XIII.—On HYDRICHTHYS BOYCEI, a Hydroid parasitic on fishes,

by

Ernest Warren, D.Sc., Director of the Natal Museum.

WITH PLATES XVII–XX.

THE hydroid which is described in this paper is of special interest in the fact that it exhibits in a dramatic form a true parasitic habit. It is not parasitic merely in the sense that the body of the fish constitutes a convenient surface for the attachment of the hydroid; but it obtains by far the greater part, or more probably the whole, of its nutriment from the tissues of the host.

I am much indebted to Mr. E. C. Chubb, Curator of the Durban Museum, for the opportunity of examining this hydroid. It was discovered by his assistant, Mr. David Boyce, on a small fish from Durban Bay, May, 1915.

The material placed at my disposal had been preserved in two ways. After carefully narcotising with 1% cocaine some of the specimens were fixed by immersion in 10% formaline, others with a hot solution of corrosive sublimate and acetic acid. For general histology the corrosive sublimate material was preferable. The sections were stained with Delafield's Hæmatoxylin followed by Orange.

I have not personally observed the hydroid alive, but I have to thank both Mr. Chubb and Mr. Boyce for careful observations on the living organism.

The first specimen obtained was found attached to the dorsal fin of a small fish about ¾ inch in length. The colony appeared as a small cluster of individuals forming a somewhat conspicuous reddish mass about 12 square millimetres in area and 2·5 mm. in height. Subsequently about a dozen colonies of varying sizes were collected. They were attached to various parts of the fish: the surface of different fins, the sides of the body, the dorsal surface of the head and the caudal portion of the body.

At least three species of fishes were attacked. One young specimen of a certain species of the *Glyphidodontidæ* was found infested, but the majority of the material was obtained from young specimens of a species of *Mugil;* and the fish locally known as the "silver" (*Ambassis natalensis*, Gilchr. & Thomp.) was also attacked.

The colony consists of a plate-like hydrorhiza bearing elongated hydranths and branching gonostyles. The plate is capable of budding medusæ directly without the intervention of any obvious gonostyle. In older colonies one or more somewhat massive, vertical outgrowths are formed, these are lobed rather than branched and bear dense clusters of developing medusæ. A hydrocaulus is absent, unless the thick vertical outgrowths and the basal ends of the hydranths and gonostyles are to be so regarded.

TROPHOSOME.—The *Hydrorhiza* consists of an irregular lobed plate firmly attached to the surface of a fin or of the body of the fish (Pl. XVII, fig. 1, H). This plate is not composed of a plexus of branching or intercommunicating tubes. At no portion of the plates of the various colonies examined was there any suggestion of the formation of tubular outgrowths which subsequently fused. The plate grows from the free edge and gradually extends over the surface of the fish. The plate is not covered with any perceptible perisarc, and, in fact, no perisarc of any kind was detected on any part of the hydroid. The hydroid appears to be perfectly naked, and the whole of it is highly sensitive and contractile. Mr. Chubb writes: "the whole colony would occasionally contract after the manner of a rotifer and slowly extend again."

The plate consists of an outer layer of ectoderm, composed of cells of moderate depth, which is continued round the free edge of the plate into the inner layer of ectoderm. The latter is in contact with the surface of the fish, and is composed of cells of great depth. These cells are capable of eating away the epidermis of the fish at the growing edge of the plate (Pl. XVIII, ep.); also, this inner layer sends into the subcutaneous tissue of the fish haustorium-like outgrowths which can penetrate deeply into the dermis, and may reach the muscular tissue. The inner ends of these elongated columnar cells send branching processes between the cells of the host, and in this way the cells are absorbed.

Within the two layers of ectoderm of the plate there is an irregular plexus of endodermal canals with only faint traces of mesoglea in certain places. On two occasions a short ectodermal tube was found, which was of the nature of an elongated pit, opening to the exterior on the surface of the outer ectoderm (Pl. XVIII, ec. p.). These pits were not a constant feature, and in some colonies appeared to be entirely absent. It must, therefore, remain doubtful as to whether they have any phylogenetic significance, or are to be regarded as of an accidental nature.

With reference to the histology it must be noticed that no nematocysts of any kind were found in the ectoderm of the plate. The outer ectoderm is otherwise of normal character. The inner epithelium consists of exceptionally deep columnar cells with very large nuclei and granular protoplasm. The irregular branching protoplasmic processes which burrow between and into the cells and connective tissue fibres of the host are especially granular in character.

The endodermal canals are generally much flattened in accordance with the fact that the space between the two layers of ectoderm is mostly very narrow. Some of the tubes consist of more or less flattened cells, and the outer and inner walls of the tube are of about the same thickness. In other tubes, however, the outer wall of endoderm consists of fairly tall columnar cells and the inner wall of very flat cells. These tubes are in direct continuity with the endoderm running up into the gonostyles or hydranths which are carried by the plate-like hydrorhiza. The outer layer of endoderm consisting of thicker cells is generally charged with rounded globules of a yolk-like substance.

Hydrocaulus.—The individuals of the colony are borne directly on the plate, on branching blastostyles or gonostyles and on certain somewhat massive vertical upgrowths. When the individuals are carried directly on the plate the hydrocaulus, if present at all, may be regarded as being represented by the basal ends of the hydranths or the short pedicels of the developing medusæ. The vertical upgrowths bear clusters of developing medusæ, but hydranths have not been found springing from them.

The thick, vertical upgrowths, which perhaps could be regarded as hydrocaulus, only differ from the branching gonostyles in being lobed rather than branched and are characterized by the possession of exceptionally thick endoderm and thick mesoglea (Pl. XVIII, mg., Pl. XIX, figs. 4, 5). The ectoderm is normal in character except that there are no nematocysts, and it is continuous with the outer ectoderm of the basal plate. The mesoglea on its outer surface is raised into short vertical outgrowths which may be branched; they support the muscular filaments of the myo-epithelial cells, and strongly recall the structure seen in the *Siphonophora.* The inner surface of the mesoglea in contact with the endoderm is smooth. The endoderm is of very great thickness and may almost occlude the lumen. It consists chiefly of large peculiar cells bearing clusters of elongated oval vacuoles which are held in a fan-like radiating structure of stiffer protoplasm. Wedged between these large cells are glandular oval cells with granular protoplasm. Since these massive vertical upgrowths appear to carry only developing medusæ it is probably preferable to regard them as modified gonostyles rather than hydrocaulus.

Hydranth.—The hydranth is elongated and is capable of serpentine movement. It is characterized by the entire absence of tentacles. Ordinarily the mouth is completely closed. Round the edge of the mouth the ectoderm forms a thickened ridge, and this bears large well-developed nematocysts (Pl. XIX, fig. 2). The nematocysts appear to be of one size only, and measure about 9·1 μ in length and 3·6 μ in width. Several nematocysts were found discharged. There is a raised collar at the base of the thread, but no obvious barbs were detected (Pl. XIX, fig. 7, 8). The remainder of the ectoderm is flat and continuous with the outer ectoderm of the basal plate. There is no perisarc.

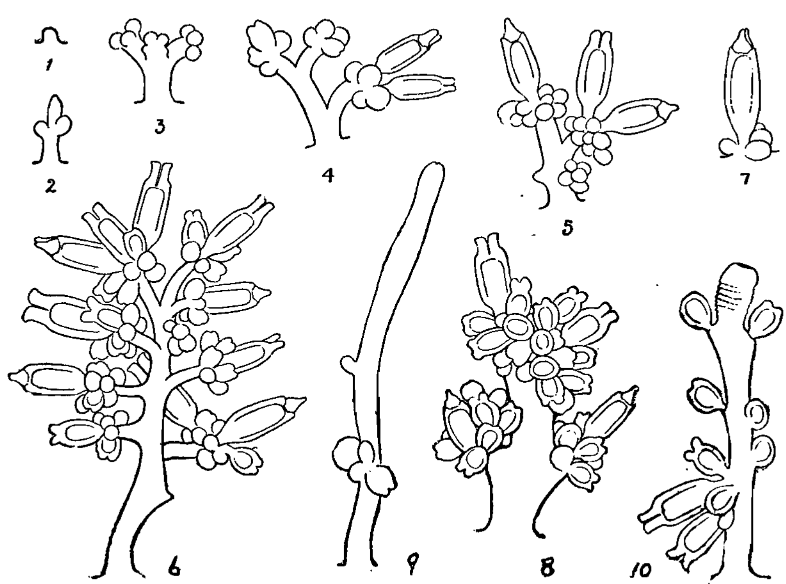
The endoderm is reddish in colour. The endoderm of the distal half of the hydroid is raised into five longitudinal ridges, while in the proximal region it tends to be raised into hemispherical swellings. The endoderm of the longitudinal ridges consists of elongated columnar cells of granular protoplasm carrying large elongated oval vacuoles (Pl. XIX, figs. 1, 2, 3). The endoderm of the proximal half is similar in character to that of the gonostyles and the lobed outgrowths. The cells contain both large, oval vacuoles and rounded vacuoles, the latter occurring at the distal ends of the cells.

Food in the form of captured prey has never been seen in the digestive-cavity of the hydranths. It is possible, however, that the hydranth may occasionally capture prey, since sometimes the mouth may be seen to be open and funnel-shaped.

The main, if not the entire, food-supply undoubtedly comes from the fish-host. The polyp is capable of bending down to the surface of the fish and of forcing its widely opened and reflexed mouth into the injured tissues, and there tapping the blood-vessels (Pls. XVII, XVIII, h.s.; Pl. XIX, fig. 3). The blood is sucked into the digestive-cavity in considerable quantities. In one case a large mass of connective tissue had been similarly engulfed. It is perhaps doubtful whether the hydranth is capable of penetrating the uninjured epidermis of the fish. In all the cases observed the hydranth had pushed itself into subcutaneous tissue from which the adjacent epidermis had been removed by the basal plate. It is probable that the basal plate is capable of contracting away from the place where a hydranth is about to dip down into the tissues. The blood-corpuscles of the fish may be found in the cœlenteron of any part of the hydroid. The hydroid is thus very effectively nourished, for not only is there an ample supply of plasma, but the red corpuscles themselves appear to be digested to a certain extent, since some of those which lie in the cœlenteron seem to be shrivelled and disintegrated; also, the endoderm cells are capable of ingesting the corpuscles. In this connection it may be noticed that definite spaces in which lymph must be collected frequently occur between the basal plate and the dermis of the fish (Pl. XVIII, l.s.) and it is clear that this fluid could be readily absorbed by the inner ectoderm of the basal plate.

Gonostyle.—The gonostyles are branched structures (text-fig. 12; 6) springing from the basal plate; they resemble those of the *Siphonophora*. There is a main axis from which are given off irregularly branches of no great length. The main axis and the branches bud off clusters of developing medusæ. It is believed that in older colonies the main axis of one or more gonostyles becomes

TEXT-FIG. 12.



The growth of the gonostyles × 36. 1–6, formation of branched gonostyle showing the growth of medusa buds and gonostyle *pari passu*; 7, developing medusæ springing from hydrorhiza with little trace of gonostyle; 8, massive vertical up-growth (unbranched gonostyle) from hydrorhiza with numerous medusæ; 9 and 10, hydranths budding medusæ.

massive and the branches are reduced to lateral lobes (text-fig. 12; 8). In this connection it must be remembered that the whole colony is very contractile, and without doubt the lobes are considerably contracted. The histology has been already described.

In the growth of the gonostyles from the hydrorhiza small buds, which will develop into medusæ, are produced at the very earliest stage: the merest peg-like out-growth from the hydrorhiza, which will grow into a branched gonostyle, already bears medusa-buds. The medusa-buds and the gonostyle itself grow up together (text-fig. 12; 1-4).

GONOSOME.—The free-swimming medusæ which are formed are capable of arising anywhere on the colony. They may arise singly budded off directly from the plate (Pl. XVII, fig. 1: text-fig. 12; 7): more usually they occur in clusters on short pedicels springing from short branches of the gonostyles which arise from the basal plate (Pl. XVII, fig. 1, g). In older colonies, as we have seen, they are budded in great numbers from one or more thick, lobed, vertical upgrowths from the plate (Pl. XVII, fig. 1, m.g.). In addition they may be budded from the sides of the hydranths (h.g.). So many buds may be formed upon the hydranth that the polyp may become practically abortive, and lose most of its power of serpentine movement.

The development of the medusa is typical and is shown in Pl. XX. It arises as a small hemispherical bud. Marked features in the development are: (1) the very early appearance of the fundaments of the two basal bulbs of the tentacles; and (2) the great increase in size of the endoderm cells as development proceeds; these gradually become charged with rounded globules of reserve yolk-material.

The bud-like outgrowth consists of a uniform layer of ectoderm and endoderm (Pl. XX, fig. 1). At the apex the ectoderm cells enlarge and the endoderm is invaginated. These large ectoderm cells divide (fig. 3) and from them a layer becomes differentiated over the invaginated endoderm. At this place the endoderm becomes slightly evaginated, this is the beginning of the manubrium; and the layer of differentiated ectoderm will become the ectoderm covering the manubrium. A split now occurs (fig. 4) which is the fundament of the umbrella-cavity. In the roof of the cavity thus formed two layers of ectoderm become differentiated, these constitute the beginning of the velum (fig. 5). The two tentacle-bulbs are becoming defined, and the double layer of endoderm running into them is continuous with the fundament of the radial endodermal canals (fig. 5). In transverse section (fig. 6) the endodermal lamella, consisting of a single layer of endoderm, is seen; also, it can be noticed that the ectoderm lining the umbrella-cavity is much deeper over the endodermal lamella than over the radial canals. This character disappears at a later stage (fig. 8). Finally the double layer of ectoderm which will form the velum (fig 5) becomes perforated (fig. 7), and the opening in the umbrella-cavity thus arises. A well-defined circular endodermal canal is formed.

The manubrium is yellowish in colour. At this stage the manubrium is of great size and the endoderm is very heavily charged with reserve food-material.

The two tentacle-bulbs taper somewhat, and begin to diverge from each other (Pl. XVII, figs. 1, 2, 3, 4).

In specimens confined in an aquarium the medusæ become free in the condition shown in fig. 4 and sink to the bottom of the vessel. It will be noticed that the manubrium is relatively very large, and the umbrella-cavity is narrow. Very rapid growth at the expense of the reserve yolk now occurs, the apices of the tentacle-bulbs rapidly grow out into thin tentacles, and the umbrella-cavity greatly enlarges, partly by the considerable expansion of the outer wall of the medusa, and partly by the shrinkage of the manubrium. A mouth at the end of the manubrium appears and it is bounded by four radially placed swellings which are continued down the sides of the manubrium as four slight ridges (figs. 5, 6). The mouth itself is more or less diamond-shaped with the corners radial in position with respect to the radial canals.

Around the outer edge of the velum a thickened ring of ectoderm is produced. Opposite one of the radial canals there is a slight, but quite definite, swelling of the ring. With the four-cornered mouth, the single swelling over one radial canal and the two well-developed tentacle-bulbs and tentacles, the medusa is bilaterally symmetrical about the vertical axis as seen in fig. 6 which is a view of the medusa from below. The slight swelling on the edge of the bell doubtless represents an abortive tentacle-bulb. It is curious that a similar one was never observed to occur on the opposite side. The two tentacles of the medusa grow to an extraordinary length, they may attain a length of about 20 times the depth of the bell (fig. 9).

The great size of the tentacle-bulbs causes a definite narrowing of the edge of the bell (figs. 5, 7, 8), so that the radial canals are bent at a more or less sharp angle in order to reach the circular canal.

The medusæ lived for about a week in the aquarium, and Mr. Boyce states that they were singularly inactive and sluggish during the whole period. He observes: "When alive the medusæ are not active, they usually keep to the floor of the tank with their tentacles, which reach a length of $\frac{5}{8}$ inch, always extended. When liberated the medusæ sink to the bottom of the water where they remain unless disturbed. In two instances only were medusæ seen swimming."

It is not possible to say whether the medusa is capable of much further growth when in the natural state; but it is practically certain that no further tentacles would arise. The single slight swelling on the edge of the bell exhibited no tendency at all to enlarge as the medusa became older.

The medusæ were not sufficiently mature to exhibit definite gonads. At the extreme base of the manubrium there occur four inter-radial swellings (figs. 5, 6, 7, 8, G) of the digestive-cavity, and possibly these mark the position of the future gonads formed in the ectoderm covering them. Germinal cells were searched for in sections through the developing medusæ but they were not clearly identified.

The outer surfaces of the developing and free medusæ are well provided with nematocysts: thus in this character the medusa differs markedly from the hydranth where the nematocysts are confined to the ridge around the mouth.

No eye-spots or otocysts could be detected.

The medusæ which were liberated varied considerably in size: the ones produced terminally on the branches of the gonostyles (Pl. XVII, fig. 1: text-fig. 12; 5, 6) were larger than those carried at the sides. Possibly the former would develop into female and the latter into male medusæ. Owing to the fact that the medusæ would not live longer than about a week in captivity it was not possible to decide this point. In other hydroids it very generally happens that the female gonophores are formed in the position of the richest food-supply, such as on the central stem, while the male gonophores occur on lateral branches.

Systematic Position.—Like other parasites the present organism has become considerably modified by its parasitic habit, and it is not easy to refer it to its true systematic position. The young stages of parasites are frequently but little modified; and they may hence give a clear insight into the real nature of the parasite.

In the present case, since the medusa is not parasite, it would appear to be advisable to endeavour to trace its affinities rather than those of the modified parasitic hydroid. Unfortunately the medusa is known only in an immature condition.

The medusa, with its pair of elongated tentacles springing from enlarged tentacle-bulbs and the absence of well-defined manubrial tentacles, recalls the medusa of *Perigonimus*. The hydroid of *Perigonimus* has a reticular hydrorhiza forming a felt on the surface of a mollusc shell or other foreign body, and in some species (as in *P. vestitus* Allman) the medusæ are budded both directly from the hydrorhiza and also from the sides of the short hydrocauli which usually bear a single hydranth. There being no sharp division between the hydrocaulus and the base of the hydranth it is not unlikely that sometimes the medusæ are actually budded off from the base of the hydranth itself. Thus in their general character and in their position of origin the medusæ of the present organism are not unlike those of *Perigonimus*.

It is quite certain that the hydroid is very closely allied to *Hydrichthys mirus* Fewkes, which was found by Dr. J. W. Fewkes* on a small fish (*Seriola zonata* Cuv.) in the neighbourhood of the Newport Marine Laboratory, New England. Fewkes did not definitely demonstrate that the organism was a true parasite, but he states: "Possibly in its parasitic life the hydroid obtains its sustenance from the fish on the side of which it lives," and further, "The question whether the fish ultimately succumbs to the parasite is an interesting one, but one which cannot be definitely answered at present . . . . . The muscles of the fish, however, under the basal plate of the hydroid were somewhat wasted." It is extremely probable, judging from these remarks, that the hydroid of Fewkes is truly parasitic and obtains its nutriment in the same manner as in *Hydrichthys boycei*.

The only obvious differences between the two species are: (1) the presence of four marginal tentacles to the medusæ of *mirus* in place of two as in *boycei*, and (2) the gonostyles bear much longer branches in *mirus* than in *boycei*.

Fewkes sharply distinguished gonostyles from the "elongated flask-shaped bodies" (hydranths); but we see in *boycei* that they may tend to merge into one another and a hydranth may gradually pass over into a gonostyle. The following statement by Fewkes is significant: "there appears to be an opening at the free end of the gonosome" (gonostyle). This opening is without doubt the mouth of a hydranth that had taken over the function of a gonostyle. Fewkes compares

* On certain Medusæ from New England.
Bull. Mus. Comp. Zoo. Harvard College, Vol. XIII, No. 7, 1888.

these gonostyles, carrying their botryoidal clusters of developing medusæ, with the gonostyles of *Tubularia;* and there is no doubt that there is marked similarity in appearance, but there can be no real affinity between the two genera.

Fewkes compares the basal plate of *Hydrichthys* with the disc of *Valella*, and points out that there is a similar polymorphism of the individuals. It is indeed conceivable that *Hydrichthys* should be regarded as a parasitic siphonophore of the *Velella* type. The branched gonostyles greatly resemble those of many siphonophores. In the hope of throwing further light on this interesting problem all the specimens of fishes were very carefully examined in order to discover if possible the youngest stages of the parasite. It was thought that possibly some trace of a siphonula larval condition might be detected. The youngest stage found, however, consisted of a very small plate with some six small bud-like outgrowths which were the beginnings of hydranths.

The histology of the organism does show some resemblance to that of the siphonophore. The branching outgrowths of the mesoglea on the ectoderm side is a common feature in the siphonophore. The presence of five ridges of endoderm in the distal region of the hydranth is also commonly found. The occasional ectodermal pits which occur in the basal plate are scarcely a sufficiently constant feature to warrant a comparison with the tracheal tubes of the disc of *Velella*.

Another genus that must be mentioned is *Nudiclava monocanthi* Lloyd. This extraordinary hydroid was found by Captain R. E. Lloyd* attached to the side of a specimen of fish, *Monacanthus tomentosus* L. tow-netted from the Andaman Sea in 1897. There is a basal plate and the hydranth is without tentacles. The gonophores are fixed and sessile. Owing to the very limited material at his disposal Captain Lloyd was unable to elucidate completely the general structure and histology of this peculiar hydroid. According to the figures given the endoderm was differentiated into an outer thick layer of muscle-cells of very peculiar structure, not properly understood, and of an inner layer of flat cells lining the cœlenteron. Thus this hydroid apparently bears no resemblance in its histology to *Hydrichthys*, except that the endoderm is of great thickness in both. The basal plate of *Nudiclava* is compared with that of *Hydractinia* and is described thus: "it is composed of two layers of ectoderm widely

* Lloyd, R. E., *Nudiclava monocanthi*, the type of a new genus of hydroid parasitic on fish.
Records of the Indian Museum, Vol. 1, p. 281, 1907.

separated by irregular tubules and spaces with endodermal walls which communicate with one another freely and form a complex labyrinthine structure" also, "parts of the plate show the more primitive type consisting of an open meshwork of irregular trabeculæ each of which is a tube composed of two layers—ectoderm and endoderm with an external cuticle" and again, "the cuticle is relatively very thin, in some parts of the colony it is hardly recognizable."

With regard to food-supply, Captain Lloyd was of the opinion that prey was probably captured by it drifting into the widely opened funnel-shaped mouth when the fish was rapidly swimming through the water. If such is the case the hydroid cannot be regarded as a very pronounced parasite. In this connection Captain Lloyd states: "it seems that *Nudiclava* does not obtain sustenance from the fish to which it is attached." Part of the skin of the fish beneath the basal plate was removed and examined under the microscope and the author affirms that it was found to be quite intact with no sign of perforation by any radical organs.

Another genus attached to fishes is *Stylactis minoi* Alcock which was found in 1892 by Alcock* attached to *Minous inermis* Alcock in the Bay of Bengal. Here the hydranth has a circle of long tentacles. The hydrorhiza has the form of a creeping stolon. E. Stechow† has shown that free medusæ with four tentacles are produced. The hydroid apparently catches prey in quite a normal manner and very possibly there is no transfusion of nutriment from the body of the fish into the hydroid.

The hydrorhiza of *Hydrichthys* resembles that of *Hydractinia* to a certain extent, but there is a characteristic absence of perisarc in the former, and this is also the case in *Nudiclava*.

A similar hydrorhiza to that of *Hydrichthys* is seen in the aberrant genus *Monobrachium* Merejkowski. The structure of *M. parasiticum* Merej. has been investigated by J. Wagner.‡ The hydrorhiza consists of a continuous sheet not formed by a collection of anastomosing stolons. On this sheet are arranged three kinds of individuals: (1)

* Alcock, A. A case of commensalism between a Gymnoblastic Anthomedusoid and a Scorpænoid Fish.
Ann. Mag. Nat. Hist., Series 6, Vol. X, p. 207, 1893.

† Stechow, E. Symbiose zwischen einem Fisch und einen Hydroidpolypen. Zool. Anzeiger, Bd. XXXII, Nr. 25, p, 752, 1908.

‡ Wagner, J. Recherches sur l'organisation de *Monobrachium parasiticum* Merej. Arch. Biol. Vol. X, p. 273–309, 1890.

sexual individuals budded directly by the hydrorhiza in the middle of the plate; around these, (2) hydranths with a single tentacle; and at the periphery, (3) modified hydranths ("pseudo-nematophores") comparable with the spiral dactylozooids of *Hydractinia*. The colonies were found in the White Sea on *Tellina* shells. Sexual cells were found to take birth in the hydrorhiza, and it is stated that they pass into the ectoderm of the radial canals of the medusa. Free-swimming medusæ are produced with four radial canals, sixteen tentacles and four pairs of gonads. This form is placed in the family *Monobrachidæ* next to the *Laridæ* and constitutes the last family of the *Anthomedusæ*.

We thus see that a continuous sheet-like hydrorhiza occurs in *Hydractinia*, *Hydrichthys*, *Nudiclava* and *Monobrachium*. It is very doubtful whether there is any very close phylogenetic relationship between these four genera, and we must regard the repetition of the structure of the hydrorhiza as an example of convergence arising through similar physiological or environmental needs. It may be noticed indeed that all four genera are habitually associated commensally, symbiotically or parasitically with other animals.

As a result of this survey it would appear that *Hydrichthys* shows marked similarities to *Perigonimus*, and very possibly the differences which occur have arisen through adaptation to the parasitic habit. On the other hand there are certain siphonophore characters already discussed; but in the absence of any knowledge of embryological facts it would be rash to assume that the similarities are due to genetic connection.

Biological Observations.—The only hydroids genuinely parasitic known to me are: *Aglaophenia parasitica* Warren* which sends haustoria into a coralline weed, *Hebella dispolians* (Warren)† parasitic on *Sertularia bidens* Bale, *Hydrichthys mirus* Fewkes (almost certainly parasitic), *Hydrichthys boycei* sp. n., *Nudiclava monocanthi* Lloyd (doubtfully parasitic) and the problematical organism *Polypodium hydriforme* (P. Owsjannikow)‡ from the ova of *Acipenser*.

The histological character of the haustoria of *A. parasitica*, consisting of clusters of very elongated granular ectoderm cells with ramifying branches from the free surfaces enveloping and absorbing the cells of

* Warren, E. Ann. Natal Museum, Vol. I, pt. 3, pp. 335–336, 1908.

† Warren, E. Ann. Natal Museum. Vol. II, pt. 1, 1909.

‡ Ussov, M. Eine neue Form von Susswasser-Cœlenteraten Morph. Jahrb. Vol. XII, p. 137–153, 1887.

the plant, is very strikingly the same as that of the inner ectoderm of the hydrorhizal plate of *Hydrichthys*, especially where haustorium-like outgrowths invade the tissues of the fish. Reserve food-material in rounded globules is concentrated in the endoderm in both cases.

With regard to the effect of *Hydrichthys* on the host, I enquired of Mr. Chubb as to whether the hydroid appeared to extend indefinitely over the fish and to cause its death. In reply he wrote: "Mr. Boyce has never seen any dead fish with the growth on them, neither have any fishes been observed with more extensive colonies than those already sent. Mr. Boyce has observed on one occasion the fish deliberately freeing itself of the parasite by jerking movement. On another occasion the colony fell off during fixation. Many fishes have been seen with scars on them, apparently where former colonies have been. It would appear that when the colony reaches a certain stage of development it relaxes its grip upon its host and either falls off or is shaken off."

On one of the specimens of the young *Mugil sp.* I found that one of the pectoral fins was stunted but much swollen. In section through the fin it was seen that the swelling was due to hypertrophy of the tissues, and at the base of the fin remnants of the hydrorhiza and hydranths of *Hydrichthys* could be detected. Thus the fin had been, without doubt, previously covered with a flourishing colony, and most of the epidermis had been removed. The hypertrophied fin was the attempt of the host to heal the wound after the disappearance of the greater part of the parasite.

In connection with the death of the colonies it is interesting to note that in the largest colony which was sectioned the parasite was infested with one of the lower fungi. The fungus possessed a delicate branched mycelium which occurred in the cœlenteron of the large gonostyle depicted in Plate XVIII; it was also found in some of the larger endodermal tubes of the hydrorhiza. The mycelial tubes were capable of penetrating the endoderm cells, and in several instances the hyphæ had grown through the endoderm, mesoglea and ectoderm to the exterior. In some parts the endoderm exhibited very marked ill-effects, the cells were greatly wasted and the protoplasm was reduced to a few strands leaving very large apparently empty vacuoles. There is little doubt that the fungus was exercising a deleterious action on the hydroid, and possibly it would cause death.

The systematic position of the fungus cannot be given with any certainty. The hyphæ were non-septate during active growth. The hyphal wall was very delicate and the protoplasmic contents were finely granular. In the protoplasm there were small darkly staining bodies, sometimes two or three together, surrounded by a clear oval area. These structures were apparently nuclei. In addition there were somewhat large oval bodies which stained faintly and probably consisted of proteid or other reserve food-substances (Pl. XX, fig. 9, a).

Older hyphal tubes appeared to become septate and there was a subsequent formation of chain-gemmæ (b, c). The fungus may possibly belong to the *Saprolegnieæ.*

Where the hydrorhiza has destroyed the epidermis of the host, the dermis shows some concentration of phagocytes, and a kind of basement membrane is formed separating it from the hydrorhizal plate. Where the hydrorhiza sends down special haustoria some of the tissue of the fish may die and there is a formation of pus. It is clear that there is a certain amount of inflammation, and the hydroid would thus be abundantly supplied with blood. It may be noticed, however, that generally the reaction of the host to the attack of the parasite is not very violent. The hydroid does not appear to poison the tissues in any way, and there is no general tendency for the production of new growths or tumours by the host. The hydrorhizal plate of the hydroid takes the place of the epidermis of the fish and shuts off the sea-water from direct contact with the inner tissues. Until the colony has grown to a considerable size there is very little ill-effect on the surrounding tissues of the host, probably less than a mechanical abrasion of equal size would produce. As the colony grows older the amount of fish tissue destroyed becomes greater and the formation of pus increases.

It is of interest to note the excessive fertility of the hydroid. The whole colony is a mass of developing medusæ, and hundreds or even thousands are doubtless produced. The medusæ are budded from all points of the colony, on the gonostyles, hydranths and hydrorhiza. Great fertility is a characteristic feature of parasites, and, of course, it arises through the fact that the embryo has only a very small chance of finding a suitable host.

It is a little curious that the parasite does not spread on the host and destroy it: but there is a marked tendency among the higher parasites not to cause undue and fatal injuries to their hosts. It would appear that a comparative short and vigorous life for a colony, in which it rapidly reproduces itself, is more favourable to the species than a prolonged life with a large colony stretching over considerable areas of the fish and threatening the life of the host.

Explanation of Plates XVII–XX,

Illustrating Dr. E. Warren's paper on "Hydrichthys boycei."

Plate XVII.

Fig. 1.—x 40. *Hydrichthys boycei* growing on caudal fin of *Mugil sp.* g. Gonostyle. H. Plate-like hydrorhiza. h. Hydranth. h.g. Hydranths bearing medusæ. h.s. Hydranths sucking blood. m.g. Massive vertical upgrowth from hydrorhiza, perhaps to be regarded as modified gonostyle, bearing dense clusters of medusæ.

Figs. 2, 3.—x 100. Stages in the development of the medusa.

Fig. 4.—x 100. Stage at which liberation generally occurs.

Fig. 5.—x 100. Medusa expanding. m.t. Manubrial tentacles.

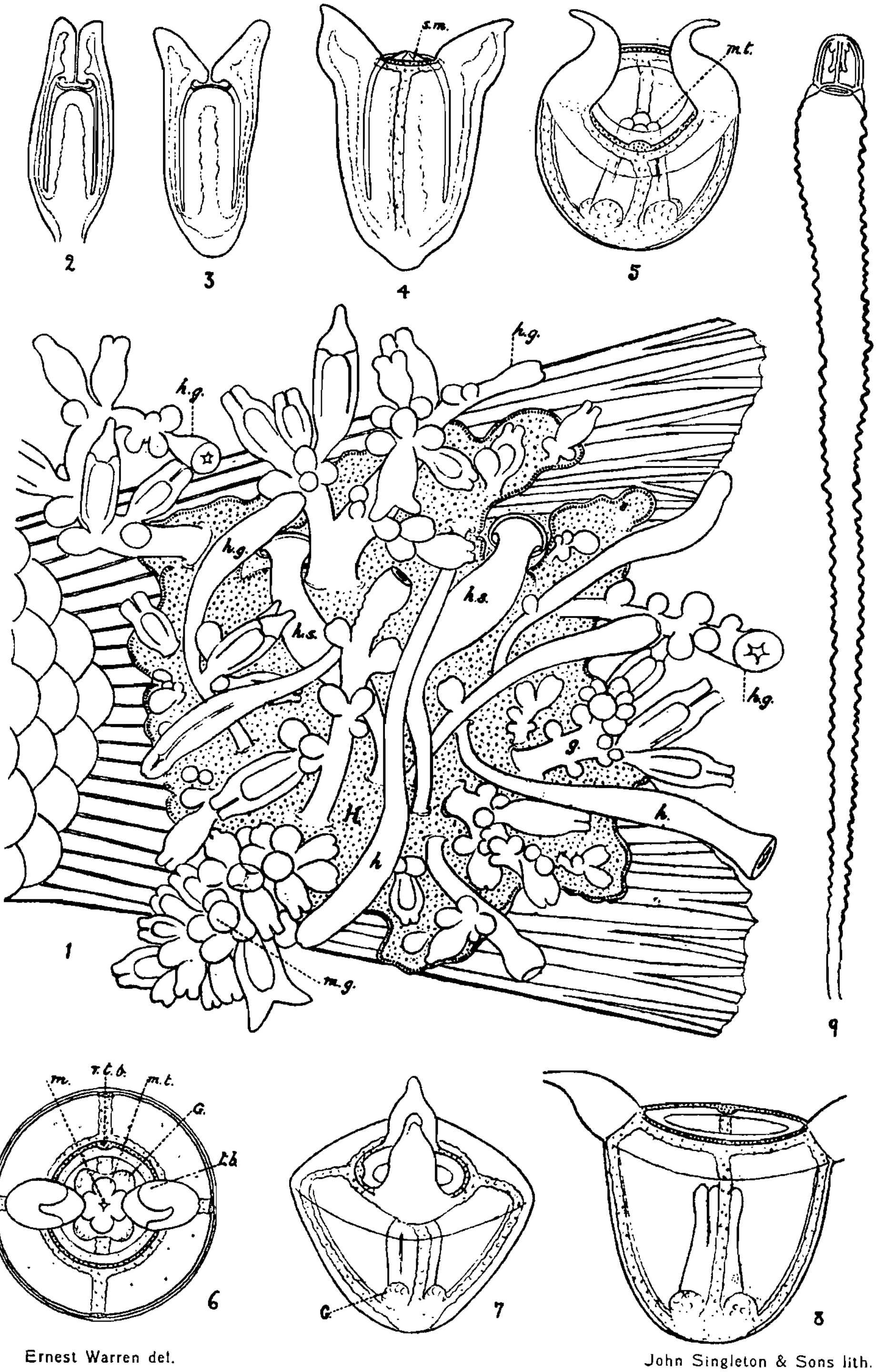
Fig. 6.—x 100. View of medusa from umbrella-mouth. G. Fundament of gonad (?) over interradial swelling of digestive-cavity. m. Four-cornered mouth. m.t. Knobs representing manubrial tentacles. r.t.b. Rudiment of tentacle-bulb. t.b. Tentacle-bulb.

Fig. 7, 8.—x 100. Older stages.

Fig. 9.—x 100. Oldest stage of medusa known, with very elongated tentacles.

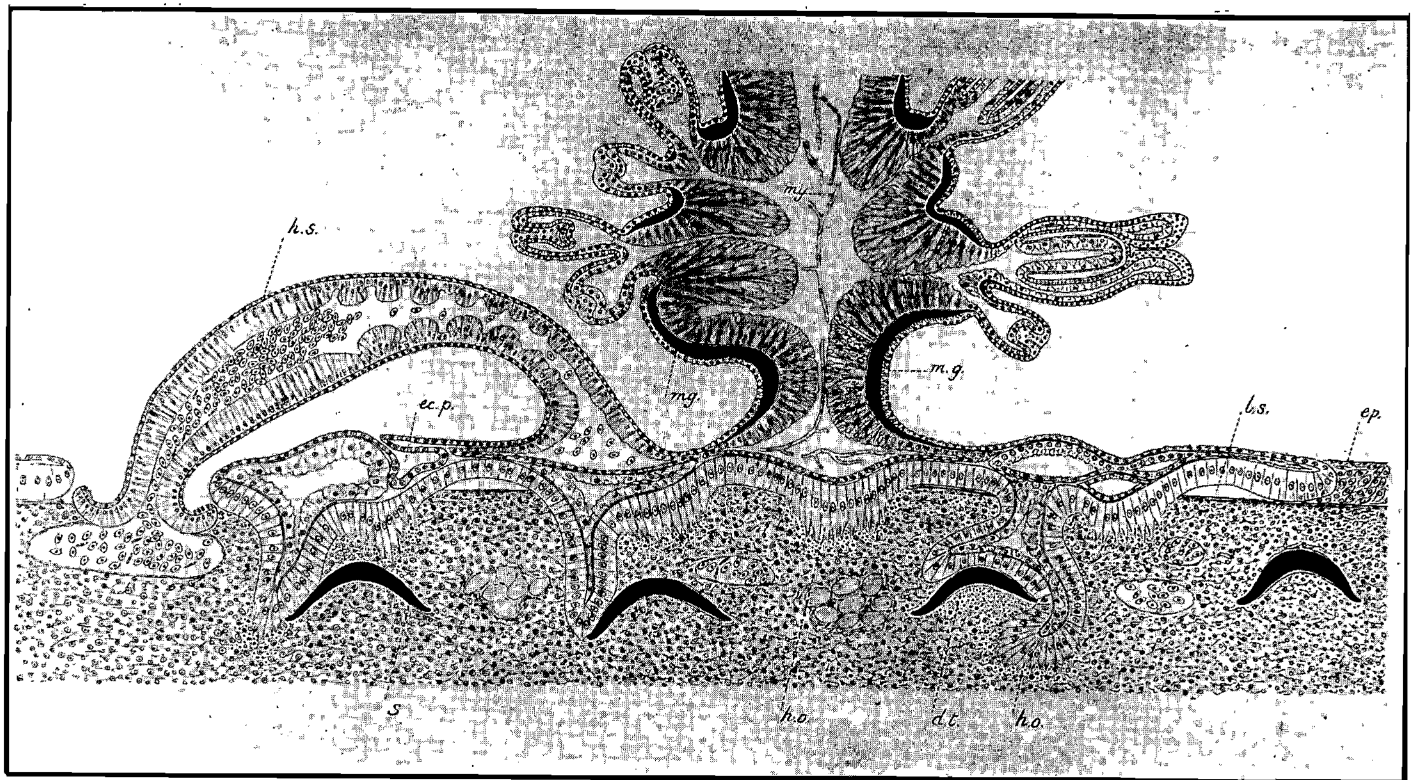
Plate XVIII.

Vertical section of *Hydrichthys. boycei* attached to side of *Mugil sp.* x 95. d.t. Dead connective tissue of fish. ec.p. Ectoderm pit. ep. Epidermis of fish. h. Haustorium-like ontgrowths of hydrorhiza penetrating dermis of fish. h.s. Hydranth sucking blood. l.s. Lymph-space. m.g. Massive vertical upgrowth from hydrorhiza, perhaps to be regarded as modified gonostyle, bearing dense clusters of medusæ. mg. Mesoglea of upgrowth. my. Mycelium of fungus. s. Scale of fish.



Ernest Warren del. John Singleton & Sons lith.

HYDRICHTHYS BOYCEI, sp. nov.



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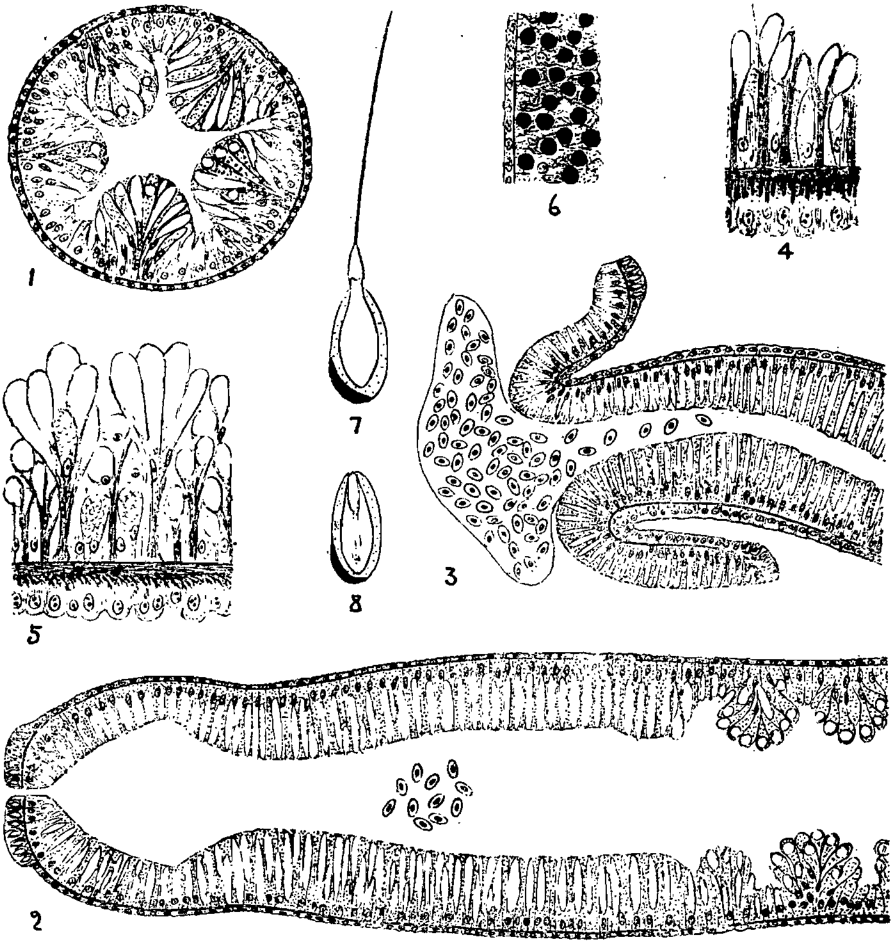
HYDRICHTHYS BOYCEI, sp. nov.



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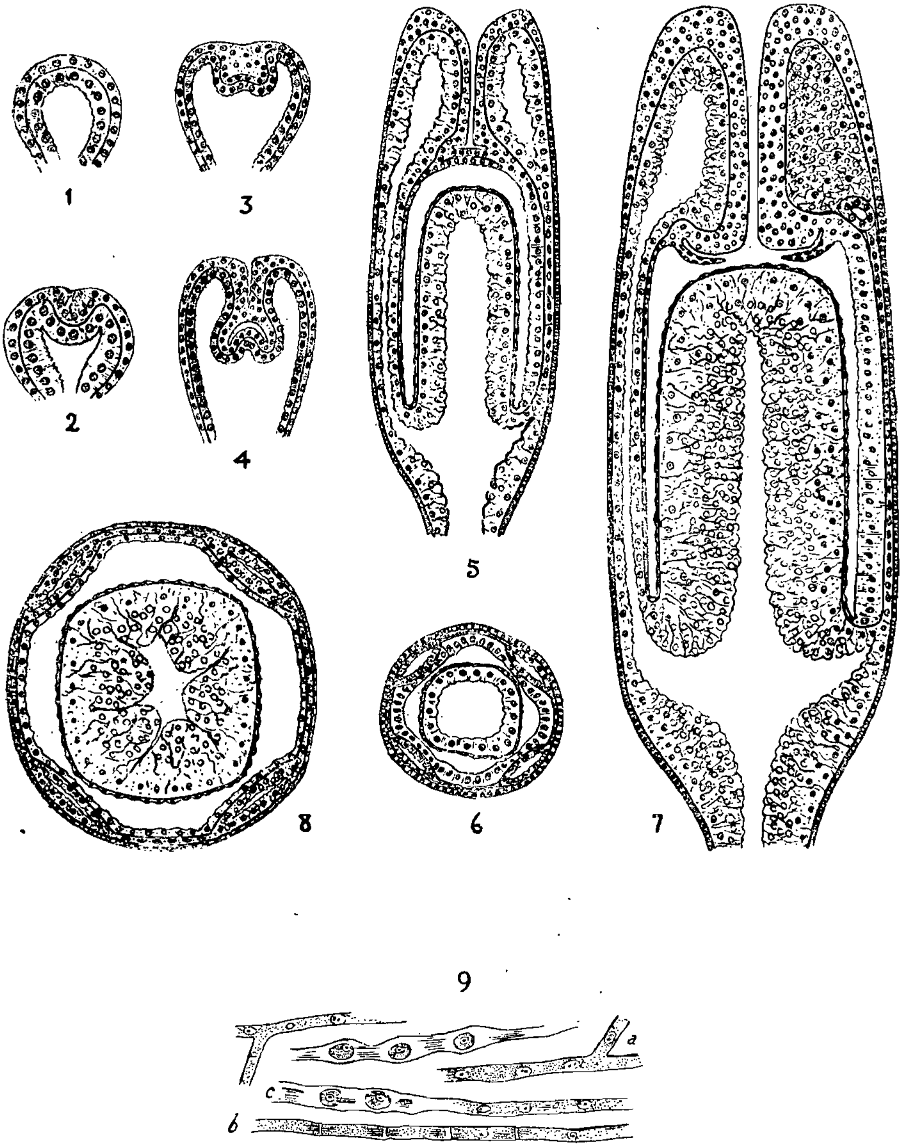
HYDRICHTHYS BOYCEI—Histology.



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HYDRICHTHYS BOYCEI.

Figs. 1-8, Development of medusa. Fig. 9, Hyphæ of fungus.

Plate XIX.

Fig. 1.—x 220. Cross-section through the distal portion of hydranth showing the five endodermal ridges.

Fig. 2.—x 220. Longitudinal section through hydranth showing nematocyst-ring round the mouth.

Fig. 3.—x 220. Longitudinal section through hydranth sucking blood.

Figs. 4, 5.—x 550. Vertical sections through gonostyles showing branching processes of mesoglea and the peculiar endoderm.

Fig. 6.—x 550. Vertical section through manubrium of developing medusa showing the numerous yolk-globules in the endoderm.

Figs. 7, 8.-x 1480. Nematocysts, discharged and undischarged.

Plate XX.

Figs. 1–8.—x 275. Developing medusæ in longitudinal and cross sections.

Fig. 9.—x 660. Portions of hyphæ of parasitic fungus showing the vegetative non-septate condition (a) and the septate condition (b) prior to the production of chain-gemmæ (c).