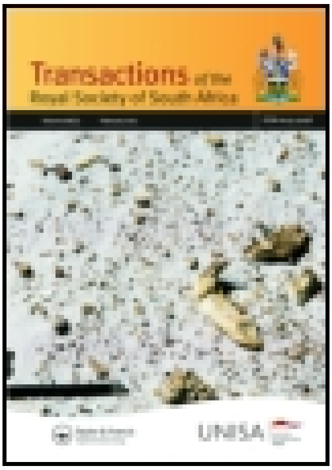

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NOTES ON THE MODE OF GROWTH OF TUBICINELLA TRACHEALIS, THE BARNACLE OF THE SOUTHERN RIGHT WHALE

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NOTES ON THE MODE OF GROWTH OF *TUBICINELLA TRACHEALIS*, THE BARNACLE OF THE SOUTHERN RIGHT WHALE.

BY DR. R. MARLOTH.

(Read September 29, 1898.)

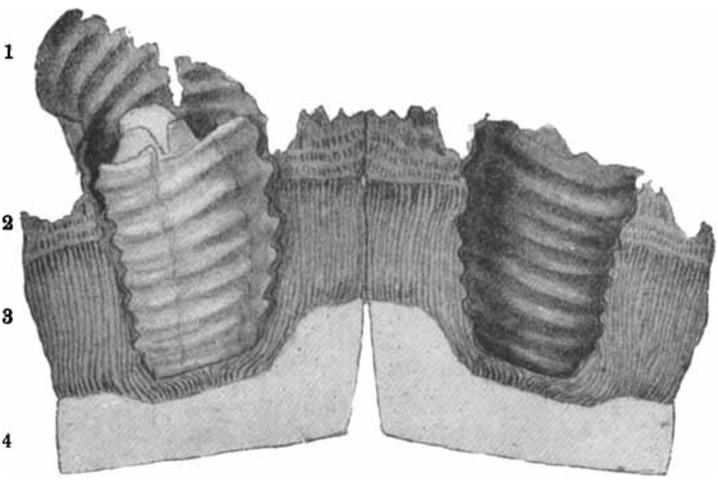
At the meeting of this Society held on the 28th of July, 1897, Dr. F. Purcell exhibited specimens of two kinds of barnacles found on whales captured in the neighbourhood, viz., *Coronula Diadema*, the coronet barnacle, from a humpback whale (*Megaptera boops*), and *Tubicinella trachealis* from a Southern right whale (*Balæna australis*).

In the discussion of the exhibits and of the mode of life of these parasites, the question was raised by what means these parasites were able to penetrate into the epidermis of the whale, seeing that their base was quite unarmed, their mouth being turned outwards towards the water. It occurred to me at the time that there might be some chemical process at work, but such a surmise was not of much value unless it could be proved experimentally. I had no opportunity of doing this last year, but when this year, in May, a right whale was captured in False Bay, I secured a piece of its skin with a number of *Tubicinellas* in it, and conducted a series of experiments in order to test the theory.

Before stating the results of these experiments, I think it desirable to explain the mode of life and growth of the parasites as far as known at present.

The most comprehensive work on the *Cirripedia* is from Charles Darwin,* who published a monograph of the class in 1854. From his book most of the following details are taken. Many members of the order are common on the rocks of the coast, on floating timber and ships' bottoms, being known under various names, according to their shape and colour. Owing to the fixed condition of their shells and their external resemblance these animals were believed to be molluscs until 1850 Vaughan Thompson recognised their crustacean nature by discovering their metamorphosis.

The young larvæ when leaving the egg exhibit their true relationship very well. They move about freely until they find a suitable resting-place, where they attach themselves by means of their



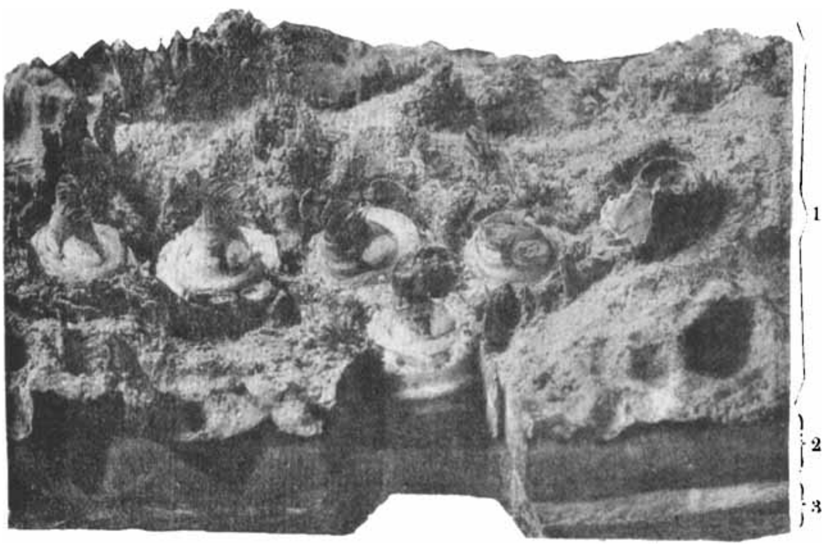
TUBICINELLA TRACHEALIS IN A PIECE OF WHALE SKIN, THE FRONT PORTION OF THE PIECE FOLDED BACK (natural size).

1. Sheath of hardened epidermis, projecting beyond the surface. 2. Outer surface. 3. Vertical section through epidermis. 4. Corium.

antennæ, or rather organs corresponding to the antennæ of the crawfish, but assuming quite a different function. The larva changes at first into a kind of pupa, and finally into the complete cirripede. When this takes place they are still very small, only gradually reaching their final size. In order to attach themselves to suitable objects the cirripedes possess a so-called cementing apparatus. By means of a certain secretion they fix themselves on their support.

* 'Charles Darwin.' A monograph on the sub-class *Cirripedia*, with figures of all the species, the *Balanidæ*. London, 1854.

Darwin does not say by what means the young cirripede forces itself into the epidermis of its host, but he describes in a detailed way the mode of growth of the parasite settled in the skin. By a comparison of specimens of different size, he came to the conclusion that the tubular shell grows at its base downwards and in a tangential direction, producing in this way the lengthening as well as the widening of the shell. As, according to Darwin, the shell is gradually pushed out of the skin, its outer edge must soon project beyond the level of the skin, and as it is very brittle it continually breaks away at the outer edge. If the whole growth of such a shell from its infancy, when it is hardly one-fiftieth of an inch in diameter,



PIECE OF WHALE SKIN WITH SIX TUBICINELLAS (half natural size).
1. Surface of epidermis. 2. Vertical section through epidermis. 3. Corium.

until it is of full size, *i.e.*, about 1 inch in diameter, could be preserved and put together, it would form a conical tube at least 6 inches long. How much longer the cylindrical tube would be which one would obtain by putting together the fragments of shells breaking away during the life of the adult animal, is, of course, impossible to say, as one does not know how long these cirripedes live and at what rate the longitudinal growth continues.

In all its stages the shell is provided with circular ridges which make it impossible for it to slip out of the skin. If one assumes that each ridge remains surrounded by, and in contact with, those layers of the epidermis in which it was formed originally, one should either find that the base of the shell had penetrated into the skin to that extent, viz., 4½ inches below the epidermis, or, as this is not the case, "*that the epidermis of the whale had ceased being formed under these specimens, whilst it had gone on being formed around and between them, to the thickness of four or five inches, and that it had subsequently disintegrated to this same thickness on its outer side, which processes would account for the summit of the shell being still on nearly a level with the surface of the whale.*" Darwin adds that he cannot believe this to have taken place, and continues: "The view which seems to me most probable is, that the rapid downward growth of the shell, besides indenting the whale's skin, at the same time slowly pushes the whole shell out of the skin, and thus continually exposes the summit to the wear and breakage which seems to be necessary for its existence. On this view, the very peculiar form of *Tubicinella*, which is retained during life, namely, the slightly greater width at top than at bottom is beautifully explained, viz., for the sake of facilitating the protrusion of the shell; for the ordinary conical shape of senile cirripedes, with the apex upwards, would have rendered the pushing out of an imbedded shell almost impossible; on the other hand, we can see that the likewise very peculiar, concentric, prominent belts may be necessary to prevent too easy protrusion."

If one remembers that the tubular shell rests with its lower edge on the soft inner skin, the corium, and that its basal surface is not closed with any hard substance, but simply with a membranous diaphragm, while the sides of the shell are provided with such prominent ridges it is difficult to imagine that it could be pushed out of the epidermis in this way. In fact, having removed a number of living specimens from the skin in which they were imbedded, I consider this pushing out as impossible. The skin around each shell is quite indurated, the ridges of the shell have their upper edge slightly turned upwards, and the shells adhere so firmly to the skin that one has to use considerable force in order to break them out even after splitting the surrounding body of skin lengthways.

The observation, however, which I have made, enables us to understand the actual process. We saw that the larvæ of the cirripedes attach themselves to their permanent support by means of a cementing apparatus. Such a cementing arrangement appears quite sufficient for those species which live on rocks, shells, wood, or any other dead material, but it is evidently quite insufficient to account for their permanent adherence to the live skin of an animal. Supposing even they succeeded in attaching themselves, they would soon be thrown off as the outer layers of the epidermis became deteriorated and worn away. But the *Tubicinella* has not only to attach itself, but also to penetrate into the epidermis to a depth of one inch and a half, and that although its base is formed by a delicate membrane.

Seeing this, it occurred to me that the animal possibly secreted some fluid which possesses the power of dissolving the epidermis. Such secretions, which contain peptonising ferments, *e.g.*, pepsine or pepsine-like bodies, and which are capable of rendering soluble the albuminous matter of animal bodies are well known in the vegetable kingdom as well as among animals. The sundew, and many other so-called insectivorous plants digest the albuminous matter of insects and other animals in this way, and the same is done by many arachnids and insects with their prey.

In order to test this theory, I removed some living *Tubicinellas* from the skin of the whale, placed their lower side in direct contact with pieces of boiled albumen (white of an egg), and poured sea-water into the vessels until the base of the shell was immersed.* After some time, varying from half an hour to twenty-four hours, I analysed the liquids. The soluble albuminoids were removed by saturating each liquid with sulphate of zinc, allowing it to stand for twenty-four hours, and filtering it. The filtrates were treated with hydrate of potash and sulphate of copper, and in each case I obtained positive reactions for the presence of peptones. This proved that a peptonising ferment diffuses through the basal membrane of the animal, and this fact explains the peculiar structure of the animal as well as that of the skin of the whale at the infested parts of its head. The young *Tubicinella* simply dissolves the epidermis with which it is in contact, absorbing the peptonised liquid. As it continually grows at its lower end it gradually descends in this way into the epidermis, the digesting of the epidermal layers taking place at the same rate as the downward growth.

When the parasite has reached its maturity, its shell is just as long as the epidermis is thick, viz., about one inch and a half, a thin layer of epidermis, about one-tenth of an inch in thickness remaining underneath each parasite between its base and the corium of the skin.

The presence of the peptonising ferment having been proved, it is not necessary any more to assume that the epidermis stops growing underneath each parasite. On the contrary, its uniform growth would produce exactly the structure of the epidermis as we find it. If the parasite did not secrete such a ferment, the layer of epidermis

* The *Tubicinellas* remained alive for two or even three days.

underneath it would gradually increase in thickness. At the same time the epidermis is permanently wearing off at its outer side, as is well demonstrated by its rough or rather torn and lacerated surface. The result of both processes would be that the parasite would be gradually but completely removed from the skin. And this actually takes place with the shells of the dead parasites, their place being afterwards indicated by a smooth depression in the epidermis. The living *Tubicinella*, however, cannot be got rid of in this way, for as it dissolves that part of the epidermis with which its base is in contact, at the same rate at which new epidermal tissue is being formed underneath it, the layer of epidermis which separates it from the corium remains of the same thickness, and the parasite retains its place, its shell disintegrating at its outer end at the rate at which it grows at its base.