of the sea; moreover, in other localities the sea itself was coloured green. Captain Parry also mentions in the same latitudes the existence of a very great number of animalcules, which he designates under the name of Beroes, and which he says nourished themselves upon this green slime. These observations, although incomplete, must not be forgotten, and may be placed alongside those of Captain Ross, in the Antarctic regions.

(To be continued.)

Description of a new species of Echeneis (E. tropicus);—*and of a new Lernean of the genus Penella* (P. remoræ), *infesting the Echeneis remora; with some remarks on the economy of the Remora.* By Andrew Murray, Edinburgh.

The *Echeneis* or Remora, as most of our readers are aware, is a genus of small fishes which have a flat oval disk, composed of a number of transverse cartilaginous plates, on the top of their head, and so contrived as to act as a sucker, by which they attach themselves to larger fishes or vessels, and are carried about with them. They also occasionally attach themselves to rocks, more especially, it is said, during storms, when they would be unable otherwise to withstand the fury of the waves. The ancients had the most absurd fables regarding the species with which they were familiar (the *Echeneis remora* of the Mediterranean), all bearing some more or less recondite allusion to its supposed resisting or attracting powers. Philtres could be made from it capable of deadening and extinguishing the fires of love. It could stop the course of justice, and delay the procedure in the public tribunals. It could arrest miscarriages in females, and when preserved in salt, its mere approach brought from the deepest wells any gold which might have fallen in. But the grand power which it possessed, was to stop ships in full sail by attaching itself to them. Pliny, who tells the above stories, gives a most graphic and eloquent account of its powers in this way, which he supports by one or two anecdotes. It was an *Echeneis* that, at the battle of Actium, stopped Antony's vessel when he was

going to survey the lines of his vessels, and encourage his adherents. "More recently," says he, "the ships bringing Caius, on his return from Andura to Antium, was stopped by an *Echeneis*. But his astonishment was not long when he saw that, of all his fleet, his galley alone did not advance. Those who went overboard to ascertain the cause, found an *Echeneis* sticking to the helm, and showed it to the prince, who was indignant that such an animal had been able to get the better of 400 rowers, and was very much surprised that this fish, which in the sea could keep back his vessel, had no longer any power when brought on board." Caius would seem not to have been quite free from doubts on the subject.

It is long, however, since the *Echeneis* has lost all claim to such supernatural properties. It is now only known as a very interesting little fish provided with the sucking apparatus I have referred to, and most associated with the shark, so much so, as to be known by mariners under the name of the pilot-fish, from its playing around and before it.* But it by no means confines itself to the shark. It attaches itself to almost any large fish that comes in its way. Yarrell records a specimen as having been taken in the British seas on the back of a cod, and it is frequently observed adhering to vessels. It usually swims upon its back, and from the under jaw being more projecting than the upper, and the colour of the upper and under surfaces being the same, one, at first sight, would imagine that the belly was the back, and that the disk was placed under the chin, instead of on the top of the head. The colour is a uniform deep olive-brown (except in the case of some albino varieties, which are wholly white); and Lacepede remarks, that the colour of the belly in this fish would seem to indicate that it was the less exposure to light which made the bellies of other fishes pale.

Four species of *Echeneis* have been described — the *E. remora*, *E. naucrates*, *E. osteochirus*, and the *E. lineatus*. I have recently received from Old Calabar, through the kindness of my friend Mr Wylie, another species, which I propose to name *E. tropicus*. It approaches the Mediterranean species, *E. remora*, in its characters, and I think it by

* The name *pilot fish* is now commonly applied to the *Naucrates ductor*, but it equally belongs to the species in question. See Lacépède, &c.

no means improbable that, from its resemblance, it has hitherto been overlooked or confounded with that species. It will presently be seen, however, that its specific characters are sufficiently distinct. The character which has been most relied upon for distinguishing the species of *Echeneis* is the number of the plates in the disk on the head. For instance, the *E. remora* has a double row of eighteen plates, the *E. naucrates* of twenty-two, the *E. osteochirus* of twenty-seven, and the *E. lineatus* of six plates. The species which I have now to describe has a double row of seventeen plates. I believe this character to be constant, and susceptible of as little variation as the parts of the internal skeleton of the fish, or of the external skeleton of an articulated animal. Indeed, we may look upon these parts of the disk as dermal plates, and therefore as a modification of the external skeleton. It should follow, that wherever we find a difference in the number of the plates, we may be satisfied that there is also a difference in the species. Mr Yarrell seems not to have assigned a sufficient value to this character, for I find him in his "British Fishes" describing the *E. remora* as having seventeen *or* eighteen plates on the disk. I do not find Cuvier, or any other author, stating the number at anything but eighteen, nor in their descriptions do they give any latitude as to number. I have myself examined a good series of specimens of the *E. remora*, and I have never found an instance in which there were more or less than eighteen plates. I have no doubt, therefore, that Mr Yarrell has had the species I now describe through his hands, and that, finding the number of plates so close to that of the true *E. remora*, and the general appearance much resembling it, he has supposed it to be the same species, and thence concluded that the character in question was variable. The constancy of this character is the more important in this genus, that the formula of the fin rays to which ichthyologists are accustomed to trust, is so difficult of ascertainment, that it cannot well be relied on. The fins are covered with a thick untransparent leathery skin, which makes it very difficult to count the rays correctly. Almost invariably in counting them I have been in doubt whether I had not omitted one or two minute rays at the commencement or ending of the fin. Nothing but dissec-

tion can allow a satisfactory enumeration of them. It is no doubt owing to this element of error that Cuvier and Yarrell give a different formula of the fin rays of *E. remora*. I do not think that either of them are quite correct, and I give the following comparison of the result come to by these authors and myself, to show the difficulty to which I allude:—

	D.	P.	V.	A.	C.
Cuvier,	22	25	6	22	17
Yarrell,	21	22	4	20	20
Murray,	20–21	25	6	19–21	17–19

In giving this latitude in my enumeration, I do not mean to say that the number of rays varies from 20 to 21, 19 to 21, and 17 to 19, but simply that, from the causes above mentioned, I have been unable to make out, to my own satisfaction, which of these numbers is the correct one.

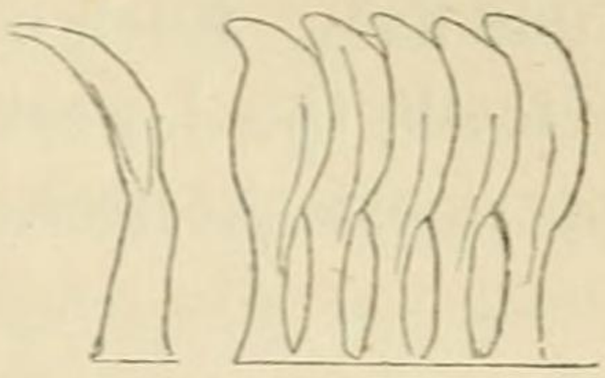
With these observations on the specific characters of the genus, I shall now give the description of the new species, merely premising that some parts of it, more particularly those relative to the mouth and teeth, are equally applicable to the *Echeneis remora*. Had I found a detailed description of these parts in any account of the latter species, I would merely have referred to such description, but as I have not done so, and the structure of the mouth in both species is curious, I have given a more careful description of it.

Echeneis tropicus.

Head, from the symphysis of the lower jaw to the end of the operculum, very nearly one-fourth of the length of the whole body; if the tail is included, it is rather less that one-fourth. The tail is nearly two-thirds of the length of the head. The depth of the body, taken immediately behind the operculum, is nearly one-twelfth part of the whole fish, and continues about the same depth till it meets the tail. It is deepest just in front of the dorsal and anal fins, which both commence about the same distance from the head, but even there the depth is not quite a tenth of the whole length; the head is very much depressed and flattened, the body in the middle nearly round, and the tail compressed. The mouth is wide; the opening nearly horizontal, with an outer fringe of close-packed, even, and regular

peculiarly-shaped teeth on the upper jaw. They are formed somewhat like the teeth of annelids, and are shown in fig. 1, where a side view is given of one tooth, and five are represented as seen in front. The upper half of the tooth looks like clear opaline enamel. They are pedunculated, and the peduncles stand quite apart, while at the upper part the teeth lie flat and close to each other. They are not continued all the way back to the gape, but at the back part are replaced by a few scattered incurved teeth; within this outer fringe there is an irregular row of sharp teeth curved inwards: * behind this row, the teeth are irregularly placed two or three deep; another similar row of teeth surrounds the front of the palate; the front and each side of the latter are broadly paved with a thick velvet-like packing of minute teeth curved inwards; its centre is free from teeth. The under jaw has an outer row of sharp teeth curved inwards, of a different shape from those in the outer fringe of the upper jaw. These teeth do not extend all the way back to the gape; within them there are four or five close-set irregular rows of small teeth; there is a small elongate diamond-shaped patch of minute velvet-like teeth, the same as on the palate, on the tip of the tongue. At the back part of the tongue the roots of the branchiæ (which are four in number) are seen to be furnished on each side with a curious dental apparatus opposed to the plate of teeth on the palate; and each tooth (if they can be called teeth) on the side of the branchial rays fits into the hollow between the two opposite ones on the next branchial ray. One or two patches of velvety teeth are situated also about the base of each branchial ray. The eye is large, placed about halfway between the symphysis of the upper jaw and the end of the operculum. The gill aperture is large. The adhesive disk is elongate, and nearly oval; it contains a double row of seventeen transverse cartilaginous laminæ, divided by a longitudinal mesial separation. The disk commences immediately behind the upper lip, and ex-

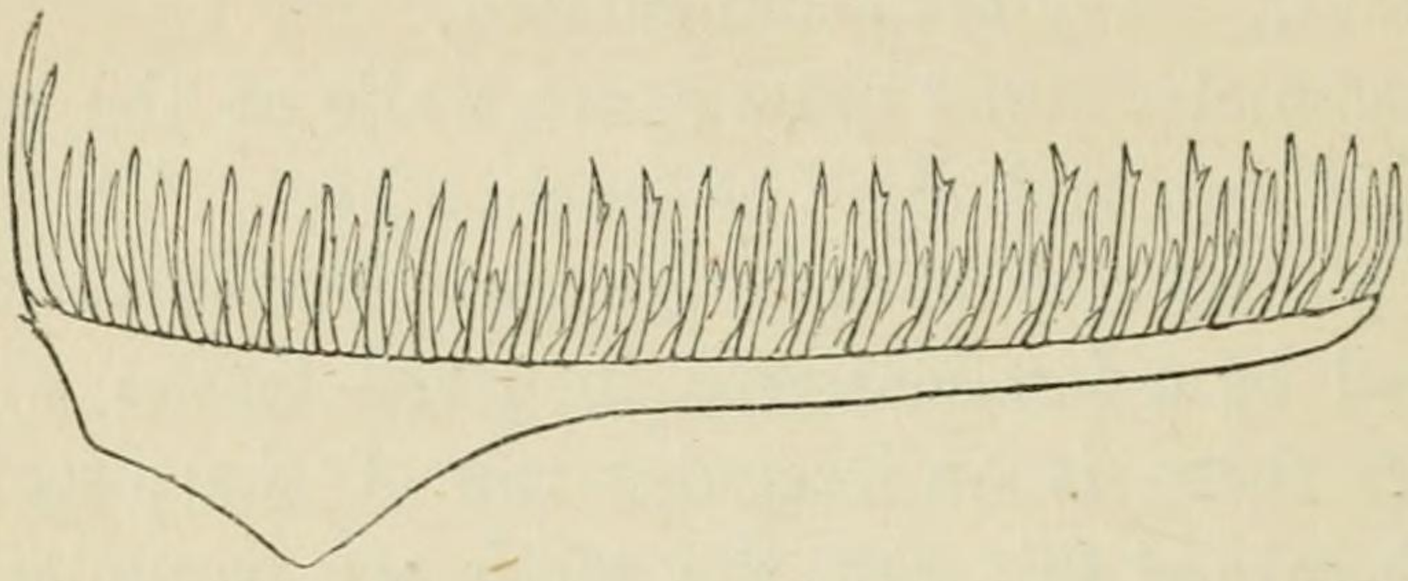
Fig. 1.



* The same arrangement occurs in the *E. remora*. Of it Yarrell says there is only one band of teeth in the upper jaw; but we see that there are two rows with several irregular interrupted rows following.

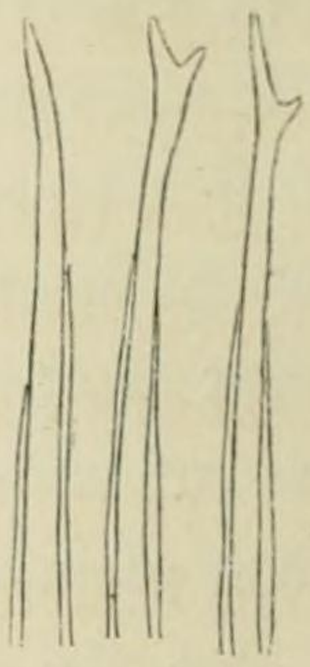
tends backwards not quite so far as the line of the ends of the pectoral fin rays. Its length is very nearly one-third of the whole fish. Each of the laminæ is furnished with three rows of teeth, the lowest row longest, the next shorter, and the uppermost shortest. See fig. 2, which represents a plate as

Fig. 2.



seen from the under side. Many of the teeth, particularly those placed towards the outer side of the disk, are bifurcate, as shown in fig. 3. There is a curved tooth longer than the rest at the inner end of each lamina next the mesial line. The pectoral fins are small and rounded; the ventrals narrow and very close together; the dorsal and anal fins are both placed behind the middle of the fish; they commence at a like distance from the head. They are equal in length, and about one-third of the whole length of the fish, ex-

Fig. 3.



cluding the caudal fin. The end of the caudal fin is concave shaped. The lateral line takes a sudden rise, and then falls again a little behind the pectoral fins. The formula of the fin rays is as follows, viz.:—

Dorsal 20. Pectoral 26. Ventral 6. Anal 23. Caudal 19.

The colour is dusky-olive brown; the under part of the body as dark as the upper, the fins a little darker than the body. The length of my specimen is seven inches.

The principal differences between this species and the *Echeneis remora* are as follows:—The plates on the disk are seventeen in number instead of eighteen. The disk itself is elongate oval, and not broader behind than in front, while in *E. remora* it is broader behind, as will be seen in fig. 4, p. 299, which represents the outline of the disk in *E. remora*. The disk in the latter also is comparatively shorter than in *E. tro-*

picus. In *E. remora*, the posterior half of the body is wedge-shaped, tapering uniformly and pretty rapidly backwards from the disk to the tail. In *E. tropicus* it tapers more gradually, giving more of an eel-shaped appearance to the body from the disk backwards. The skin appears to me to be softer and less leathery than in *E. remora*, but as I have only one specimen, and it has suffered somewhat from coming home in spirits, I cannot say positively as to this.

I have never seen any account which to my mind was perfectly satisfactory of the *modus operandi* by which the *Echeneis* attached itself to the fishes or vessels to which it has been found adhering, and as I think I have ascertained what the process is, it may not be uninteresting if I endeavour to explain it.

The difficulty I felt was not how the fish sustained itself fixed after it had once put its sucker in action. The familiar example of the limpet sufficiently explains this. But the puzzle was, how the remora got its apparatus set agoing upon a fish or vessel in rapid motion; for although vessels may be becalmed, and sharks may be basking motionless for hours, I assume that it is not alone at such times that the *Echeneis* fixes itself. I have not met with any author or any observer who was an eye-witness of the fixing, but the possession of an apparatus peculiarly adapted for fixing itself upon bodies in motion (which I shall presently explain) entitles us, I think, to hold that it does fix itself upon them while in motion, without exposing us to the charge of reasoning in a circle. It is obviously something more than a mere air-exhausting apparatus which enables it to do this. If we find a limpet thoughtlessly standing at ease on its rock, and push it along the surface, it makes an effort to hold on before starting, but after its travel is fairly commenced, it in vain attempts to stop its onwward course. It cannot get the edges of its sucker placed so as to exclude the air. So a cupper could never fix his cupping-glasses if it were made a condition that they should never stand still, but must be constantly kept moving over the body of the patient; but this is what the little remora has to do. A gigantic whale or voracious shark rushes past him, going almost with the speed of light; but quick as he has been, the remora has been

quicker, and in the twinkling of an eye rests firmly seated on his slippery back, or side, or belly, for all positions seem alike to him. How does he manage this? The structure of the disk will explain it. It is composed of two organs which appear to be distinct and independent of each other, each fulfilling separate functions, although both employed to bring about a common result. It has a sucking apparatus composed of a free fleshy flexible lip or margin all round the disk, similar to the edge of the sucking apparatus of the limpet. This, as well as the skin of the whole disk, is furnished with pores, which doubtless exude a mucous or slimy fluid to secure an impervious edge. This apparatus seems quite sufficient for the purpose of establishing a vacuum, and thus securing the adhesion of the fish. But besides this, it has the double row of transverse cartilaginous plates shown in fig. 2. These plates, as already mentioned, are furnished with these rows of teeth; there is a spongy gum-like substance through which three teeth project, so that they reach very little beyond its surface, and yet it can be pushed back until they are laid almost bare.

The account Lacepede gives of their action is this:—"It (the remora) attaches itself often to whales, and to fishes of a very great size, such as the sharks, and more particularly the white shark. It sticks to it very strongly by means of the plates of its buckler (disk) of which the little teeth serve like so many hooks to keep it clutched on (*cramponné*). These teeth, which bristle the edge of all the plates, are so numerous, and multiply to such a degree the points of contact and of adhesion of the remora, that all the strength of a very powerful man is not sufficient to tear this little fish from the side of the shark to which it has attached itself, so long as one attempts to separate it in a direction opposite to that of the plates. It is only when we attempt to follow that direction, and take advantage of the inclination of these plates, that we are able easily to detach the *Echeneis* from the shark, or rather to make it slide over the surface of the shark, and finally to separate it from it."*

* Although it is perhaps a little irrelevant to the immediate point under consideration, I may continue the quotation for a few lines. "Commerson relates, that having chosen to bring his thumb near the disk of a living remora which he had under observation, he experienced a power of cohesion so great that a remarkable numbness, and even a sort of paralysis, seized his finger, and did not disappear for a long time after he had touched the remora."

the rest, at the inner end of each plate, next the mesial line. Under a lens, the teeth are seen to be in no way shaped like hooks; most of them are simple straight spikes, but those nearer the outer edge of the disk are bifurcate (see fig. 3), as if to give additional power of resistance where it is most needed, in the same way as a palisade or paling is strengthened by an oblique supporter nailed to it and driven into the earth. The plates cannot be forced up so as to stand perpendicularly, as would be best their duty, if their purpose was to give the greatest area for a vacuum. They lean backwards, lying very flat when at rest, the mere points of the teeth only then projecting, but elevated to about an angle of 45° when raised. If the finger is passed down along the disk, from the head towards the tail, it glides easily and smoothly over it, but if passed however slightly in the reverse direction, it is at once caught by the teeth, and if the motion is persisted in, the plates are forced backwards as far as they can go, and the teeth penetrate the skin of the opposing object. The action of a fish passing the remora would have the same effect as the finger. As it glided along, the row of long teeth in the plate would be first touched, and the more rapid the motion, the deeper they would be buried; the second row below the long ones would next be reached, and they too would be imbedded in the skin of the fish, and would be, in their turn, supported by the third and lowest row. To allow the disk thus to operate, both the larger fish and the remora must be going the same way, and the former must pass the latter. If passing in the opposite direction, the fish would glide smoothly over it; but let it brush ever so lightly past the disk of the remora while going in the same direction, and it is instantly caught by the projecting teeth, and, as it pursues its course, it carries the remora along with it; it has run upon the little palisades of the remora, and all that the latter has now to do, is to put its sucking apparatus into operation, which it can do at its leisure (though we may be sure much time will not be required), for the teeth of the disk will maintain it in its position, so long as it does not seek to move forward. It must remain stationary or pull in the reverse direction to allow the teeth to continue to hold. If it wishes to release itself, all it has to do is to dart forward; the

teeth are then taken with the hair, drawn out of the skin of the fish, and move softly and harmlessly along.

The above, I imagine to be the sole purpose of these plates. The sucker is quite sufficient for the mere purposes of adhesion; and may be probably used without the teeth or plates, when the remora fixes itself upon rocks or stationary objects; but the plates and teeth are required to enable it to fix itself upon bodies in rapid motion. A necessary consequence of my view (if correct) is, that the remora must always fix itself with its head in the same direction as the fish or vessel it attaches itself to, is going; it can never be found with its head to the tail, for the only way by which it could fix itself, if placed in that position, would be by either it or its supporter swimming backwards, which they cannot easily do. I do not know how the actual fact stands in regard to this position of the fish, and invite observers to notice it in future; but I feel sure that it is an impossibility for a remora to fix itself with its head pointing towards the tail of its supporter. And its being so is only another instance of the beautiful harmony and adaptation of things which are daily forced upon our attention. It would have been as easy to have made the plates and teeth point forwards as backwards, and then the remora would only have had to meet its supporter, and fix itself in brushing past him; in that case, it would have always been looking towards the tail, which would have entailed more serious inconveniences than at first sight appear. In the first place, the rapid motion of the creature to which it has attached itself through the water could not be met by the tail of the remora in a straight position; it would always be bent aside, which would not be comfortable. Again, if the remora opened its gill-covers to breathe, the rush of water would fill them, and keep them open, so that in a short time it would be drowned. Instead also of meeting its food and snapping it as it came, it would be like Tantalus, and never see it till it was borne resistlessly away from it. And supposing it to escape all these dilemmas, and, heartily sick of its position, to have resolved to lead a life of independence and self-reliance henceforward, how was it to escape from the false position it had assumed? Instead of easily escaping by moving forward (as the real remora does), our inverted animal would only fix it-

self the more firmly the more it attempted to escape. The only release would be by swimming backwards, but it would find it as difficult to do so against the onward impulse of the larger fish, as we ourselves too often find it to retrace a false step.

The mention of their food suggests to me that the curious conformation of the teeth, which I have above described, may help us to a knowledge also of this subject; for that is a point which is not as yet quite certain. Sir Wm. Jardine, in the *Naturalist's Library*, says it feeds on small fishes. The usual belief of sailors is, that it feeds on the fragments of the prey of the shark. Commerson thought this likely enough; but Lacepede mentions that in some seas they are in great numbers, and that they follow vessels in shoals in order to feed on the animal matter thrown away. This, he says, has been particularly noticed in the Gulf of Guinea, and that is the reason, according to Barbot, that the Dutch who frequent the west coast of Africa have called the remora "*poisson d'ordure.*"

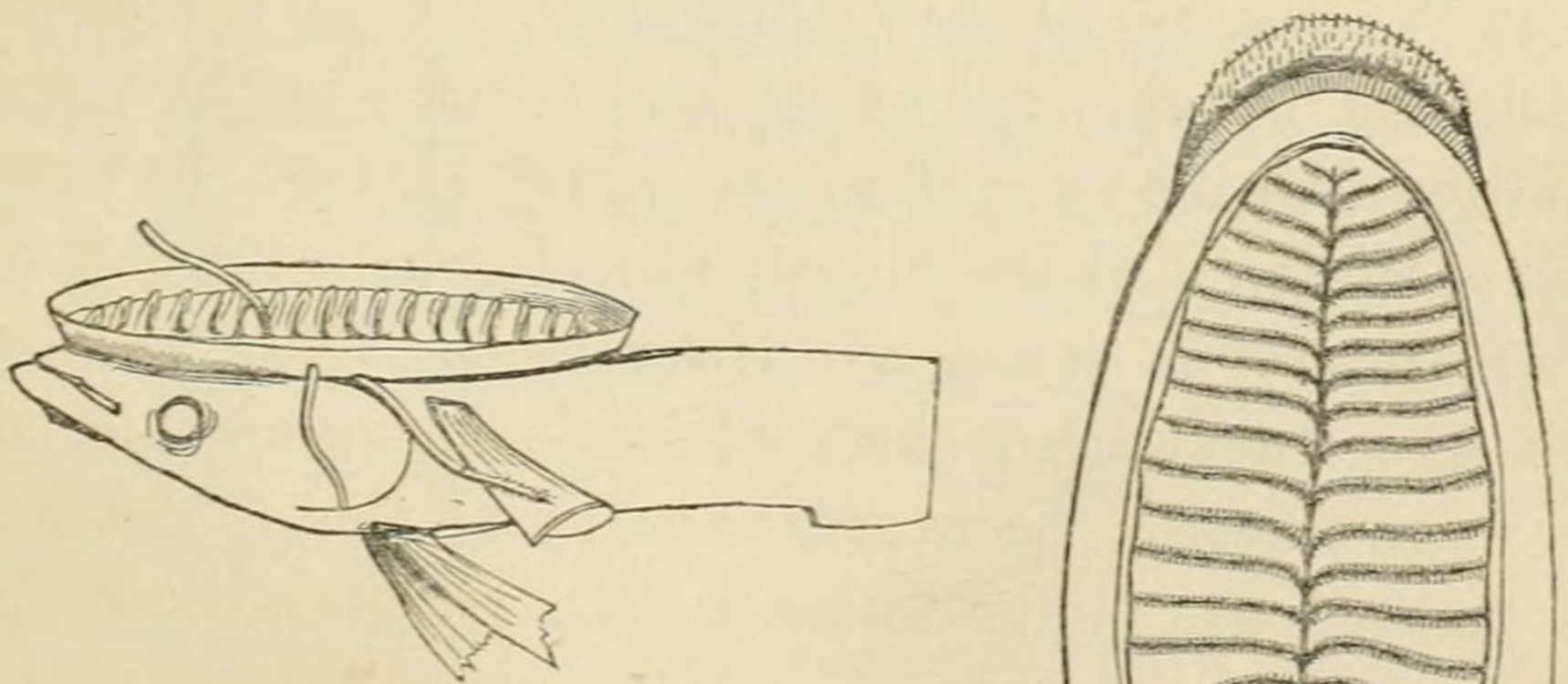
The teeth, I think, show that this is very probable. The mouth is wide, with the lower jaw very much projecting beyond the upper, which, as it were, fits into the cavity of the mouth, just within the teeth of the lower jaw. The lower jaw has several rows of small sharp teeth, curved inwards; but the upper jaw alone has the peculiar outer fringe of close-packed regular pedunculated teeth already described. These are apparently admirably adapted to serve the purpose of a sieve. Suppose the small sharp curved teeth in the lower jaw, along with the inner irregular row in the upper jaw, to seize a portion of comminuted matter, and the mouth to be then closed, the water would escape out at the intervals between the peduncles of the upper fringe, and the food be retained within. The small size of the seizing teeth, and the several rows of still smaller ones, show that they are not adapted for seizing any solid very coherent body. It must be something that it requires a great many points of contact to lay hold of, and which is probably in a soft semi-fluid state. The thick velvet-like pavement of minute teeth in the interior of the mouth is obviously constructed for comminuting some substance which has been very much comminuted already, and the apparatus on the branchial rays

would appear to be intended not only for comminuting purposes, but also (or perhaps rather) for the same purpose as the outer fringe of teeth in the upper jaw—viz., to prevent the escape of the food with the water through the gills.

It has been a subject of conjecture how the *Echeneis* can play before and around and close to the very jaws of the shark without being devoured. Some have supposed that these terrible fishes have a sort of antipathy to the taste or smell of the flesh of the remora, and hence do not care to eat them. We certainly have plenty of instances of animals instinctively refusing to feed upon what is bad for them. Others fancy that the remora has sufficient agility, address, or cunning, to escape the murderous teeth of the shark ; or, again, it may not be an unreasonable speculation, that the shark might find the remora *stick in its throat* in swallowing it, and after one or two trials abstain from them.

In examining some specimens of *E. remora*, which were kindly lent to me by my friend Dr Fleming, I was struck by finding one receiving strict poetical justice from the intrusion of a *Lernean* sticking to its head, which I have no doubt gave it as much uneasiness as ever the *remora* itself occasioned to any fish to which it may have chosen to affix itself. The position which these parasites occupied will be seen in fig. 4, where the head of the remora is figured with them attached to it.

Fig. 4.

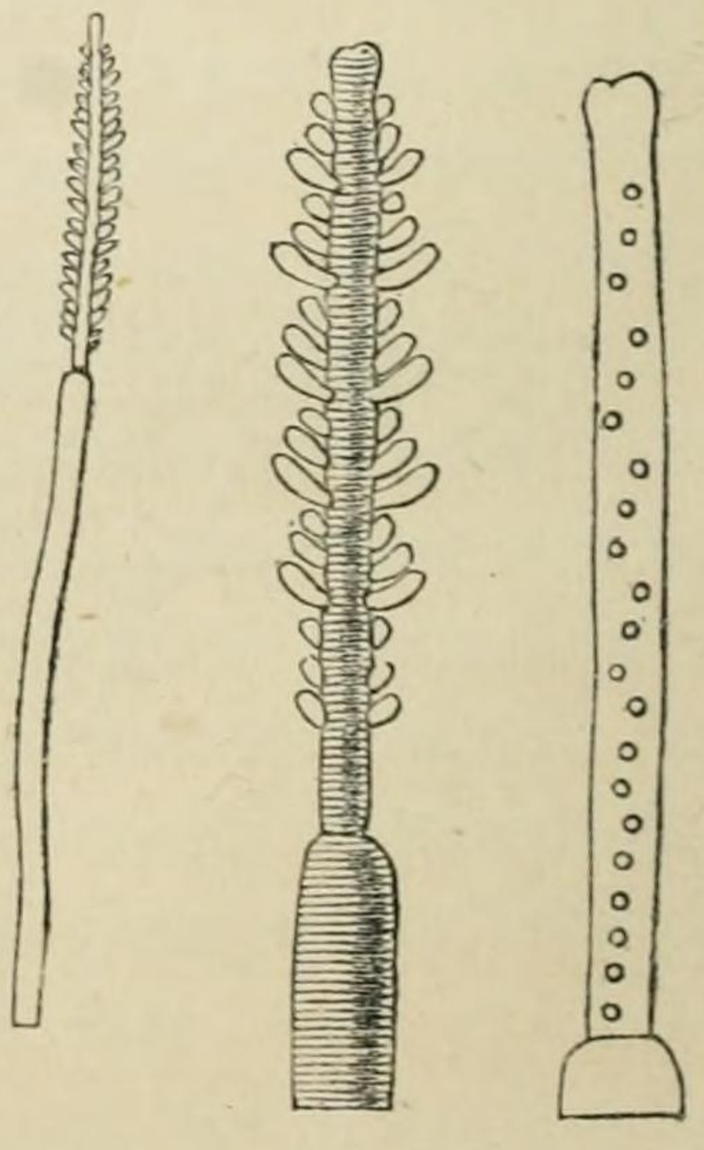


There were six or seven of them in a greater or less stage of

advancement—one or two only a couple of lines in length, and two of them nearly an inch, and buried at least as deep in the head of the fish. All these, with the exception of one, had merely the appearance of threads hanging out from under the edge of the disk. One, however, emerged from the side of the mesial line nearly in the centre of the disk. They all entered the head at some chink or cranny, where the young crustacean had found a hiding place. The individual that occupied a position on the disk itself was thinner, and had less substance than the others; from which we may infer, that although it had been able to live and grow in an occasional vacuum, it was not altogether insensible to the injurious effects of such treatment.

They were all annular, of a dirty olive colour (the same as the colour of the fish), and semi-transparent. At the termination of one of them, I made out, by a little pressure under the microscope, that there were two nipples or slight elevations, which were probably, as was suggested to me by Professor Owen, the points of attachment of the two ovaries which had dropped off. These traces of ovaries were found on one of the thread-like individuals; and this would seem to imply that it was fully grown, although the great difference of form in another specimen, which I am going to describe, shows that if full grown, it was at least not fully developed. The one I refer to was a somewhat larger specimen than any of the rest, of the form and with the appendages shown in fig. 5. This shows that it is a species of the genus *Penella*, one of the *Lerneans* which has appendages at its termination like the wing of an arrow. This specimen had very much the appearance of a miniature arrow with a well-feathered shaft sticking in the flesh. Seen sideways, the feathers are found to be buds arranged in a double or treble oblique row, as represented in the sketch on the right hand, which is a magnified outline, intended to show the position and arrangement

Fig. 5.



of the buds when looked at in profile. The left hand sketch is a representation of it as seen in front; the middle sketch is the same, but more highly magnified.

Milne Edwards divides the genus *Penella* into two sections, one distinguished by the head (which penetrates deep into the victim, burrowing through flesh or bone indifferently, and generally attacking some part of the head) being furnished by two horns or diverging prolongations; the other by having three such arms or horns on its head.

Two species of each section have been described. The *Penella sagitta*, Lin., and *P. filosa*, Lin., fall under the former section, and the *P. Blainvillei* and *P. Sultana*, Nord., under the latter. The present species corresponds with none of these. I have endeavoured to dissect out one or two of them to find to which section it belonged, but their minute size, fragile texture, and great length to which it was buried in the head, combined with the degradation of the tissues, owing to their having been long immersed in spirits, have got the better of me. I am, therefore, obliged to confine myself to the above external description of the portion of the creature which I saw. From its habitat, I have named it *Penella remoræ*.

On the Discovery of Paradoxides in the altered Rocks of Eastern Massachusetts. By Professor WILLIAM B. ROGERS, F.G.S., &c.

It is well known that the altered slates and gritty rocks which show themselves interruptedly throughout a good part of Eastern Massachusetts, have, with the exception of the coal measures on the confines of this state and Rhode Island, failed hitherto to furnish geologists with any fossil evidences of a Palæozoic age, although, from aspect and position, they have been *conjecturally* classed with the system of rocks belonging to that period. Indeed, the highly metamorphic condition of these beds generally, traceable, no doubt, to the great masses of igneous material by which they are traversed or inclosed, would naturally forbid the expectation of finding in them any distinguishable fossil forms.