schuppen vollständig. In der Rinde der Internodien liegen kleine, im allgemeinen scheibenförmige Schuppen von 0,2 mm Durchmesser, mit weitstehenden großen Warzen besetzt. In der unteren Stammrinde werden diese Schuppen kleiner, 0,12 mm breit, kompakter und sind noch stärker mit großen Warzen besetzt, und in der Basis werden daraus mehrere kugelige 0,6—0,9 mm im Durchmesser haltende Gebilde, die sehr große zackige Warzen aufweisen.

Farbe weißgelb.

Fundort östlich von der Bouvetinsel in 450 m Tiefe.

Von den neun bis jetzt beschriebenen Arten ist *Pr. flagellum* Stud. vorliegender Form am ähnlichsten. Bei beiden ist die Achse sehr schlaff, und bei beiden stehen die Polypen in ungefähr gleicher Anordnung.

Von Abweichungen sind folgende zu konstatieren. Bei vorliegender Art ist die Zahl der in einer abaxialen Reihe liegenden Schuppen größer, von adaxialen (ventralen) Schuppen sind nur einige wenige distal und basal vorhanden, und diese sind sehr klein, während von *Pr. flagellum* im Challenger Report (p. 86) berichtet wird: »The ventral scales are well developed and form two rows.« Die Gestalt der Randschuppen (von Weight und Studer fälschlich für die Deckschuppen gehalten) ist recht verschieden, und die Gestalt und Skulpturierung aller andern Schuppen eine andre. Diese Abweichungen machen eine artliche Abtrennung der vorliegenden Form notwendig.

Breslau den 17. Oktober 1906.

4. Notes on the habits of some Sea Anemones.

By H. J. Fleure and C. L. Walton.

eingeg. 19. Oktober 1906.

I. The experiments described here were carried on in the Zoological Laboratories at the University College of Wales, Aberystwyth, the animals being kept in the experimental aquaria of the College, and observed as soon as possible after they had recovered from the shock of removal from the shore near by. During the progress of the work, it became more and more evident that numerous and repeated trials were necessary before any result could be regarded as certain, for anemones vary greatly in condition from time to time and many circumstances difficult to control have their effects on behaviour. Some anemones may be closed for a fairly long time, others will be on the move, and others again about to cast their skin, and all these things affect the experiments. There seem to be also characteristic differences in responsiveness and so on between different individuals, so that inference from experiment is not only difficult, but falls short of the degree of certainty that would be desirable. Prolonged tank life may also modify their characteristic activities.

The sensory reactions of the common sea anemones have been our chief study, the enquiry being made in part for the purpose of arbitrating between the conflicting views of Nagel and Loeb, and, in part, to picture as far as possible the manifestations which make up the life of anemones. We shall discuss the reactions to mechanical stimuli, to chemical stimuli, and to the stimulus of light, adding notes on the question of persistence of impressions received, on inferences as to the nervous system of the group, and on various details of the life of anemones which have come under observation.

II. Romanes (1883) says that if an anemone is near the surface in a tank and a jet of water is playing on the surface, the animal is soon surrounded by a turmoil of bubbles. Soon it will none the less expand the tentacles just as in calm water. If now an expanded tentacle is gently touched by a solid body several others close round it, i. e. the tentacles show differential reaction to the stimuli supplied by the turmoil of bubbles, and those supplied by contact with a solid body. We have found that *Actinia*, *Tealia*, and *Anthea* take practically no notice of such a turmoil of bubbles while *Sagartia sphyrodeta*, and *S. troglodytes* react by retracting more or less and the same result is obtained with *Aiptasia Couchii* and *Bunodes gemmacea*. Tentacles show very little reaction, if any, to chance contact with a pebble that is being moved in the aquarium, but react markedly to contact with a finger. The edge of the base is probably the most sensitive region for mechanical stimuli, the animal closing very quickly if this is touched. The surface of the column is sensitive throughout its length but more so towards the edge of the base. The disk and mouth are less sensitive to mechanical stimuli, in *Tealia* this dullness is peculiarly marked. The tentacles have naturally developed a high degree of sensitiveness to mechanical stimuli and, as we have just seen, a fair amount of differential reaction to them.

III. Pollock and Romanes (1882) believed that anemones were capable of distinguishing food when it was placed near them, but could not tell the direction unless it was exceedingly close. Nagel (1892—1894) found that the tentacles will take flesh but refuse inedible matter such as filter paper. They will, however, he says, take the latter when soaked in meat extract, and meat etc. placed near the mouth induces a reaction only when the juices have diffused out to the tentacles. He believed that *Actinia*, *Adamsia*, *Aiptasia*, *Anthea*, and *Cerianthus* have a sense of taste in the tentacles which he describes as Wechselsinnesorgane, sense organs responding to different classes of stimuli.

Loeb (1895) cut the tentacular crown away and found that the remaining stump took up food but speedily rejected paper or sand and from a variety of observations he concludes that Nagel is quite wrong. He found also, as we do, that the base of *Actinia* is the region of maximum sensitiveness to contact. Parker (1896) found that the tentacles of *Metridium* are not noticeably affected in any direct fashion by soluble food. Torrey (1904) on the other hand says that the tentacles of *Sagartia davisi* show very definite adaptive reactions and can distinguish between mechanical and chemical stimuli, making even certain choices in the quest of food.

Our conclusions approximate much more closely to those of Loeb and Davis than to those of Nagel and Torrey. The tentacles do certainly show some amount of characteristic reaction to chemical stimuli for, when tried with strong bovril or meat extract, those immediately affected are set on the move. If the solution used is very strong, we may find rapid contraction of the tentacles affected. Solutions applied to the mouth caused the lips to open immediately and led to movements of the tentacles more or less all round; if, on the other hand, tentacles are tested only those in the immediate neighbourhood are moved. If fairly strong solutions are placed against the base of a horizontally extended *Anthea*, the animal bends its tentacles and disk towards the stimulated region. Very strong solutions cause rapid contraction but such reactions are quite out of the ordinary course of the animal's life, so no great importance should be attached to them. We find then, so far, that the mouth region possesses the maximum sensitiveness for chemical stimuli, that the edge of the base is also sensitive, but that the sensitiveness of the tentacles for this type of stimulus is almost nil unless the extract used is unnaturally strong.

In *Anthea cereus* some of the tentacles are constantly on the move, and if any object is left in their field, they are fairly sure to touch it sooner or later, but we cannot say that the tentacles show any reaction at all to chemical stimuli due to food set for them in this way; it is in every case evidently a haphazard movement leading ultimately to contact. In other species, and especially in *Actinia*, the tentacles move less and demonstrate the same conclusion much more effectually.

If a piece of fresh raw meat, or of paper soaked in meat extract be suspended over the mouth of *Actinia* or *Anthea* and fairly close to the disc, the tentacles begin to move about in all directions after the mouth has started opening. If meat be placed near the tentacles of *Actinia*, they will be affected only if and when the juices of the meat have stimulated the edges of the mouth unless they chance to wander into contact with the food. In all cases it seems evident that the special region of sensitiveness to the more ordinary and likely chemical stimuli is the mouth, not the tentacles.

The mouth opens towards the food, i. e., towards the direction from which the stimulating solution reaches it: the tentacles, when they receive a motor stimulus, apparently passed on to them from the mouth region, move in all directions till some happen to come into contact with the prey. If an object is not placed satisfactorily in the mouth, it may be temporarily ejected to be reswallowed later. In such a case, or if a tentacle has secured some morsel, several tentacles bend over the fragment to prevent its escape. The number of tentacles affected seems to vary with the size of the capture, and a small piece taken by some outer tentacles will be passed on to tentacles further and further in, until those nearest the mouth deposit it there for digestion. If anything swallowed is not completely digested, the inedible remains are discharged in a characteristic manner; the centre of the disk is elevated and the object slides outwards, the tentacles either do not hold it, or separate and allow it to pass between them, and, especially in *Anthea cereus*, shrivel to very small dimensions. The facts here noted seem to indicate that the tentacles are in part controlled (receive motor or inhibitory stimuli) from the mouth region and perhaps we may say that the nematocysts act as if controlled from the mouth region, at any rate in *Actinia* and *Anthea*.

Summarising the results discussed thus far, we may say,

1) That the tentacles react to many contact stimuli. They show some amount of differential reaction in this respect but, none the less, carry all manner of unsuitable stuff to the mouth.
2) That the tentacles are almost completely indifferent to the chemical stimuli they are likely to receive under normal circumstances.
3) That motor stimuli can be communicated from the lips to the tentacles when the former have been stimulated, (especially chemically stimulated).
4) That motor stimuli can be communicated from the tentacles to the mouth causing the latter to open when the former have been stimulated (especially by contact).

IV. Further experiments with small pellets of filter paper and scraps of indiarubber led to very interesting conclusions.

We have given a specimen of *Actinia* a scrap of filter paper about once every 24 hours, placing it on the same tentacles each time. As a general rule, the fragment was carried by the tentacles to the mouth and there very often swallowed, to be ejected as inedible after a longer or shorter period. After a few days, the number varying in different individuals from 2 to 5 days, the fragment is no longer swallowed and, in about another two days, the tentacles will no longer take hold of it. This procedure is more regular in the case of pellets of paper than in the case of indiarubber, for which results were very variable. The results seem to indicate a certain amount of persistence of impressions, when the latter are received several times in succession at short intervals.

The first impression which persists is one in the mouth region leading to refusal of the pellet.

As this is strengthened the sequence is further abbreviated, an inhibitory stimulus would seem to proceed from the mouth to the tentacles preventing them from gripping, when the stimulation due to contact with the filter paper has passed from them to the mouth.

A further point of interest is that what does persist seems to remain the property of the tentacles affected, and of that part of the mouth directly related to them.

It does not appear to be a possession of the whole animal, for other tentacles, on the opposite side for example, can be tricked subsequently, at any rate once or twice, before they too exhibit the inhibitory reaction.

Apparently, however, the nervous connections are fairly continuous all round the mouth for the inhibiting tendency is soon manifest in the second region tried, and so on. A further indication of this continuity of nervous connections, this time in the column, is the fact that, when one side of the hase of *Tealia* is irritated, the opposite side often contracts rapidly. In *Tealia crassicornis* impressions seem to persist more readily than in *Actinia*, material which has been found inedible will be rejected by the tentacles after a very few repetitions of the experiment at one day intervals.

The responsiveness of tentacles in *Tealia* is also probably more varied and delicate than in *Actinia*, for example, they will refuse filter paper soaked in acetic acid while those of *Actinia* will hold such paper, though they contract somewhat at the same time. Different species and individuals are very differently affected by acetic acid, but in several forms contraction ensues when that substance is applied to the column. This contraction is very rapid in *Tealia*, and affects all but the tentacles nearest the region stimulated, these latter being often very widely expanded.

We notice that the tentacles of *Tealia* may be somewhat more sensitive to chemical stimuli than are those of *Actinia*, though even this is not sufficient to have probably meaning for the normal life of the species. We have spoken of the persistence of impressions due to repeated contact of tentacles with filter paper, but this is only a very temporary affair; all traces of the impression are lost if the animals are allowed a 6—10 days respite, though we incline to fancy that they »learn« more quickly from a second set of experiments than they did from the first, -i. e. it seems to be more easy to reinduce the persistence of a particular impression that it was to induce it originally.

V. When a number of anemones of various species are kept in aquaria subject to fairly marked variations of illumination, it will be found that, on the whole, more individuals will be open when the light is weak or absent, though the common *Actinia* does not show any reaction as far as we can tell. Gosse mentions that *Phellia brodricii* closes if a light is brought near. Nagel (1894) finds that *Cerianthus* closes when illuminated but neither *Adamsia* nor *Anthea* do so. One of us hunted several pools at a spot on the N. Wales coast without succeeding for some time in finding any anemones. The pools were shallow and open, but contained a few inches of mud at the bottom. As it grew dusk, however, several individuals of *Sargartia* bellis pushed up through the mud and expanded their black and white tentacular crowns above its surface.

Tealia crassicornis is by far the most interesting species in this connection. It lives in the moist chinks between rocks and under boulders, well below half-tide level, so it is under water for perhaps 8 hours each tide or even more. The exact conditions of its life vary considerably with the spot selected and this is the case more especially with regard to the average illumination it receives. Many individuals of *Tealia* will remain closed during the day, or at any rate whilst they are exposed to fairly bright light, but their reactions differ according to the situations in which they have lived previously. Those which had lived in rather well illuminated situations, for example, showed less aversion to bright light, and gave sometimes no regular reaction when artificial light was thrown on to them in the expanded condition at night. Those which had lived fairly deep in the shadow usually, though not always, closed when artificial light was thrown on the expanded tentacles at night; the reaction is slow, but closure is nearly or quite complete after about five minutes exposure.

This sensitiveness varies from one individual to another and in the same individual according to its condition at different times, but, on the whole, those with white tentacles are most sensitive, those variegated red and white less so, and the dark red ones least of all. Occasionally the anemone reopens after closing as just described.

It is possible that these reactions to the stimulus of light may have biological value in various directions. Many kinds of prey will be more likely to stumble on the anemones when it is dark than when their powers of sight help them to avoid the danger, and anemones in sunny pools might suffer detriment from high midday temperatures if they remained open too long. We may mention that *Actinia* and *Anthea* seem to enjoy a slightly raised temperature when warmed from 8° to 20° C. in a dish; as the temperature was raised beyond 22° C. the animals retracted.

We have spoken of *Tealia crassicornis* and before leaving the subject it seems not superfluous to recall a few of the many points of biological interest connected with this species, though some of them may be well known. It may be supposed that the red pigment of the column of *Tealia* is a warning colour, but this form has evolved one stage further, the glands of the column secrete adhesive substance which attaches small fragments of stone and shell. In this way, an individual living in the shingle under shore boulders becomes quite inconspicuous to prey which may then stumble on it unawares. We have therefore, probably, warning colouration which has given place to aggressive resemblance, resemblance not so much for protection from enemies as for deceiving prey. When the tide is out, *Tealia* may also expand to an unusual extent; not only are the tentacles bent out, but the digestive tissue is protruded from the mouth ready to catch small crabs and other crustaceans, or worms that may be moving about, most animals of this kind being very awkward and blundering in the absence of water. The contrast between the long filament-like tentacles of several shore Anemones and the short, stout ones of *Tealia crassicornis* points to the fact that *Tealia* is by no means so helpless as *Actinia* or *Anthea* when not covered by the tide.

VI. When moving, anemones inflate the side of the base in the direction of motion, as Gosse described, they then raise it and flatten it out with simultaneous expulsion of the water taken up during inflation, the part of the base which thus becomes posterior is next contracted and drawn up, and then the process begins over again. *Actinia* and *Anthea* move a good deal in this way and so does *Aiptasia Couchii*. *Sagartia nivea* moves in similar fashion and flattens to a remarkable extent in the process of refixing the base at each stage; it may take 24 hours to complete one of the cycles of movement just described. *Actinoloba dianthus* may move as much as 7 inches in one day and both *Actinia* and *Anthea* have done greater distances in that time in our tanks. This last species and some others, notably *Tealia crassicornis*, can shift their locality by loosening their basal adhesion, inflating the body and rolling in some way not adequately understood; during the autumn months they may be found floating or rather 'washing' about.

Some of the more active species, such as *Anthea cereus* may progress on the tips of their tentacles, or may move up to the surface of the water, loosen themselves from their attachment, hollow out the base and float with tentacles downwards. There is a good deal still unknown about the movements of whole colonies or groups of anemones. In the

Tenby neighbourhood in March 1903 *Bunodes gemmacea* was to be found sparingly here and there in one of the bays, by the middle of April it was abundant with often two or three large ones together. In March of that same year a careful study around St. Catherine's Rock, Tenby, demonstrated to one of us the occurrence of *Actinia*, *Tealia* etc.: as usual, together with some species of *Sagartia* (*nivea*, *venusta*, *troglodytes*, *bellis*) but no *S. rosea* and no *Actinoloba dianthus*. By the middle of April reasonably large specimens of the two last-named species were taken in fair numbers at the same spot. Have we to do here with a case of special sheltering during the winter months? It is of interest that the rocks surveyed were rather isolated and stood out of sand.

VII. Anemones eat almost any prey that blunders into their tentacle-net, but it is of interest that molluscs seem able to avoid the danger in some cases. Trochi and Littorinae may fall victims, especially to *Tealia*, but have been watched pushing their way unheeding through the tentacles of *Actinia* etc. We think they must be protected by the abundant mucus on their skins which makes it difficult for the nematocysts to penetrate, and so for the tentacles to get a firm hold. The same applies to some of the Nudibranchs; a *Goniodoris nodosa* which fell into the clutches of an *Anthea* was finally left free by the anemone after nearly two days struggle, but it died soon afterwards from the effects. Larger Nudibranchs seem to be safe from the nematocysts of Anemones, and *Eolis papillosa* is the most formidable enemy the latter possess, at any rate on the British coasts. It will rasp at the base, column, or spherules of an *Actinia* or at an *Anthea* without mercy, and many are killed in this way; we have not seen *Eolis* eat the tentacles of an anemone though Gosse claims to have found this; perhaps the tentacles are more efficiently protected by the nematocysts. As *Eolis* approaches an *Anthea*, if the tentacles of the latter touch the slug's papillae, the anemone contracts in great alarm and retreats as effectively as possible. It's best pace is, however, nothing much, and the *Eolis* keeps up with it and goes on gnawing. Once we observed this for some $2^1/_2$ hours till the anemone had moved quite an inch and had chanced to back against a closed *Tealia*, it then mounted on top of the *Tealia*, and thus escaped, for *Eolis* seems always to avoid this species. Later on, the fugitive redescended from the *Tealia* but as it moved always in one direction it was now on the far side of *Tealia* away from the slug and therefore safe.

Anemones generally move for about 12 hours after such an attack.

Of other enemies we have once noticed *Trochus ziziphinus* nibbling at the base of an anemone, we have seen crabs worry them and once eventually make off with the prey the anemone had gathered. We believe that blennies and other fish of the rock pools and shore occasionally tackle a small anemone, perhaps when they are very hungry, and there is no doubt that crabs and prawns sometimes pick at moribund individuals.

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5. Neue Cumaceen aus den Familien Diastylidae und Leuconidae von der Deutschen und Schwedischen Südpolar-Expedition.

Von Dr. C. Zimmer.

(Mit 3 Figuren.)

eingeg. 23. Oktober 1906.

Familie Diastylidae.

Diastylis anderssoni n. sp.

Weibchen: Thorax und Abdomen sind von annähernd gleicher Länge, der Thorax deutlich vom Abdomen abgesetzt. Der Carapax ist beträchtlich länger als die freien Thoracalsegmente zusammen, breiter als hoch und etwa doppelt so lang wie hoch. Von der Seite gesehen ist er oben wenig gewölbt. Die Oberfläche ist durch fein gezähnelte Rippen skulpturiert: über den hinter dem Frontallobus liegenden Teil des Carapax laufen jederseits 8 Rippen, unter sich parallel und annähernd parallel dem Hinterrande des Carapax, d. h. also in Bogen, die nach vorn offen sind. Davor liegt eine Rippe, die nur in der unteren Hälfte ausgebildet ist und an der Hinterecke des Frontallobus endet. Dann folgt in etwa $^2/_3$ Länge des Frontallobus eine, die über diesen und die Pseudorostrallappen verläuft. Weiter ist eine Querrippe ganz vorn auf dem Frontallobus vorhanden und eine geknickte vorn auf dem Pseudorostrallappen. In den Hinterecken des Frontallobus steht jederseits eine höckerartige Hervorragung. Der aufgeworfene Hinterrand und hintere Seitenrand des Carapax ist fein gezähnelt. Der Augenlobus