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XXX.—On *Guard-Polyps and Urticating Cells*.

By Dr. R. VON LENDENFELD *.

I. *The Guard-Animals of the Plumularidæ.*

The Plumularidæ are distinguished, above all other Hydroids, by the fact that a great part, up to five sixths, of all the animals of a colony are converted into guard-polyps without stomachs. Busk † was the first who accurately described the chitinous calices in which the armed animals are seated, and directed attention to these structures, which he called *nematophores*. Subsequently Allman ‡ published some observations upon the contents of these nematophores, in which he sometimes found urticating capsules, sometimes not. He states that, leaving out of consideration the urticating capsules, the whole contents consist of structureless protoplasm, which emits long pseudopodia and retracts them again. Hincks § confirms Allman's statements, and carries the analogy of the contents of the nematophores with Rhizopoda still further, assuming, like Reichert, for the whole ectoderm of the Hydroida a *Bathybius*-like ground-mass in which urticating capsules are seated.

Although F. E. Schultze || as long ago as 1872 demonstrated the cellular structure of the ectoderm of the Hydroida, it is only quite recently, by the researches of Hamann ¶, that we have attained to a more exact insight into the finer structural characters of the guard-animals. Hamann explains the contents of the nematophore as a modified polyp, for which he proposes the designation "*machopolyp*." I adopt this view, and consider that the expression "nematophore" should be reserved for the chitinous envelope of the guard-polyp. Hamann has demonstrated muscle-cells in the greatly protrusible guard-polyps; and there is no doubt that the movements of the guard-polyp are in part effected by these muscles. I say in part, because the parallel fibres, which lie in one bundle, can only effect the retraction of the guard-polyp, while its protrusion is produced by other structures.

* Translated by W. S. Dallas, F.L.S., from the 'Zeitschrift für wissenschaftliche Zoologie,' Band xxxviii. pp. 355-370. The author's third communication "Ueber Cœlenteraten der Südsee."

† Hunterian Lectures, 1857.

‡ Ann. & Mag. Nat. Hist. ser. 3, vol. xiii. (1864) p. 203.

§ British Hydroid Zoophytes, p. xvii (note).

|| Cordylophora, p. 15.

¶ Jenaische Zeitschrift für Naturwissenschaft, Bd. xv. p. 17.

The richness of the South-Australian shore-fauna in Plumulariæ is extraordinary. I have seen about forty different forms, the skeletons of which are in part already described. I have examined most of them in the living state, and would here communicate some observations which I have made upon their guard-polyps.

Notwithstanding the extraordinary variety which we meet with in their number and arrangement and in their form and size, they can all be referred to three fundamental forms, which often occur together upon the same stock :—

1. Guard-animals with urticating capsules.
2. Guard-animals with adhesive cells.
3. Guard-animals with urticating capsules and adhesive cells.

1. *Guard-Animals with Urticating Capsules.*

The guard-animals with urticating capsules occur chiefly upon the *Plumularia*-like Hydroids; they agree with the figure given by Hamann*.

The solid endodermal axis consists of elements like those of the tentacular axis, and extends to the middle of the guard-animal. The endoderm of the branch upon which the guard-polyp is seated passes directly into the endoderm of the latter. The cells which form the inner lining of the cœnosarcæ tube of the branch are turbid and completely filled with granules. The nearest endodermal cells of the axis of the guard-animal are also turbid and entirely filled with plasma. It is only at some distance from the branch that the axial cells begin to acquire more the form of chorda-cells, such as characterizes the cells of the tentacular axis; but the endodermal cells of the machopolyps, even in the distal part of the axis, are much more turbid and rich in plasma than the corresponding structures in the tentacles. In the contracted state they are quite opaque.

The ectoderm is highly developed, and consists of two layers, an epithelial and a subepithelial layer. The surface-cells appear cylindrical when the machopolyp is contracted; on the contrary, they are depressed and flat when the guard-animal extends itself. These surface-cells are for the most part entirely filled with plasma; they occur upon the whole basal part of the guard-animal. Between them and the thin supporting lamella, which is closely applied to the endodermal cells, there is a layer of smooth muscular fibres, which do

* 'Der Organismus der Hydroidpolypen,' pl. xxv.

not belong to the surface-cells, but are decidedly subepithelial. In isolation-preparations it is easy to detect the muscular corpuscles in the isolated fibrillæ; they lie between the centripetal ends of the surface-cells, and consequently may be called interstitial cells.

The muscular fibres form a cylindrical tube by lying in a parallel position upon the supporting lamella. When the guard-polyp is contracted they lie in a straight line and longitudinally. At the extremity of the endodermal axis the muscular cylinder also terminates, and there are here in the subepithelial layer from two to four fine large multipolar ganglion-cells. In the superficial layer of the whole terminal portion of the machopolyp we find large elongated urticating capsules. Each urticating capsule is enclosed by a thin plasma-envelope; the centrifugal end alone seems to be free. In this plasma-envelope there is a flat nucleus. The cnidocil is short and forms an angle of 60° with the surface; it is always situated opposite to the nucleus. Sometimes it is slightly bent, and then the concave side is always turned towards the urticating capsule.

The centripetal end of the plasma-envelope is drawn out into a process which lies radially and always appears to be straight. All these processes unite at the centrifugal extremity of the endodermal axis; therefore at the same place where the ganglion-cells are situated. Further, there are also in the terminal knob of the guard-animal radial muscular fibres, which are sometimes closely applied to the pedicles of the cnidoblasts. Supporting cells with broad centrifugal terminal lamellæ also occur. Some of the superficial cells are remarkable for their slenderness, and may be interpreted as sense-cells. I have not succeeded, however, in detecting any connexion of these cells with the subepithelial ganglion-cells, so that I am not sure whether or not these elements perform a tactile function.

The guard-polyps are capable of extraordinary extension in length, which, however, takes place slowly, like the extension of the tentacles of *Hydra*, and never shows that precision and rapidity of movement which characterize the solid tentacles. The retraction of the guard-animal takes place much more quickly; it may be effected in half a second. The movements of the extended guard-animal are inconsiderable and really amœboid.

Both the extension and contraction and the movements which are performed in the extended state may be easily recognized as the effects of two antagonists. Just as in the tentacles, we have here to do with an elastic rod on all sides

of which longitudinal muscles are applied. That the extension does not take place so rapidly as in the tentacle is easily explained by the fact that the axial cells of the guard-polyp have not attained the same degree of differentiation as the chorda-cells of the tentacular axis. This is certainly to be accounted for by the fact that the tentacles are phylogenetically much older structures than the machopolypts, and consequently their axial cells had a much longer time to adapt themselves to their new purpose than the endodermal cells of those polyps which became transformed into guard-animals.

If we start from a *Protohydra* with hollow tentacles and consider its transformation into the guard-polyp of a *Plumularid*, we meet with a gradual suppression of the gastral space. First of all the tentacles become solid; then the stomachal walls grow together. Centralization of the gastral space first of all in the person and then in the stock.

The machopolypts are certainly employed as defensive weapons, as they do not retract themselves when the polyp-stock is touched; on the contrary, they protrude themselves from their chitinous calices when the branch upon which they are seated is separated from the stock.

How far the guard-animals with urticating capsules in the nematophores of many *Plumulariæ* also act offensively I could not ascertain; but these, as well as the machopolypts with adhesive cells, hereafter to be described, may be employed in the capture of prey. In all species of *Plumularia* that I have investigated the urticating capsules at the centrifugal extremity of the guard-polyp remained always at the apex of the animal, and consequently accompanied it in all its movements. I must particularly insist upon this in opposition to Allman's statement*. Allman concludes, from his observations upon certain *Plumularidæ*, that "the clusters of thread-cells, when they exist, remain quite stationary, being never carried out with the sarcode in its pseudopodial processes." I think that I can demonstrate that this observation relates to another fact than Allman supposes; and I am sure that in all cases that I have observed, when urticating capsules and no adhesive cells occurred upon the machopolyp, the urticating capsules were never left behind in the movements of the animal.

2. Guard-Animals with Adhesive Cells.

The animals which belong to this category occur principally in those nematophores of the species of *Aglaophenia*

* 'A Monograph of the Gymnoblasic Hydroids,' vol. i. p. 116.

which are placed in front of the nutritive animals. Further, they may sometimes occur in the genus *Antennularia*. In other Plumularidæ, which, on account of their peculiar gonophores, will necessitate the establishment of a new genus, I have observed such machopolyps together with guard-animals bearing urticating capsules. They do not differ essentially in their structure from those above described. The greatest difference is that *instead of urticating capsules they possess adhesive granules which are exactly similarly formed to the corresponding elements in the tentacles of the Ctenophora*.

The adhesive animals, as I will briefly designate these machopolyps, are distinguished by their extraordinary mobility. If an occasional change of form is possible to the urticating guard-animals, the adhesive animals can entirely draw themselves out into long fine threads, at the extremity of which there is then a bulbous dilatation, which on its part is capable of considerable change of form.

In these guard-animals we can detect surface-cells, sub-epithelial muscles and ganglia, the supporting lamella, and endodermal axis. The thickened terminal part consists of pyramidal cells radially arranged, all, or the greater part of which, produce adhesive granules. Thus we find in each of them a rounded drop of a strongly refractive substance; and by this means these cells acquire exactly the appearance of gland-cells. The drop originates at the narrowed centripetal end as a small vacuole, and migrates during its growth towards the widened centrifugal end of the cell. The perfect adhesive granule attains nearly the diameter of the free surface of its formative cell and is globular; it projects pretty far above the surface of the terminal enlargement of the guard-animal. Such mature adhesive granules generally occur in considerable number; but they do not stand so close together as on the surface of the prehensile apparatus of the Ctenophora, and never show that regular arrangement which Chun figures* in *Euplocamis stationis*. The great similarity between our guard-polyps and the prehensile filaments of the Ctenophora strikes one at once. The difference consists essentially only in the fact that the filaments themselves in the Plumularidæ are not spirally rolled up. We shall revert further on to the analogy of these weapons. Allman† figures an *Antennularia* the guard-animals of which are branched. In those Australian species of that genus which contain only machopolyps with adhesive cells, I have only met with ramifications when cer-

* 'Die Ctenophoren des Golfes von Neapel,' pl. xviii. fig. 11.

† 'A Monograph of the Gymnoblasic Hydroids,' vol. i. p. 116.

tain adhesive granules remained adherent to any object which could not be drawn nearer, and then, during the contraction of the guard-animal, the thickened terminal part was much drawn out in length. If then another part of it adhered to some other object and the machopolyp contracted still further, it sometimes acquired, in a certain sense, a ramified form.

These guard-polyps are exclusively offensive in their action. If the polyp-stock be disturbed they retract themselves into their chitinous calices. I can completely confirm Allman's statement*, that the "pseudopodium-like processes" are visible only on perfectly fresh stocks, as regards the adhesive polyps; and I believe that the statements of Allman and Hincks relate principally to these adhesive polyps. We shall recur to their function further on.

3. *Guard-Animals with Urticating Capsules and Adhesive Cells.*

These machopolyps are found exclusively in the genus *Aglaophenia*; and here they occur in those nematophores which are placed behind the nutritive animals and project beyond these. I call them paired superior guard-animals.

For our investigation some species of *Aglaophenia* with large superior guard-animals which are abundant here (Melbourne) are admirably adapted. The nematophores which contain these machopolyps have, besides the circular orifice at the extremity, also an oval aperture at the side; this is placed towards the nutritive animal, at the spot where the chitinous calice of the nutritive animal terminates, on the concave anterior side of the nematophore which is turned towards the nutritive polyp. In these nematophores are seated guard-polyps which are composed of two parts. In the distal extremity, close under the terminal orifice, there are urticating capsules; while from the proximal aperture a filament can be extended, at the extremity of which there is an adhesive knob. The distal part resembles an animal armed with urticating capsules, while the proximal part is to be compared to an adhesive animal.

Of the former, however, only that part is developed which represents the distal part of an animal armed with urticating capsules, such as I have described above. There is no endodermal cellular axis, and therefore also no supporting lamella. But ganglion cells occur in the subepithelial layer; and between the cnidoblasts there are radial muscles and supporting

* *Loc. cit.* p. 115.

cells, and perhaps also sense-cells. This part of the guard-animal, the muscular stem being deficient, is not very mobile, and it is protruded only for a short distance from the terminal orifice of the nematophore. In the basal part of the nematophore there is a second head, which exactly resembles an adhesive polyp; its thickened extremity can be protruded far out of the inferior aperture of the nematophore, and it possesses an endodermal axis.

Although at the first glance the whole rather gives us the impression that we have to do here with *two* modified polyps, the simple undivided endodermal axis indicates that the whole is homologous with a *single* polyp. If we trace the development of these guard-animals we see distinctly that both pieces are parts of an originally simple armed polyp. Thus the end of the branch always forms a pair of guard-polyps; long before the nutritive animals in front of these have become developed, the next pair of machopolyps sprouts. At the ends of the branches of young stocks we can find all stages; and in this way it is easy to trace the development.

Young guard-polyps of this kind are inserted in chitinous calices, the hinder margin of which is somewhat higher than the anterior margin; they are completely filled with urticating capsules and tolerably mobile, so that they can stretch forth their mitrailleuse-like heads for a considerable distance. While no chitine is secreted at the anterior side, the hinder margin grows very rapidly. In this way the nematophore acquires the form of a very obliquely truncated straight circular cylinder. Then the chitine secretion ceases at the lower part of the elliptical margin, while the uppermost part grows in all directions, and its margins finally unite again into a tube. This tube then elongates, and in some *Aglaophenia* bends outwards in a hook-like form.

In some instances the formation of two apertures is not attained; and then the nematophores possess a wider or narrower cleft, which unites the two apertures. This applies without exception (?) to those nematophores which are closely applied to the upper surface of the nutritive animal in the plane of symmetry of the branch, the unpaired, superior machopolyps.

Even when the two apertures are separated, when a nutritive polyp is in course of formation in front of the nematophore, and the buds of the next pair of guard-animals are already indicated, no adhesive cells are yet to be met with; there is rather an urticating battery behind each aperture. It is only subsequently that small drops begin to appear in the supporting cells between the cnidoblasts of the lower

battery; and these in older guard-animals attain the form and size of adhesive granules. At the same time the number of cnidoblasts diminishes, the urticating capsules falling out and the plasma-envelopes degenerating. Frequently, however, a few urticating capsules are found even later in the head of the prehensile filament, and these are not thrown off until very late. In the older parts of the stock they never occur.

Allman states* that in some Plumularidæ, and especially in *Antennularia*, the nematophore is divided into two stories by a diaphragm. I can confirm this statement for the Australian *Antennulariæ*; and add that in many (perhaps all?) species of *Aglaophenia* also such a diaphragm is more or less developed in the paired superior nematophores.

The division of the body of the nutritive polyps of the Plumularidæ into an oral and an aboral half, which is caused by a considerable circular constriction in the middle of its length, has already been described by Hamann†. His statements apply also to the Australian species. The division of the large guard-polyps into a distal defensive and a proximal offensive half seems to me to indicate that in this case the centripetal part is homologous with the aboral and the centrifugal with the oral part of the nutritive animal.

I have frequently had the opportunity of tracing in the living animal the mode of action of the armed animal, and will here give the most important points. The *Aglaopheniæ* live principally upon zoëæ and other larvæ. If a zoëa comes in contact with a tentacle it is struck by several cnidocils and makes vehement movements in order to escape. These efforts, however, are fruitless, which I would ascribe to a numbing action of the nettling threads. As soon as the zoëa has touched the tentacle, all the prehensile threads (there are five of them) belonging to the particular polyp bend and stretch themselves towards the spot. Usually the zoëa at the same time touches the adhesive head of one or other of the prehensile threads and adheres to it firmly. While the prey-loaded filament rapidly shortens, the zoëa, which makes very strenuous movements, soon sticks to several prehensile filaments, which shorten as soon as they are touched. The zoëa is quickly so surrounded that it can no longer move. In this state it gets again within reach of the tentacles. The separation from the head of the prehensile filament is effected by the casting off of the adhesive granules. Whether a poisonous action is to be ascribed to the adhesive granules also

* 'Monograph of the Gymnoblasic Hydroids,' vol. i. p. 28.

† Jenaische Zeitschrift &c. Bd. xv. p. 57.

cannot be determined. I have never observed a case in which a zoëa which had once been caught freed itself again.

Quite another picture is presented when a larger animal, such as an Annelid, accidentally touches a tentacle. Immediately all the prehensile filaments are withdrawn; but, on the other hand, the urticating batteries at the terminal ends of the large nematophores are projected far out; the tentacles also are concealed; so that a comparison with the formation of a square to resist an attack of cavalry is certainly appropriate.

I have indicated above that Allman's statement that the urticating capsules were not pushed forth with the other parts of the armed animal relates to a particular condition. I believe that he must have observed composite guard-animals in which the urticating capsules cannot indeed be protruded with the prehensile filaments, but certainly by themselves.

As a matter of course, I am far from assuming any genetic connexion between those Ctenophora which possess prehensile filaments and the Plumularidæ; but nevertheless I believe that, by the discovery of adhesive granules in Hydroids, some light is thrown upon the corresponding and hitherto isolated structures among the Ctenophora. As we see in the Plumularidæ that in the development of the composite guard-polyps urticating capsules *first* appear, and these are then *gradually* replaced by adhesive granules, we may well assume that the adhesive granules represent phylogenetically the younger structures. The same causes must produce the same effects; and thus, in the Plumularidæ as in the Ctenophora, selection may very well have converted the urticating capsules in part into adhesive granules: we have before us *analogous* structures.

Chun* and, subsequently, Claus† have asserted the homology of urticating capsules and adhesive granules; and I believe that, by the observations above described, this interpretation will be completely established as correct.

If we inquire, further, to what tissue the cells in which the adhesive granules originate are to be ascribed, their great resemblance to dermal glands, such as we know in various Coelenterata, must immediately strike one. In fact I do not hesitate to refer them to the unicellular skin-glands, and regard the adhesive granule, *which, like the urticating capsules, only acts once and then disappears*, as their secretion.

* Zoolog. Anzeiger, Bd. i. p. 50.

† 'Grundzüge der Zoologie,' p. 297, note.

II. On Urticating Cells in the Gelatinous Mass of the Disk of *Crambessa mosaica*.

During the histological investigation of this magnificent Rhizostomatous Medusa, which sometimes occurs in enormous swarms, I came upon some peculiar structures which occur in the gelatinous mass of the disk.

This gelatinous mass is pretty tough, and, in its firm structure, resembles the jelly of *Cyanea Annaskala**, which has been fully described by me. Only here, in accordance with the firmer consistency, the fibrillæ lie much closer together than in *Cyanea*. The increase in number affects chiefly the smooth fibrillæ. Granular fibres occur particularly well developed beneath the olfactory pit. Here they run chiefly vertically, and therefore pass through the disk-jelly transversely. Notwithstanding the probability raised by their position that we have here to do with nerve-fibres which unite the sense-epithelia of the oral and aboral surfaces of the disk, I am not inclined to regard them with any certainty as nerves, as, in spite of all my endeavours, I have not succeeded in detecting any direct connexion with them of the nerve-fibres which spread under the sense-epithelia.

Some of the granular fibres of the jelly beneath the olfactory pit become thickened at certain points, and contain large, long, and narrow urticating capsules, slightly curved into a sabre-like form. In the enlargement of the granular fibre, in which the urticating capsule lies, a nucleus may always be detected; and consequently the whole is probably to be interpreted as a cnidoblast. I found some of the capsules discharged; and in these cases the nettling thread was repeatedly bent and imbedded in the granular plasma which surrounds the capsule.

The consistency of the jelly is such that sections may be made through it without first hardening it. I was thus enabled to observe these urticating capsules in the living state. By the addition of acetic acid they may be at once caused to discharge, but the thread remains always in the plasma and never issues into the jelly. This seems to indicate that between the jelly and the cnidoblast there is a firm separating layer, which, however, is not optically perceptible. As with the tentacles of *Cyanea Annaskala* (*l. c.*), I have tried here also whether the urticating capsules discharge themselves when no direct irritation affects them, in order to ascertain whether a nervous action has anything to do with the discharge

* Zeitschr. f. wiss. Zool. Bd. xxxviii. p. 472.

of the capsules. In the present case this test succeeds very easily. When a transverse section through the margin of the umbrella under the olfactory pit is brought under the covering-glass in such a manner that the olfactory pit shows freely, and then its sense-epithelium is touched with acetic acid, the urticating capsules go off one after the other, those first which lie nearest to the irritated spot.

If it is thus rendered probable that the granular threads with which the cnidoblasts are certainly, and the irritated sense-epithelium perhaps, in continuity, this mode of discharge of the urticating capsules leads us to consider how the capsule is burst. We have here no mechanically acting cnidocil; and therefore cannot regard a pressure exerted from the sides upon the cnidoblast as the cause of the rupture. It seems to me rather to follow necessarily from the state of matters described that the irritation is transferred through the fibre to the plasma of the cnidoblast, and causes this to contract; for it is probably a fundamental property of still undifferentiated plasma to contract upon irritation. The plasma of the cnidoblast, however, has the form of a closed tube; and the uniform contraction of such a tube will have as its consequence a preponderance of the pressure on the sides of the elongated capsule, by which the nettling thread will then be pressed forth.

These urticating capsules occur exclusively in that part of the disk which, as the so-called covering lamina, closes from above the cavity in which the marginal corpuscle lies. At any rate they serve as defensive weapons for the protection of the marginal corpuscles, and are consequently analogous to that urticating pad which runs above the nervous ring of the *Craspedota*.

III. On *Urticating Cells*.

The valuable investigations of Hamann * have essentially advanced our knowledge of these peculiar microscopic weapons. Wright †, the discoverer of the palpocils of *Syn-coryne*, without further consideration ascribed to the cnidocils the function of tactile setæ; but Schultze ‡ raised doubts as to this interpretation, and Hamann now seeks to prove that in the urticating cells we have not to do with sense-cells. I believe that all zoologists will probably adopt this opinion. Hamann endeavours to prove that the centripetal process

* *Jenaische Zeitschrift*, Bd. xv., "Ueber Nesselkapselzellen."

† *Proc. Roy. Phys. Soc. Edinb.* vol. i. p. 341.

‡ '*Cordylophora*,' p. 22.

which Schultze (*l. c.*) discovered and all later observers have also found on the cnidoblasts is nothing but a pedicle which stands in direct connexion with the supporting lamella and represents a product of metamorphosis of a part of the plasma of that cell which also produced the urticating capsule in its interior. He states that this pedicle possesses the same optical and chemical properties as the supporting lamella. From his careful observations, extended over all groups of the Coelenterata, he draws the conclusion that in *all* Cnidaria the process has only a supporting function. To this induction, as such, of course no certainty can be ascribed, and it is in fact not correct.

In isolation-preparations of *Cyanea Annaskala** I have often seen cnidoblasts the centripetal processes of which were in connexion with ganglion-cells of the subepithelial layer. Leaving this out of consideration, these processes are not hyaline, but granular, and not different from that part of the plasma which surrounds the urticating capsule and lies in the neighbourhood of the nucleus. Besides these urticating capsules, I have also described smaller ones in which I could detect no processes, and the discharge of which does not depend, like that of the large ones, upon the will of the animal. I regard it as probable that these in reality possess such pedicles as Hamann describes, but which escaped me owing to their fineness. Thus I have found (*l. c.*) that the surface of the jelly beneath the urticating warts shows asperities. These asperities resemble sharp-angled sea-waves; and it is quite possible that fine threads issue from the projecting points and bear the small urticating capsules at their distal ends.

With regard to the pedicles of the urticating capsules of a *Syncoryne* which I have carefully investigated, and which is characterized by its quadrigonate structure, I can completely confirm Hamann's statements. The pedicle is perfectly hyaline and enlarged in a cup-like form at the distal extremity.

It is otherwise with the urticating capsules of *Medusæ* and *Actiniæ*; their processes are granular, and, as regards their substance, essentially different from the jelly and the supporting lamella. They are always soft, generally curved, and exactly resemble plasma-cords. It can easily be shown that, just as in the tentacles of *Cyanea*, so also in the *Actiniæ* the discharge of the urticating capsules is dependent on the will of the animal, so that we must assume that some mechanism

* Zeitschr. f. wiss. Zool. Bd. xxxvii. p. 480.

or other exists in these animals which is in connexion with the nervous system of the animal, and the action of which consists in its exerting, under certain conditions, a pressure upon the urticating capsule. Such a mechanism might exist either within the cnidoblast or outside it.

I believe that the former is the case, and support my opinion upon three facts.

In the first place we have before us in the cnidocil a structure which is evidently connected with the mechanism of discharge, just in the same way as the nervous system of the animal, because, under certain conditions, a touching of the cnidocil suffices to burst the capsules, just like an impulse of the will of the animal. But it is precisely the plasma-envelope of the urticating capsule in which both the cnidocil and the pedicle open, and thus at this place alone we shall probably have to seek the mechanism which can be set in motion from both sides.

It is indeed not impossible that the irritation of the cnidocil in fact comes as sensation to the knowledge of the subepithelial ganglion-cells, and that then only is some other mechanism for the discharge of the urticating capsules set in motion from this point. But this appears to me extremely improbable.

In the second place the urticating capsules in the disk of *Crambessa mosaicæ* discharge themselves upon nervous irritation; and it can scarcely be supposed that the irritations cause the contraction of the jelly in the vicinity of the cnidoblasts, but rather that they superinduce a discharging action in the plasma of the cnidoblasts itself.

Thirdly, we must here cite the noteworthy discovery of Chun *, who has detected in the plasma-envelope of the urticating capsules of *Physalia* a network of contractile fibres, by the contraction of which a rupture of the capsule can be easily effected. Here, in an animal celebrated for its urticating qualities, we find the plasma of the cnidoblasts of a higher grade; it has already secreted muscular fibres.

Considering these points, I would assume the contraction of the plasma-envelope to be the cause of the discharge of the urticating capsules, and not a contraction of the pedicle.

I have postponed the discussion of the centripetal extremities of the pedicles of the urticating capsules of the guard-animals described in § I. until now, because it may be of more general importance. Although I am not sure, the impression has been made upon me that the pedicles, as stated

* Zoologischer Anzeiger, Bd. iv. p. 646.

by Hamann, unite with the supporting lamella, and that therefore only a supporting function is to be ascribed to them, but that *finer threads from the multipolar ganglion-cells run up on these pedicles and place themselves in connexion with the plasma of the cnidoblast.*

If we compare the morphological characters of the urticating cells with the observation of living animals in the aquarium, we shall be struck especially by one peculiarity of the arenicolous Actiniæ; although hundreds of capsules discharge themselves when a digestible body touches the cnidocils, not a single one is discharged when sand falls upon them. If a freshly torn-off tentacle is placed under the microscope and there are many small animals in the water, we can easily observe how every contact of an animal with the surface of the tentacle is accompanied by a salvo of nettling threads, while not a single one can be coaxed forth if a rapid current is produced, and sand-grains, fragments of covering-glass, and the like are introduced under the cover.

In the Actiniæ therefore it seems to be dependent on the will of the animal whether the touching of the cnidocil shall or shall not be followed by a discharge. If this phenomenon be considered in connexion with the fact that urticating capsules are never discharged when the animal retracts its tentacles, when the pressure in the vicinity of the cnidoblasts is heightened by muscular contraction, and the cnidocils touch other bodies, I think I am justified in regarding the following process of discharge of the urticating capsules as the most probable:—*There exists a continuous connexion between the nervous system and the plasma-mantle of the urticating capsule. The urticating capsule is ruptured by the pressure which the plasma-mantle exerts upon it* *. In Cyanea Annaskala there is added to this a stellule which breaks through the membrane of the distal pole. In Physalia the plasma has already separated muscular fibres. The contraction of the plasma-mantle is induced by an excitation proceeding either from the cnidocil or from the nervous system. Further, however, a preventive excitement may issue from the nervous system, which paralyzes the cnidocil—excitation which, under ordinary circumstances, would burst the capsule. The nervous system can therefore take on the function of a "preventive centre," while the discharge by the cnidocil-excitement is to be compared to a "reflex movement." Here therefore we already see the commencement of that reciprocation of reflex and preventive action to which modern psychology ascribes such great importance.

* In this I find myself in agreement with Chun (*l. c.*).

If we now consider the urticating cells we shall find that they may be compared both with the epithelial muscular cells and with the dermal gland-cells. Certainly in all cases, with the exception of *Physalia*, their glandular nature comes most prominently forward, for we have a plasma-derivative which is thrown off outwards, and consequently may be regarded as a secretion, while usually there is no contractile plasma-derivative; and we are not justified in speaking of muscles when we describe a structure which certainly contracts on irritation, but in which two kinds of substance are not recognizable, and in which therefore no profound division of labour has taken place in a contractile and a plasmatic part.

Independently of this, however, the double irritability of the cnidoblasts is in favour of the view that there may be "neuromuscular cells" which occur together with sense-organs and ganglion-cells, a view which has been opposed by Claus, the brothers Hertwig, and myself. But the cnidoblasts are such peculiar structures that we can scarcely draw any conclusion from them as to epithelial muscular cells, so that the neuromuscular theory can hardly be supported by them.

The glandular nature of the cnidoblasts becomes particularly probable if we accept the homology between adhesive granules and urticating capsules; and I would therefore regard *the cnidoblasts as unicellular dermal glands*.

XXXI.—*On a Case of Commensalism of a Caranx and a Crambessa*. By M. GODEFROY LUNEL*.

THE case which has furnished me with the subject of the present memoir relates to animals belonging to very different classes, namely Fishes and Medusæ. Numerous memoirs, the enumeration of which would be out of place here, have been published by the older and more recent naturalists upon the organization and anatomy, or upon the development or the zoological characters of the animals of the latter class. I shall therefore confine myself to referring, at least in part, to what has been said upon their mode of alimentation.

The Medusæ feed upon small naked pelagic animals, and even, according to some authors, upon small fishes, which they

* Translated by W. S. Dallas, F.L.S., from the 'Bibliothèque Universelle,' période 3, tome x., Archives des Sciences, p. 271, September 15, 1883.