes's views as to the absence of animal life at great depths, have been puzzled for a solution of the difficulty. Such a theory, of course, ought only to be built on well-ascertained facts, some of which, however, do not seem quite in agreement therewith.

Thus *Terebellæ* and *Gephyrea* in vast numbers are characteristic of muddy beaches, such as those between St. Peter Port and St. Sampson's, in Guernsey, and near Rat Island, Herm. Not only these, but many other annelids are found nowhere else than amongst mud or muddy sand, and this is often of such a nature that the sea-water which covers them must always be loaded with minute particles of mud. So distinctly is this the case, as at Lochmaddy, that the fronds of the seaweeds (both those covered and those uncovered by the tide) in quiet creeks are coated with a deposit of fine mud. Yet marine life, from sponges upwards, is nowhere more abundant than in such muddy regions. Indeed the contrast in this respect between these creeks and the rocks washed by open (not rough) water is marked.

Certain mollusks, it may be true, like very young salmon, do not thrive in muddy water, yet some of the most delicate and beautiful annelids, with the finest branchial plumes, live amongst the most tenacious chalk-mud, as it is called, which it has been my lot to encounter. Yet these annelids are so sensitive to other impurities that a very slight admixture of fresh water (although the supply be taken from the sea) is instantly fatal, as I, unfortunately, have reason to remember. The habits of the littoral annelids are also instructive in this respect. Many of the *Polynoidæ*, *Ophiodromus*, numerous *Nereidæ*, *Lumbrinereis*, the large *Marphysa sanguinea*, *Onu-*

* Proc. Roy. Soc. No. 125 (1870), p. 202.

phis (*Hyalinæcia*) *tubicola* (in deep water), *Arenicola*, several of the *Spionidæ* (e. g. *Nerine foliosa* and *Scolecoplepis vulgaris*), *Cirratulus*, *Sabellaria*, many of the *Terebellidæ* and *Sabellidæ* habitually live amongst mud or ooze, often of a putrid description, while *Tubifex* and other annelids swarm in the mud of the Thames. Some of the Nemerteans, again, a group of animals with most sensitive ciliated skins, which, moreover, are supposed to subserve the purposes of respiration, live constantly amongst fine and often odoriferous mud. No branchial organs can be more delicate than those of many of the above-mentioned annelids, and no skins more tender than those of the Nemerteans; yet, according to this theory, they are placed in most unfavourable circumstances, to a very great extent more calamitous than the condition of any denizen of the muddy depths of the Mediterranean can be. They must, indeed, pass a life alternately of asphyxia and semiasphyxia. Further, the curious type *Balanoglossus*, Delle Chiaje, has an elaborate and delicately ciliated branchial apparatus, forming part of the dorsal arch of the first region of the alimentary canal, the only possible separation, as shown by Kowalewsky, being by an incurvation of the body-wall, which, of course, can hardly be complete. Now this animal lives in muddy sand, and swallows it wholesale, so that, not to speak of the currents of muddy water which otherwise bathe its respiratory organs, we have at least an occasional application of mud in mass to this important surface.

In glancing at the other divisions of the animal kingdom, also, we observe that many littoral sponges are found on extremely muddy ground, in some the terminal spicula alone being visible through the oozy coating. The siliceous sponges, again, all over the world, affect a muddy bottom: Muddy ground is a favourite haunt of zoophytes and other coelenterates. In the sandy mud of certain parts of the West Voe of Scalloway (where, by the by, a few oysters are) *Scrobicularia* and other mollusca live and thrive; yet the stinking odour of the ooze is most penetrating, the comparatively still water probably preventing the decaying tangles and other débris from being carried off. Other mollusks, such as *Corbula gibba*, abound on a muddy bottom; and ascidians and mussels are not only powdered by the mud of their respective sites, but the latter are often almost imbedded in it. Those familiar with the habits of the common *Carcinus menas* would be cautious in attributing a deleterious character to mud of any description. In general, muddy ground is found to be much more productive in marine life of all kinds than where the rocks, seaweeds, and sands are pure. I need only instance, in

conclusion, the muddy ground on which the horse-mussels thrive in Bressay Sound and in the Voes on the west coast of Shetland. The agglomerated masses of mussels, tangle-roots, stones, and odoriferous mud teem with marine life. Even where the margin of the sea is rendered perfectly turbid from mud (and this, too, calcareous), as at White-Cliff Bay, in the Isle of Wight, marine animals are abundant between tide-marks.

There is doubtless some reason why animals were not found by Dr. Carpenter in the dredgings referred to; but it is, on the whole, unlikely that such barrenness was due to the muddy condition of the water *per se*. Whether his alternative restraining condition, viz. "*the stagnation produced by the almost entire absence of vertical circulation*," be founded on a more secure basis, must remain, as he adds, a matter of future inquiry.

II.—*Seventh Account of new Species of Snakes in the Collection of the British Museum.* By ALBERT GÜNTHER, M.A., M.D., Ph.D., F.R.S.

[Plates III., IV., V., & VI.]

THE following species of Ophidians have been added to the collection of the British Museum since the publication of the last paper on the same subject in this Journal (June 1868, i. pp. 413–429). The total number of species in that collection amounts now to 920, and that of the typical specimens to 366. In the following lists a part of the species are marked with an asterisk(*); of these, as well as of a few others, I have added descriptions or short remarks.

I. *List of Species which were formerly desiderata.*

- Typhlops travancoricus, *Bedd.* Travancore. Capt. Beddome.
 Typhlops striolatus, *Ptrs.* Khassya. T. C. Jerdon, Esq.
 Typhlops exiguus, *Jan.* Belgaum. Dr. Leith.
 Plectrurus sanguineus, *Bedd.* Anamallays. Capt. Beddome.
 Rhinophis punctatus, *Müll.* Ceylon. T. H. K. Thwaites, Esq.
 Adelphicos quadrivirgatum, *Jan.* Java. M. Boucard.
 Ablabes reticulatus, *Jerdon.* Khassya. T. C. Jerdon, Esq.
 Cyclophis monticola, *Jerdon.* Khassya. T. C. Jerdon, Esq.
 Colophrys rhodogaster, *Cope.* Rio Chisoy. O. Salvin, Esq.
 Simotes albocinctus, *Cant.* E. I. archipelago. Dr. van Lidth de Jeude.
 Coronella (Liopeltis) sagittifera, *Jan.* Tucuman, Mendoza. Purchased.