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### THE HAIR-EEL (*GORDIUS AQUATICUS*, L.).

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Most people are familiar with the story according to which horse-hairs soaked sufficiently long in a pond or stream will be transformed into eels. I have seen a small book, published in Scotland 50 or 60 years ago, by an intelligent Forfarshire gardener, which, to the apparent satisfaction of its author, proved the vulgar belief to be true. Like most vulgar fallacies, this belief has some apparent foundation to rest upon. The elastic, hard, thread-like body of the Hair-eel (*Gordius aquaticus*) so resembles a brown or black hair from the tail of a horse that the origin of the popular error is easily explained. The further circumstance that ponds and other waters, in which hair-eels were never seen before, suddenly become peopled with these creatures, and that eels also appear unexpectedly in the most out-of-the-way localities, added strength to the theory, especially as the origin of the fish was a matter of dispute amongst naturalists. The sudden appearance of hair-eels was readily explained by the alleged transformation of horse-hairs; and the presence of eels was no mystery if they were simply developed from horse-hairs.

When a boy, I remember well discovering, to my surprise, specimens of *Gordius aquaticus* in the basin of a moss-grown spring by a Yorkshire (England) roadside. This clear, sparkling spring, as a rule, contained no visible signs of aquatic animals, and the appearance of the writhing, active hair-eel seemed difficult to understand.



A few weeks ago, during a short holiday at Fort William, P. Q., on the Ottawa River, about 120 miles above the Capital, I noticed examples in a pond about a mile from the Fort. A week later in a sand-pool, 6 or 8 inches across, which had been dug by some children the evening before, I obtained a specimen. In this newly excavated pool, only an inch or two deep, and thirty or forty yards from the Hotel Pontiac, the hair-eel appeared actively undulating and twisting about in characteristic fashion. Grenacher's paper "Zur Anatomie der Gattung Gordius" happened to be in my hands at the time, and I resumed the study of this curious creature after the lapse of many years.

Villot's monograph ("Monographie des Dragonneaux"), in which a detailed account of *Gordius* is given, had also been recently consulted by me.

My specimen was almost exactly 12 inches in length and a little over  $\frac{1}{25}$  of an inch in thickness. Its smooth hard hair-like body, without distinctive head, and its uncanny contortions, suggested, at once, an animated horse-hair. It was engaged unceasingly in winding itself into endless gracefully curved knots, and as constantly unwinding itself. The Gordian knot of classical tradition was not more tortuously twisted, and the generic name *Gordius* seems very appropriate.

Observations have shown that these creatures will survive if removed from water and dried. Doubt has been cast on the somewhat venerable story that the Abbé Fontana kept a hair-eel in a drawer for three years, and that at the end of that time it was dry and hard, and exhibited no sign of life; but, on putting it into water, it very soon recovered its former vigorous activity. On the authority of the distinguished Professor Alexander Macalister, this traditional story is confirmed. "They are remarkable," he says, "for their tenacity of life, as they can be dried into hard, brittle threads, and yet appear lively and active on being moistened." Some author, whose name I cannot just now recall, tells of a museum curator who observed a hair-eel emerge from the body of a beetle which had long been killed, dried, and put away in a cabinet.



The usual colour of *Gordius* is black or dark brown, some are of a pale shade; but my specimen is of a very deep brownish black colour for the posterior  $4\frac{1}{2}$  inches of its length, while for about  $\frac{7}{8}$ ths of its length, from the head, it is yellowish or olivaceous-brown. The attenuated head end is very pale in colour. The hind portion of the body is thicker than the anterior part. I notice that Grenacher describes a reverse coloration in specimens from the Philippine Islands, the head end being dark, while the hind portion of the body is a lighter shade of blackish-brown. *Mermis acuminata*, Leidy, a species of the genus *Mermidæ*, allied to the *Gordiidae*, is of a pale brown colour.

From what has been said, it is clear that the Hair-eels are widely distributed on this continent and in Europe, while Grenacher's studies were largely based on specimens brought by Carl Semper from the Philippines.

The zoological position and the details of their anatomy and structure have been matters about which high authorities have seriously disagreed. Grenacher refers at some length to the contradictory views held. As he states, one author describes a mouth-opening, others deny its existence; one states that the digestive canal is obsolete in the adult, another gives a detailed account of its various parts; one found a pair of secreting organs, others regard them as alimentary pores. The great Carl Gegenbaur speaks of an enteron or alimentary tube in the entoparasitic larva of *Gordius*, but declares that it so degenerates that the mouth disappears, the ingestion of food ceases, and the adult relies upon the store of food taken in during its earlier life as a parasite. In my specimen a mouth is certainly present, though there can be no ground for the statement of Captain Thomas Brown that "its bite, sometimes, inflicted on being taken out of the water, has been known to produce the complaint called whitlow." The further statement that Linnæus recorded it as a popular opinion in Sweden, and that the fact has since been confirmed by various other persons, may be passed over. The mouth of *Gordius* is too small and feeble to inflict a bite: it is a simple minute pore.



Though *Gordius* has no jaws and not the slightest traces of biting or masticating organs, the round mouth-opening can be very distinctly seen in my specimen, when viewed in full face,—a small circular pore, like a black spot in the centre of the finger-like anterior tip. It is not situated towards the ventral side as in Grenacher's Philippine specimens, in which the head-end is very obtuse and bluntly flattened terminally. The lumen or chamber of the gullet, viewed from the dorsum, appears as a hair-like tube in optical section and is surrounded by a pale fibrous matrix, with striations passing forwards, the tissue becoming denser immediately posterior to this lighter anterior area. Microscopic sections show the gullet to be a minute tube with a simple epithelial wall. The body becomes gradually thicker posteriorly, and the tail end in the male *Gordius aquaticus* is split, the two halves separating like two cotyledons with an internal rounded projection between them. In *Gordius varius*, according to Kingsley's drawing, given by Packard, the terminal cleft is trifid and much more marked than in other species. *Gordius ornatus*, according to Grenacher (and shewn in his fig. 1, Taf. xxiii), exhibits a simple blunt termination with a centrally situated cloacal aperture. My specimen is apparently a female; yet the posterior end shows a slight indication of bifidity, a central depression being discernible: but no terminal aperture can be made out.

There are no traces of eyes or other sense organs; nor have glands, a water-vascular system, or definite nerve structures been determined beyond question in our common species. The various species differ greatly in the details of their anatomical features. Thus, in *Gordius aquaticus* the external cuticle, save for a few corrugations near the head end, is smooth. As the creature curls about, irregular creases, usually transverse, appear: but in *Gordius ornatus* remarkable protruding sense-organs are described by Grenacher. These structures have the character of cuticular mounds, and when highly magnified, are seen to consist of a bundle of stout threads, projecting like tendrils with a circle of papillæ around them. The tail region in *Gordius aquaticus* is



studded with small rounded papillæ. Beneath the outer cuticle is an inner cuticular layer, underneath which is a thinner stratum composed of a granular matrix containing a few nuclei. This stratum sends up through the next layer, to be described later, a thin perpendicular lamella, which expands into a thickened rod or cylinder lying longitudinally upon the muscle layer. It may be likened to the hypoderm ridges projecting inwards from the subcutaneous layer in the Nematode *Ascaris*. *Ascaris* possesses four such internal ridges, dorsal, ventral and two lateral, these last being pierced by a minute canal, probably excretory in nature. If this comparison be justified, the ventral ridge (Grenacher's "Bauchstrang") is the sole representative of the hypoderm ridges in *Ascaris*. A thick muscular layer lies internal to the cuticular and granular layers mentioned. Its greatest thickness is midway along the body, and it is of a most interesting character. The fibres are flattened and longitudinal: but in transverse vertical section the cut ends look like radial fibres converging upon the internal organs. They are really large muscle cells, naked and pressed against each other, and are the simplest form of muscular tissue known, if we except the neuro-muscle cells in the Cœlenterates, or the peculiar transition cells in *Ascaris*. Each fibre exhibits a slight cavity which is much reduced, owing to their mutual pressure and flattened form. To this thick layer of muscle cells *Gordius* owes its marvellous power of contortion, of tying itself up in complex knots, and ceaselessly untying them.

Inside the muscle layer is the perienteric tissue, composed of irregular nucleated cells and fibrous intercellular tissue. In the midst of this tissue the central digestive tube passes, and on each side of the tube the genital glands lie. The latter, as long ovaries and cylindrical testes, pass backward and finally unite with a large terminal chamber, above which lies, in the female *Gordius*, the *receptaculum seminis*. When the ova are nearly mature, the ovaries become greatly expanded, and along the inner margin of each of these organs, passes an efferent canal, called the egg sac in the female, which further back becomes a slightly convoluted oviduct, or *vas deferens*, according to



the sex. Both these tubes end in a spacious atrium in the centre of the body. The digestive canal posteriorly is so pressed upon by these large viscera that it becomes reduced to a mere slit in the walls of the atrium. Villot states that the atrium or cloaca is capable of protrusion externally, and Grenacher found also, in *Gordius ornatus* a well-defined cloacal aperture, but Vejdovsky failed to discover it, or to make out the testes and *vasa deferentia*.

No doubt the main function of the adult *Gordius* is the production of eggs, and the perpetuation of the species, as the digestive organs are of limited capacity and appear to end blindly in the wall of the atrium. The modes adopted for dispersal are most remarkable. Adult Hair-eels have been taken from the bodies of water-beetles when flying from one pond to another by night, the serpentine creature being, it is stated, coiled around the abdomen under the wings and elytra, though Packard states that it actually penetrates into the body of beetles and locusts, twining round the intestines of its host, and finally emerging into free life, when the water is at last gained. It is difficult to understand how the adult *Gordius* can do this, and become for the time an entoparasite. The female, on reaching the water, deposits minute whitish pear-shaped eggs, attached in strings by a cement secreted in the atrium. A thick capsule and two or three thin internal layers protect the egg, which soon divides up into a group of rounded cells, like a thimble-berry; for one end becomes pushed in, converting the germ into a cup-shaped gastrula. Later the embryo elongates, becoming pyriform, and developing three rows of hooks in the gullet, and three sharp stylets at the apex of the body. With the last-named instruments it pierces the shell, and escapes into the water. The head is everted or can be drawn in like the finger of a glove. Villot describes a strong muscular band around the anterior half of the embryo, a protrusible proboscis, a gullet or throat-tube and a capacious intestine with a ventral pore a short distance in front of the acuminate posterior end of the body. As Packard points out, the larva is wholly unlike the adult, having "some resemblance to *Acanthocephalus* by its cephalic armature,



to the Nematoidea or thread worms by its alimentary canal, and in the nature of its secreting glands to the larva (Cercaria) of Trematodes." It enters the body of a water-snail, such as *Lymnæa* or *Planorbis*, but has also been found in the frog, fishes, aquatic insect larvæ, and in these it becomes encysted, or encased in a hard capsule. A second form of *Gordius* larva, more elongated and without head-armature, has been described in the body cavity, outside the intestine, of *Dytiscus*, the large water-beetle, *Carabus*, spiders, certain fishes and amphibians; and it was observed to move freely amongst the internal organs of its host. Later it loses its larval features and distinctively ento-parasitic habits, and takes on the form and free life of the adult. The larval life has been stated to last five or six months, at the end of which time it doubles its length, loses its spines, becomes swollen and soft: but on attaining a length of two inches the skin hardens, and the dark brown or black color is assumed.

If naturalists still disagree in their descriptions of the minute structure and anatomy of *Gordius*, and if there is some inconsistency in the existing accounts of its larval development and adult habits, it might be anticipated that its zoological position had been decided beyond dispute. But this is not so. It has been usual to group the Gordiidæ, Mermidæ, and Spherularidæ, in the order Gordiacea, alongside the order Nematoda, in the class Nematelmia; others place them amongst the thread-worms or Nematodes with which they agree in many important particulars; but other authorities remove them altogether, and regard them as aberrant, and not closely allied to the parasitic worms mentioned. The Nematode worms, it is true, are cylindrical animals, tapering towards each end, and never divided, like so many groups in the sub-kingdom Vermes, into segments or successive joints; and the Gordiidæ agree in this total absence of metamerism or segmentation: but in their minute structure they exhibit as many diverse features, as features of resemblance, and further study is necessary to establish the position and real character of the Hair-eels. Even their alleged survival after long periods of dessication needs



accurate corroboration, and this and other problems in the life of the Hair-eels offer subjects worthy of the attention of naturalists.

#### LITERATURE.

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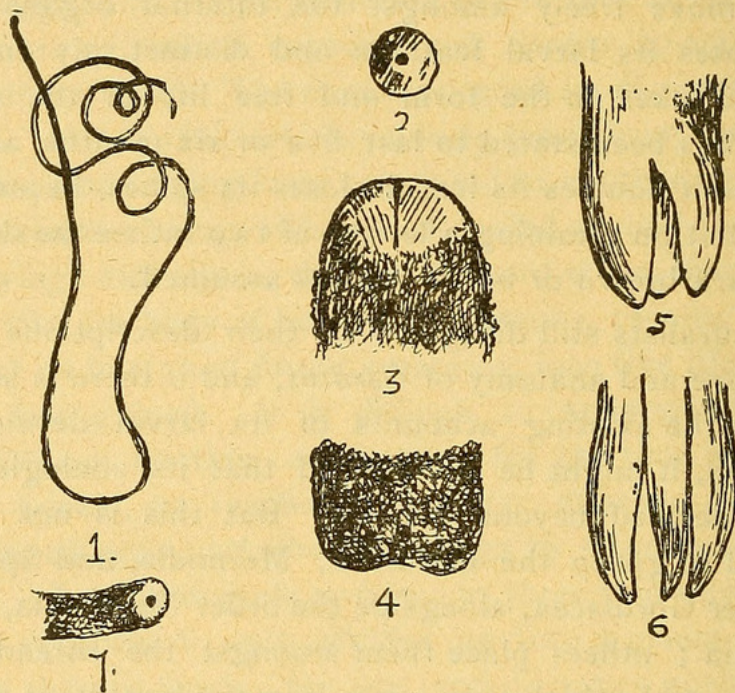
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#### EXPLANATION OF FIGURES.

1. *Gordius aquaticus*, natural size.
2. Head end of same, shewing centrally situated mouth. x 36.
3. Do. do. somewhat compressed under cover-glass, viewed from the dorsum. x 150.
4. Tail end of *Gordius aquaticus*, probably a female specimen, showing slight bifurcation. x 120.
5. Tail end of male *Gordius aquaticus* (from Packard).
6. Tail end of male *Gordius varius*, showing trifid termination (after Kingsley).
7. Tail end of *Gordius ornatus*, showing cloacal pore, enlarged from Grenacher's figure.





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