ENTOZOA[1].

By Arthur E. Shipley, Fellow and Tutor of Christ's College, Cambridge, and University Lecturer in the Advanced Morphology of the Invertebrata.

THE Hawaiian Archipelago or the Sandwich Islands are separated by some 2350 miles from the mainland and by about the same distance from any other group of inhabited islands. Hence, as might be expected, their fauna is highly specialized, and although we know very little about the Entozoa of this island group, two at least of the forms described, living within the bodies of birds characteristic of the country, are new and up to the present time have not been recorded from elsewhere.

But although the Hawaiian Archipelago is so far from other lands it is a much frequented spot. Since the Spaniards first found it, before the visits in 1778 of Captain Cook, it has by degrees become one of the meeting places of the world. Its position "at the cross-roads of the North Pacific" on the line of the great marine trade-routes between Northern America, Japan, China and Australia has attracted to its harbours men of all nations, so that, like Singapore, it has a most mixed population. And man has brought not only his own parasites with him but has imported his domesticated cattle with their entozoa.

What little I have been able to find out about the human parasites in the Sandwich Islands I owe to a paper by Dr A. Lutz[2], and as the parasites he mentions are well known and almost cosmopolitan I have said little about them, still they should be mentioned in a Fauna Hawaiiensis, for though probably the majority of them have been introduced and may not be endemic, this is not certainly the case and is susceptible of no proof.

[1] I have much pleasure in thanking Prof. E. Ray Lankester for permission to reprint matter and figures from the Quarterly Journal of Microscopical Science; Mr Shipley has availed himself of this permission in his communication. EDITOR.

[2] Centrbl. Bakter. XIII. 1893, p. 126.

I. NEMATODA.

The following Nematodes are recorded by Dr Lutz :—

(1) *Ascaris lumbricoides* L.

This was found with *Ancylostoma duodenale* but also—and this was especially the case in children—alone. It is said to be very common among the poorer inhabitants.

(2) *Trichocephalus dispar* Rud.

This was determined only from eggs which passed from the intestine. It appeared to be widely distributed but not in very great numbers.

(3) *Oxyurus vermicularis* L.

Observed in one white family who had become infected through an adopted child. It is a very common parasite among the poor.

(4) *Strongyloides intestinalis* Bavery.

This parasite was observed in company with *Ancylostoma duodenale*, but in the larval state. It apparently produced no special symptoms, and Dr Lutz repeats his doubts as to its being the cause of the so-called Cochinchina-diarrhoea.

(5) *Ancylostoma duodenale* Dubini.

The anaemia and accompanying troubles due to the presence of this parasite are very common in the Hawaiian Archipelago. Dr Lutz found it only amongst the Portuguese, employed for the most part in the sugar plantations and careless about their supply of drinking water. These Portuguese came not from Europe but from Madeira and the Azores and it seems probable that they brought their parasites with them. Dr L. F. Alvarez of the "Hospital for the Treatment of Leprosy" tells me that this entozoon is very common amongst the Portuguese labourers of the city of Hilo and its neighbourhood in the Island of Hawaii. It produces a very severe form of anaemia.

(6) *Sclerostomum armatum* Dies.

This parasite was found in the Horse and at least in one district was the cause of the death of the host.

(7) *Filaria immitis* Leidy.

Found in the heart of dogs. It is widely spread through the Pacific Islands[1].

[1] Shipley, P. Cambridge Soc. VIII. 1892—5, p. 211.

II. PLATYHELMINTHES.

A. Trematoda.

(1) *Distoma clavatum* Rud.

Found in the stomach of the *Coryphaena hippuris*. Several other unidentified species of Trematode were met with in other fish.

(2) *Distoma hepaticum*[1] L.

The presence of this parasite caused a veritable epizootic amongst the cattle on many of the islands of the Hawaiian Archipelago. Horses, though to a less extent, and wild swine are also said to have suffered. Dr Lutz was successful in cultivating the embryos of the Fluke, and he also succeeded in finding and observing the development of the Redia in the fresh-water snail *Limnaeus pereger*. In his second paper[1] Dr Lutz gives the opinions of certain distinguished conchologists on the species of water snails which he found infected with the larvae of *Distoma*. These Molluscs seem to afford matter for a considerable amount of disagreement and the reader is referred to this paper for the details of the subject. Dr Alvarez, to whose kindness I am indebted for several details in this paper, tells me that this Fluke sometimes attacks man.

B. Cestoda.

(1) *Drepanidotaenia hemignathi*[2] Shipley.

Plate XIII.

The specimens of this tapeworm, of which I received but ten, are all small; they vary in length from 10 mm. to 22 mm. The head is very small; immediately behind it, there being practically no neck, the body begins to broaden out, and in some specimens the proglottides attain a width of 2 mm. The segmentation of the body commences immediately behind the head, and is very well marked a little further back. The posterior border of each segment overlaps the succeeding one with a prominent edge or rim; this is well shown in longitudinal section (fig. 6). The number of segments varies from some fifty to sixty to over a hundred. The measurements given above are about the average, but, as is well known, tapeworms are extremely extensible animals, and this to a great extent diminishes the value of figures quoted in reference to their size. In some of my specimens the body is stretched, and the length of the segments equals one-half or even two-thirds of their breadth, but in the commoner forms the segments are very short and broad, sometimes eight or ten times as broad as long. They are flattened, as is seen in transverse section, and sometimes, especially towards

[1] Centrbl. Bakter. IX. 1892, p. 783, and XIII. 1893, p. 320.

[2] The description of this species is reprinted (with certain alterations) from the Quart. J. Micr. Sci. XL. 1898, p. 613.

the posterior end, the whole body is hollowed so that each segment is curved. The most posterior segments, which are crowded with embryos well advanced in their development, are rounder, less flattened, longer, and they readily broke off.

I was not able to detect any genital pore on the exterior even with the aid of powerful lenses, but sections (figs. 4 and 6) and stained mounted specimens show that it is on the same side of the body in all the segments.

The head of the tapeworm bears four suckers, and in the midst of them is the rostellum (figs. 3, 8 and 9). The shape of the head is very various: in some cases the suckers are, as it were, hunched up and lie at each corner of a square, the lateral diameter of which does not exceed the dorso-ventral (fig. 8); in other specimens the head is not separated from the body by a deep constriction, but is flattened and spread out (fig. 7), so that the lateral suckers are separated from one another by a space considerably wider than that which lies between the dorsal and the ventral suckers.

The rostellum is minute and sunk in a pit (fig. 3); it bears a wreath of ten hooks. In all the specimens which I cut into sections, and I think in the others as well, the rostellum was retracted, the points of the hooks folded in against the axis of the rostellum, and not reaching so far forward as the mouth of the pit. When the animal is fixed to the mucous membrane of its host this rostellum is doubtless protruded from its sheath, and the hooks are divaricated. Certain muscle-fibres which run from the base of the rostellum, and lose themselves in the parenchyma, probably serve to retract it.

The hooks are slightly curved, and the projection which corresponds with the inner fork of the more triradiate hooks of other genera is hardly, if at all, marked (fig. 2). Measuring in a straight line from the base to the tip the hooks are 18—23μ in length, thus corresponding pretty closely with those of *Drepanidotaenia tenuirostris* which, according to Railliet[1], measure 20 to 23μ, and to those of *D. lanceolata*, which measure 25 to 31μ.

The four suckers present no peculiarities; they are deeply cupped, with a small orifice to their lumen, but probably they are capable of considerable change of form (fig. 9). They are probably retracted by some muscle-fibres which cross one another and run into the parenchyma.

The segmentation of the body begins immediately behind the suckers; at first the segments are very short, but they gradually increase in size throughout the first three-quarters of the length of the body. For the last quarter the segments are crowded with embryos; they become in this region much narrower, more cylindrical in shape, and longer, and are very easily broken off. The posterior free edge of the segments of the anterior two-thirds of the body is sharp, and may overlap the segment behind, or may stand out clearly from it.

The water-vascular system is well developed; on each side of the body are two longitudinal canals,—one, the ventral, much bigger than the other, or dorsal. The

[1] Traité de Zoologie médicale et agricole, Paris, 1895.

lining of the former seems to be a structureless cuticle with no cells especially related to it, but the wall of the dorsal vessel is surrounded by a number of small deeply stained cells (fig. 4). I did not see any communication between the vessels of one side, but the larger vessels communicate as usual, one with another, by a transverse vessel running from side to side along the posterior border of each segment. In the head the vessels all communicate. In some of the better preserved sections such structures as are depicted in fig. 10 were seen: these may or may not be flame-cells; they look rather like them. No valves were seen in the course of the vessels.

The lateral nerve-cords are well marked, lying externally to the ventral excretory canals; they fuse together in the head, forming a ganglion which is indicated in fig. 3. No traces of the nerve-ring described by Tower[1] as running round the posterior end of each segment of *Moniezia*, or of the secondary nerves described by the same observer, were to be seen. But these, if present, probably require fresh material and special methods of preservation to make them manifest. Special nerve-cells, described below, are scattered through the parenchyma of the body.

The histology—at least in some specimens—could be fairly well made out, and agrees roughly with what Blochmann has described in *Ligula monogramma*[2]. The whole body is covered by a cuticle, the outer fifth of which stains more deeply than the remainder. Within this, with a high power, a number of dots or knobs become visible (fig. 10). These are the swollen terminations of certain strands or processes of the ectoderm cells. The cells themselves, as Blochmann has shown, lie removed to some distance from the cuticle they secrete, but are in contact with it by means of the above-mentioned processes ending in the knobs.

The ectoderm cells are not all at one level, but on the whole form a fairly well-marked layer. Each cell is fusiform in shape, and produced into two or three processes, which project both peripherally and centrally. They contain large and well-marked nuclei. Neither the cells nor their processes are laterally in contact; they are separated one from another to varying extents by the intrusion of some of the parenchymatous network which makes up so much of the body of a Cestode.

This parenchyma consists of a meshwork which permeates everywhere the body of the tapeworm, surrounding all the organs, and often, as is the case with the ectoderm and the muscles, passing in between their constituent cells. In the spaces of the meshwork there is believed to be a fluid. The meshwork itself is secreted and nourished by certain large star-shaped cells which are irregularly scattered through the parenchyma, and which give off processes in all directions (fig. 10).

Round the generative glands this parenchymatous network becomes condensed, the spaces disappear, and it forms a close sheath to the ovary, testis, &c. At the posterior end of each segment it is also somewhat condensed, and in section presents

[1] Zool. Anz. vol. XIX. 1896, p. 323.

[2] Die Epithelfrage bei Cestoden und Trematoden, Hamburg, 1896.

the appearance of a well-marked double line, which is very characteristic, and is well shown in fig. 6.

Scattered amongst the parenchyma are certain faintly stained cells which seem to be bipolar, and which differ from the cells of the parenchyma both in shape and in their powers of absorbing the staining reagents. These I take to be nerve-cells which are in communication with the nerve-fibres of the lateral cords. The latter are entirely devoid of any nerve-cells on their course.

Muscle-fibres are scattered through the substance of the body, and one set of longitudinal muscles are most definitely arranged. This layer is situated just below the epidermis in the anterior part of the segment, but as the latter increases in size posteriorly, the cylinder of muscle-fibres, which retains the same diameter throughout, comes to lie more deeply in the tissues. These muscles, like the nervous system and excretory canals, run from segment to segment; some of them, if not all, end in the cuticle, where it is most bent in at the posterior end of each segment. Laterally the fibres are not in contact, being separated by considerable intervals. Their regular arrangement is shown in fig. 5.

In the posterior segments, which are so ripe that the slightest touch breaks them off, the parenchyma has undergone considerable degeneration, the cells are less clear, and the spaces of the meshwork are larger and more irregular.

The generative organs begin to arise very early in the series of segments. Already in the eighth or tenth segment clusters of cells are segregating, and their deep staining shows that they belong to the gonads. In the sexually ripe segments the ovary is centrally placed, and is supported on each side by a lobe of the testis. From the latter a fine vas deferens leads into an extensive vesicula seminalis, which is as a rule crowded with spermatozoa; from this a muscular duct leads to the unilateral genital pore. I was unable to make out the details of the penis, and similarly I failed to detect any yolk-gland amongst the female genitalia.

The vagina leads at once into a large receptaculum seminis, whose walls were strengthened by a series of cuticular-looking rings, whose cut ends are shown in figs. 4 and 6. This communicates both with the oviduct and with the uterus. The latter presents no special points of interest; in the posterior segments it contains the typical three-hooked larvae, each segment containing at least one hundred and probably more.

Classification.

In his paper on taenias in birds, Dr Fuhrmann[1] remarks that of the 240 odd species of tapeworm described from avian hosts, only twenty-one have been studied anatomically; the remainder are but little more than names, and probably many of the names are of doubtful validity.

[1] Rev. Suisse Zool. tome III. 1895—6, p. 433.

A certain amount of order has been introduced into this mass of material by the establishment of certain sub-groups, and by the giving of a new generic name to the members of these subdivisions; thus in 1891 Blanchard and Railliet[1] established the genus *Davainea*; in 1892 Railliet[2] suggested two new generic names, *Drepanidotaenia* and *Dicranotaenia*, for certain tapeworms inhabiting, for the most part, domestic birds. These are characterised chiefly by the nature of the hooks. In the following year Diamare[3] founded the genus *Cotugnia*, in which the generative organs are double and have two pores, but which is distinct from the genus *Dipylidium* of Leuckart. All these genera are characteristic avian tapeworms, and are, with but very few exceptions, confined to birds.

There is little doubt that the tapeworm which I have described above from the intestine of *Hemignathus procerus* corresponds with a *Drepanidotaenia* of Railliet[4], who defines his genus as follows:

"Tapeworms provided with a simple crown of uniform hooks, which are usually few in number; the outer limb (manche) of the forked base of the hooks is much longer than the inner (garde), which is always slight; the point is directed backwards when the rostrum is withdrawn. The majority live in the intestines of aquatic birds. Their larva is a Cysticercoid, and is found encysted in the bodies of small fresh-water Crustacea."

Railliet describes eight species of *Drepanidotaenia*; in one of these the genital pores are on alternate sides of the body in successive segments; the remaining seven species are unilateral in this respect, but they fall into two groups,—one, with three species, in which the number of hooks is eight; and the other, with four species, in which the number of hooks is ten.

It is to this latter group that we must add the tapeworm from *H. procerus*. The four species *D. anatina*, *D. sinuosa*, *D. setigera*, and *D. tenuirostris* differ *inter se* in several respects, but perhaps the simplest way of determining the species is by measuring their hooks. Of these four species, *D. hemignathi* most nearly resembles *D. tenuirostris*, which occurs in certain of the ducks; it differs, however, markedly in size, being when mature about $\frac{1}{5}$ to $\frac{1}{12}$ the length of the last named. It resembles *D. tenuirostris* in the length of its hooks in the head, which in the latter are 20—23 μ, in the former are 18 to 23 μ; but whereas the hooks of the embryo are about the same length in the new species, i.e. about 20 μ, in *D. tenuirostris* they are but 7 μ. The neck is short, not long as in the last-named species, and the eggs are small, about 40—50 μ in diameter, and spherical in shape, not cylindrical as Krabbe[5] figures them, with a length of 85 μ. The hooks also differ in shape; those of *D. tenuirostris* have a much more strongly

[1] Mém. Soc. Zool. France, tome IV. 1891, p. 420.
[2] Ibid. tome XVII. 1892, p. 115.
[3] Boll. Soc. Napoli, ser. I, vol. VII. 1893, p. 9.
[4] Traité de Zoologie médicale et agricole, Paris, 1895, p. 298.
[5] Danske Selsk. Skr. VIII. 1870, p. 249.

developed process corresponding with the inner limb of the forked base than occurs in *D. hemignathi.*

The species, which I named after its host, may be characterised as follows:

(1) *Drepanidotaenia hemignathi* Shipley.

D. hemignathi Shipley, Quart. J. Micr. Sci. XL. p. 620.

Length 1—2·2 centimetres; breadth, in the middle of the body, 2 millimetres. Head flattened and compressed, rostrum with a crown of ten hooks; each hook 18—23 μ in length, and with but a slight trace of the inner limb of the forked base. Neck short. The first segments are short, but they very soon (eighth or tenth) show traces of reproductive organs. Genital pore unilateral. The posterior limit of each segment is sharply defined, and forms an angle of about 45 degrees with the sides. Egg spherical, diameter about 40—50 μ. The three pairs of embryonic hooks measure about 20 μ each in length.

HAB. *Hemignathus procerus*, Sandwich Islands: in the intestine.

(2) Mr Perkins has also given me two or three specimens of a tapeworm from a *Loxops*, sp. This bird, like the *Hemignathus*, is a member of the family Drepanididae, which is confined to the Sandwich Islands. Unfortunately the specimens are without their head, and I am unable to identify them. They differ markedly from the *Drepanidotaenia* described above.

(3) *Echinococcus* ?.

Echinococcus is mentioned by Dr Lutz as occurring occasionally amongst cattle killed for the market.

(4) *Taenia crassicollis* Rud.

This cysticercus larva of this species was found by Dr Lutz in *Mus decumanus.*

(5) *Taenia solium* L.

The entozoon is said to be very uncommon, but is occasionally met with.

III. ACANTHOCEPHALA.

(1) *Apororhynchus hemignathi*[1] Shipley.

In the summer of 1894 I received from Mr Perkins seven small parasites which he had noticed adhering lightly to the skin around the anus, but beneath the skin, of a species of bird, *Hemignathus procerus*, which he collected in the island of Kauai. Each

[1] Quart. J. Micr. Sci. XXXIX. p. 207 and XLII. p. 361.

of these parasites was divided into three regions,—a head, a collar, and a trunk; and, in fact, they have an almost ludicrous resemblance to a young *Balanoglossus* with one or two gill-slits (figs. 11, 12, and 13). On investigating their anatomy it at once became evident that the animals belonged to the group Acanthocephala, and, further, that they differed from the other members of the group in the absence of what is perhaps their most characteristic organ,—from which, indeed, they take their name—the hooked proboscis or introvert. Careful inspection failed to reveal any trace of a scar or mark where the introvert might have been broken off; and although in the absence of hooks and introvert sheath, &c., the anterior part of the body which I have called the head is as unlike the typical introvert as possible, still in its relation to the lemnisci and to the ligament it occupies the position of that organ, and until we can get further information I think the best plan is to regard this part of the body as equivalent to the eversible part of more normal forms.

The second of the three regions into which the body is externally divided is shorter than the head and smaller in diameter; it may be termed the collar. The third or posterior region, which may be called the trunk, is the longest and the most slender of the three; behind it tapers to a point where the orifice of the genital duct is situated, and this end of the animal is always a little turned up (figs. 11, 12, 13, 17 and 23). The exterior of the collar and trunk are smooth or lightly wrinkled, but the head is covered with a number of small depressions or pits which give it a very characteristic appearance, and which are well seen in sections. The head is attached to the collar by a narrow neck, which is surrounded and concealed by the edge of the collar. This is obvious in sections (figs. 15 and 23). All the specimens were somewhat shrivelled and apparently distorted. The largest measured 3·5 mm. in length, the smallest 2·5 mm.; had they been fully distended they would probably have been 1 to 1·5 mm. longer. The body-cavity of the head is continuous with that of the neck, and the latter opens freely into the cavity of the trunk (fig. 23). The first-named space is by far the largest. The lumen of the collar region is reduced by the great thickness of the walls of this part of the body, and both here and in the trunk much of the internal space is occupied by the lemnisci and the reproductive organs.

The skin is one of the most characteristic features of the Acanthocephala, and as far as I know is only paralleled by that of the Nematodes, but it possesses certain features not found in the last-named group. The whole body is covered by a thin cuticle which does not vary much in thickness in the different regions of the body, and which is invaginated a short distance into the genital pore. Beneath this is the true epidermis, or subcuticle as it is called; this has in my specimens the usual structure met with in the group so well described by Hamann, and consists of a matrix of a fibrillar nature, the fibrils being as a rule arranged radially, in which are embedded a certain number of amoeboid nuclei (figs. 16 and 20). This tissue is much thicker in the region of the collar than elsewhere, and it is thicker in the trunk than in the head. It is pierced

in all directions by a series of tubes or lacunae which have no definite lining, but which seem to be mere splits in the fibrillar matrix. The lacunae—except in the head—have a general circular direction which is very well marked in the trunk region where each runs into a lateral longitudinal split (figs. 20 and 24). They contain a small amount of coagulum, the remnant of the fluid which circulates in them; during life this fluid, in other species, holds in suspension fat and coloured oil globules. If these are present in my species they must have been dissolved out in the processes which precede embedding. The circular lacunae of the trunk not only communicate with one another by means of the two longitudinal lateral lacunae (figs. 20 and 24), but they open into one another by numerous small branches which have an oblique or longitudinal direction. In the head the lacunae have a general longitudinal course; they are not, however, straight, but twist in and out between the pits on the surface; they anastomose freely (fig. 14). Thus in a transverse section of the head the lacunae appear as round holes more or less uniformly arranged in the skin, and the same effect is produced by a longitudinal section of the trunk.

In the collar region the subcuticular tissue is much thickened, and the lacunar system forms a single more or less definite ring which gives off numerous branching anastomosing twigs (fig. 15).

Although the above account attempts to give the general course of the lacunae in the skin, it should be mentioned that there is considerable irregularity in the arrangement, and one is almost inclined to believe that the canals do not remain permanent, but that they sometimes close up and new ones appear. As they have no lining of any kind, such a closing would leave no trace.

As Schneider[1], Hamann[2], and Kaiser[3] have shown in the species investigated by them, the lacunar system of the introvert is completely shut off from that of the neck—if it be present—and of the trunk, by a fold inwards of the cuticle which cuts the subcuticular tissue in two. I have not been able to find any such cuticular ring in the species in question, but the state of preservation of my specimens does not allow me to say definitely that it does not exist.

The lemnisci are two elongated sac-like prolongations of the subcuticular tissue which are attached anteriorly to the skin at the junction of the head and collar. They extend backwards to the extreme posterior end of the body, and are slightly bent so that a longitudinal section may cut them in two or three places (fig. 23). Histologically they are composed of the same substance as the subcuticle in direct continuity with which they arise, and they are traversed by a similar system of canals. Physiologically they seem, as Hamann suggests, to act as reservoirs for the fluid of the canal system of the introvert; when the fluid they contain is forced into the spaces of the introvert the latter is everted. It is withdrawn again into the body by special muscles. In most

[1] Arch. Anat. 1868, p. 584.
[2] Die Nemathelminthen, Heft 1 and 2, Jena, 1891 and 1895.
[3] Bibl. Zool. Heft 7, 1892, p. 1.

species the canal system of the lemnisci opens into that of the introvert in front of the cuticular ring, and is thus completely independent of that of the trunk. If we assume that the head of my species corresponds with the introvert of other forms which have lost its introvert sheath, the lemnisci open into the same region of the skin as they do in other Acanthocephala.

The nuclei of the subcuticle and of the lemnisci are very remarkable; they correspond in structure with those described by Hamann in *Neorhynchus clavaeceps*, in which species according to this observer both the skin and the lemnisci retain in the adult their embryonic condition. As in *Neorhynchus* the number of nuclei is very small, some twelve to twenty seem to suffice for the whole of the subcuticle, and perhaps two to four for each lemniscus. The structure of the nucleus shows a most striking resemblance to an amoeba with rather short pseudopodia (figs. 16, 20, and 23). No single nucleolus can be detected, but numerous chromatin particles are present, and in some a distinct vacuole can be observed. These nuclei are scattered about in a most irregular fashion; not one may be seen in a number of consecutive sections, and then perhaps three or four may appear, and from their large size persist through several sections. The nuclei lie, as a rule, embedded in the substance of the subcuticle; more rarely they are found in the lacunae. Although there is no proof, one is tempted to believe that the nuclei wander through the subcuticle and lemnisci in an amoeboid manner, and that the small number of nuclei which are found in these tissues is compensated for partly by the large size of each, but more especially by their mobility. Similar amoeboid nuclei undoubtedly move about, fuse with one another, and undergo fission in the subcuticle of the larval forms of *Neorhynchus clavaeceps*.

Within the subcuticle and completing the skin on the inner side, is a layer of circular muscles, and still more internally a layer of longitudinal muscles (figs. 16 and 25). The muscles of these layers are but a single fibre thick, and they are not very uniformly present. The circular layer is most complete in the region of the trunk, and I have figured a section to show this (fig. 22). The longitudinal layer is even less definite, but scattered fibres can be detected here and there (figs. 16 and 25). Each fibre appears to be spindle-shaped, and in the circular muscles has the striated portion only on its outer face, forming a thin band; the inner half of the fibre consists of vacuolated strands of protoplasm in which is a nucleus. The longitudinal layer of muscles alone is continued over the lemnisci (figs. 19 and 24). These muscles are not covered on their inner side by any layer of epithelial cells, neither does any such layer cover the ligament, but both tissues lie freely exposed to the fluid of the body-cavity.

In the more typical Acanthocephala the anterior end of the body terminates in a hollow eversible portion provided with rows of hooks whose number and shape have a certain systematic value. This introvert can be withdrawn, not into the general body-cavity, but into the cavity of the introvert sheath, which is shut off from the general body-cavity by a double (Echinorhynchidae) or a single (Neorhynchidae) wall. The

extrusion of the introvert is believed to be effected by fluid being forced into its lacunae by the lemnisci. It is retracted by special muscles attached to the inside of its tip; besides these, other retractor muscles run from the outside of the introvert sheath, and these serve to retract the whole sheath and its contents into the trunk. The chief nerve ganglion lies as a rule on the posterior end of the introvert sheath, usually in the middle line, but in the Gigantorhynchidae it is placed to one side. From the posterior end of the introvert sheath, and having its origin between its two walls when they are present, the ligament runs backward, traversing the body cavity, and ending in the funnel-shaped internal opening of the oviduct in the female and in the vas deferens in the male.

Owing to the absence of an introvert and its sheath, the relations of the ligament in the present species is somewhat altered. It takes its origin from the anterior end of the head, and at first seems to consist of a few strands of muscular fibres which arise from the muscles of the skin (fig. 21). All my specimens but one proved to be mature females, whose ovaries had broken up into the egg masses which are characteristic of the Acanthocephala. These egg masses consist of packets of a dozen or more cells of which the peripheral layer develop into ova at the cost of the central cells which serve them as a food supply (figs. 14, 16, and 23). These packets coexisted in my specimens with ova in various stages of development, some without any egg shell, whilst others were provided with a thick deeply-staining membrane. The whole lumen of the head was crowded with these ova. In the region of the collar the ova were confined by a thin-walled membrane, and in the trunk there were two such masses of ova, which, however, seemed less mature than those lying in the head. Lying amongst the various organs in the body-cavity were a number of very finely granular masses, which I take to be the masses of spermatozoa (figs. 16 and 20). Of the complex system by means of which the ova leave the body, little could be made out beyond the fact that a well-marked funnel is present opening into the posterior end of the body-cavity of the trunk (fig. 19). I failed, however, to find a second opening near the narrow end of the funnel such as occurs in other forms, but this may have been due to the poor state of preservation. The funnel leads into a duct which opens on the posterior end of the trunk.

The testes are two in number, and lie one behind the other in the ligament, though owing to its looping both may appear in the same transverse section. The spermatozoa do not escape into the body of the male as the ova do into that of the female, but pass down a duct in the ligament which opens at the end of the body. Traces of accessory glands were seen, but the details were not clear.

The brain lies on or in the ligament just behind its point of attachment to the skin of the head (figs. 21 and 23). Owing to the disruption of the ovaries in my female specimens the ligament could not be traced very far, but in the only male it reached from one end of the body to the other. The brain consists of a few large ganglion cells with a clear homogeneous cytoplasm and deeply-stained nuclei; the divisions

between the cells were very sharp and straight (fig. 21). In the females this mass of cells lay on the ligament; in the male, on the other hand, it occupied the centre of the fibrous and muscular strands which compose that body (fig. 25). In the former I could trace no nerves leaving the brain, but in the male two nerves surrounded by muscles pass backward; these obviously correspond with the retinacula of other forms.

Classification.

Until recently the group Acanthocephala included but one genus, *Echinorhynchus*, which comprised several hundred species. Recently, however, Hamann[1] has pointed out that these species present certain differences which enable him to divide the group into three families, each with a corresponding genus. To these I venture to add a fourth, to include the remarkable form above described. This family may, I think, be called the Apororhynchidae, and the new genus *Apororhynchus*[2], which name refers to the absence of the eversible introvert; and, inasmuch as it is convenient in naming a parasite to have some indication of its host, I think the specific name may be *hemignathi*.

If these terms be adopted, the classification of the Acanthocephala will be as follows, the characteristics of each of the first three families being taken from Hamann's papers.

I. Family ECHINORHYNCHIDAE. The body is elongated and smooth. The introvert sheath has double walls, and the introvert is invaginated into it. The nerve ganglion is in the introvert sheath, mostly embedded in it and central in position. The hook papillae are only covered with chitin at their apex, and the hooks have a process below.

Genus *Echinorhynchus*, with the characters of the family.

The vast majority of Acanthocephala belong to this family; a few may be mentioned. *E. proteus*, found in many fishes and varying in size with its host; its larval forms inhabit the Amphipod *Gammarus pulex*, and are also found in the body-cavity of numerous fresh-water fishes. *E. clavula* occurs in many fishes and in the intestine of a species of *Bufo*. *E. angustatus* is found also in fishes, with its larval form in the Isopod *Asellus aquaticus*. *E. moniliformis* is said to attain maturity in the human intestine; its usual host is a mouse, and its larval host is the larva of a beetle, *Blaps mucronata*. *E. porrigens* invests the intestine of the rorqual, and *E. strumosus* that of a seal. There are many others.

[1] Loc. cit. and Zool. Anz. Bd. xv. 1892, p. 195.

[2] In my original paper I suggested the name *Arhynchus*, but as Professor C. Wardell Styles and Professor A. Hassall have pointed out that this name is preoccupied, having been used by Dejean in 1834 for a beetle, I later (Quart. J. Micr. Sci. XLII. p. 361) suggested the name *Apororhynchus*.

II. Family GIGANTORHYNCHIDAE. Large forms, whose body is ringed and flattened during life like that of a *Taenia*. The hooks are like those of a Taenia, the hook-papilla being entirely covered with chitin. There are two root-like processes in each hook. The introvert is muscular, has no lumen, and the introvert cannot be retracted into it, but the whole retracts into the body-cavity. The ganglion is excentrically placed to the side, behind the middle of the so-called sheath. The body-cavity is enclosed in a structureless membrane, and is traversed by membranes stretched transversely. The lemnisci are long, coiled, with a central lacuna.

Genus *Gigantorhynchus*, with the characters of the family.

Hamann includes three species in this family—*G. echinodiscus*, *G. taenioides*, and *G. spira*; and points out that *E. gigas* agrees with them in all points but that of the external annulation. The first of the above-named species occurs in the intestine of anteaters, and has been found in *Myrmecophaga jubata* and *Cycloturus didactyla*. *G. taenioides* has been found in a species of *Cariama*, *Dicholophus cristatus*; and *G. spira* lives in the king vulture, *Sarcorhampus papa*. *E. gigas* in the adult stage occurs in the small intestine of swine, and its larval host is believed to be the grubs of *Melolontha vulgaris* and *Cetonia aurata* in Europe and of *Lachnosterna arcuata* in the United States[1]. It is recorded once from the human intestine.

III. Family NEORHYNCHIDAE. Sexual maturity is reached in the larval state. The introvert sheath has a single wall. A few giant nuclei only are found in the subcuticle and in the lemnisci. The circular muscles are very simply developed, and the longitudinal muscles only present in places.

Genus *Neorhynchus*, with the characters of the family.

This genus includes but two species, *N. clavaeceps* and *N. agilis*. They both present interesting cases of paedogenesis, the large embryonic nuclei of the young larva do not break up into numerous nuclei as they do in the commoner species. *N. agilis* is found in *Mugil auratus* and *M. cephalus*; *N. clavaeceps* in the Carp, *Cyprinus carpio*, its larva form according to Villot[2] in the fat bodies of the Neuropterous insect *Sialis niger*; it has also been found in the alimentary canal of the leech *Nephelis octocula*, and specimens of the water-snail *Limnaea* have been artificially infected with it.

IV. Family APORORHYNCHIDAE. Short forms, with the body divided into three well-marked regions,—head, collar, and trunk. The head is pitted, the collar smooth, and the trunk wrinkled, not annulated—in spirit specimens. There is no eversible introvert, and no introvert sheath, and no hooks. The sub-cuticle and the lemnisci have a few giant nuclei, and the lemnisci are long and coiled.

[1] C. W. Styles, Zool. Anz. xv. 1892, p. 52.

[2] Zool. Anz. VIII. 1885, p. 19.

Genus *Apororhynchus*, with the characters of the family.

This family in the length and curvature of its lemnisci resembles the Gigantorhynchidae, and in the persistence of the embryonic condition of the nuclei in the sub-cuticle and the lemnisci, the Neorhynchidae; but in the shape of the body, its division into three well-marked regions, the absence of eversible introvert, introvert sheath, and hooks, it stands alone, though to some extent nearer to the Neorhynchidae, in which the introvert is relatively small, the introvert sheath simple, and the number of hooks reduced, than to either of the other families.

The single species *Apororhynchus hemignathi* was found attached to the inner side of the skin in the neighbourhood of the anus of a Sandwich Island bird, *Hemignathus procerus*. This bird is a member of a family Drepanididae, which is entirely confined to the Sandwich Island group. Professor Newton tells me that it is probable that the "food of *Hemignathus* consists entirely of insects which it finds in or under the bark of trees"; hence it is probable that the second host of this parasite, if such exists, must be looked for amongst the Insecta.

(2) *Echinorhynchus campanulatus* Dies.

Found by Dr Lutz in Water-rats. This species is said to be a facultative parasite of man.

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