

XXII. *Observations upon the Structure and Oeconomy of those Intestinal Worms called Tæniæ.* By Mr. Anthony Carlisle, F. L. S.

Read Nov. 6, 1792.

THE following observations are offered to the Linnean Society, as an attempt to explain the mechanism and physiology of a very simply-constructed animal.

How far such investigations will assist in establishing that arrangement of Nature's works which Linnæus has planned, or how far those enquiries may aid in fixing doubtful connections, this Society are best able to determine*.

The habits and manners of *Tæniæ* are little known, because they live in situations where they cannot be observed, and therefore only become the subjects of examination when they are removed out of their natural situations, or after the death of the animal in whose body they have lived.

The *Tæniæ*, as well as many other worms that inhabit the bodies of living animals, appear destined to feed upon the juices of those animals which are already animalized; they are consequently found in the alimentary canal, and usually at the upper part of it,

* I cannot omit publicly acknowledging my great obligations to Mr. Watson, Mr. Hunter, and Dr. Baillie, for their liberality and friendship in permitting me to examine and make drawings from the worms in their respective collections.

where

where there is the greatest abundance of chyle, which seems to be the natural food of *Tæniæ*.

It does not appear that *Tæniæ* are calculated to live in any other situations than living animal substances. — That these worms should be created for the purpose of producing disease in the animal which they inhabit, is absurd; it would rather seem that nature has not intended any situation to be vacant, where it was possible to carry on the work of multiplying the species of living beings. By allowing them to live within each other, the sphere of increase is considerably enlarged. There is however little doubt that worms, and more especially the *Tæniæ*, do sometimes produce diseased states of the bodies which they inhabit; and we are also well assured, that worms do exist abundantly in many animals without at all disturbing their functions, or annoying them in the smallest degree.

Some diseased states of animal bodies are highly favourable to the increase of worms; as dropsy to that of hydatids, and the rot in sheep to that of the *Fasciola hepatica*, &c. But, in these instances, worms are rather to be considered as concomitants of diseases, than a source of them. When *Tæniæ* have arrived at some considerable growth, it appears that they always produce diseased affections. With respect to the probable duration of these animals lives, Mr. Hunter has given me permission to make the following extracts from a very curious history of a *Tænia* which is preserved in his collection.

“ *Marian Burgoin*, a native of Lausanne in Switzerland, at the age of fourteen years, was affected with pains in her stomach and head, rigors, &c.; these symptoms continued and were gradually increased. At the age of nineteen she came to England, and was advised to take purging medicines, by which she voided a portion of *Tænia lata*. She continued for some years to take drastic purges,

and repeatedly voided portions of this *Tænia*, which were generally about two yards in length; she voided, at different times, twelve of these pieces, but none of them had that extreme joint which is considered to be the head. About eight years after her coming to England, she took the Switzerland medicine, and afterwards the head, together with a large portion of this animal's body, were evacuated; she then perfectly recovered her health. From the foregoing history it is probable that the head of this *Tænia* had existed for the space of twelve or thirteen years; or if she had voided a head previous to her arrival in this country, we may still suppose the present animal to have lived eight years, because during this last period the history was accurately and attentively preserved."

It is a curious circumstance in the account of this woman, that she was considerably relieved from all her uneasy symptoms after voiding each portion of this *Tænia*; but in the course of three weeks they always returned as before, and were not alleviated until she voided another portion. May we not account for this by supposing that the body of the *Tænia* was gradually regenerated, after each piece, which we have mentioned, had been broken off; and that the symptoms returned and kept pace with the growth of the worm; its extension along the alimentary canal, and its attachments there, proving a source of irritation proportioned to its length?

There appears to be a series of distinct species of *Tæniæ*, each having its peculiar animal, like the *Pediculi* and *Acari*. The species of *Tæniæ* are however not confined *singly* to particular animals. Men are subject to several different species of them; and even the people of particular countries and climates are subject to particular species of *Tæniæ*. The people of England have the *Tænia Solium*, and rarely

any other species. The people of Switzerland have the *Tænia lata*, &c.

The structure of *Tæniæ* is very simple, for, being intended to be nourished by already digested food, they are destitute of the complicated organs of digestion.

The *Tænia Solium* of Linnæus is the animal which I intend to describe particularly; but other species, and other similar worms, will be taken notice of, by way of illustration.

This animal is composed of a head, in which is a mouth adapted to drink up fluids, and an apparatus for giving the head a fixed situation. The body is composed of a great number of distinct pieces, articulated together, each joint having an organ whereby it attaches itself to the neighbouring part of the inner coat of the intestine. The joints nearest the head are always small, and they become gradually enlarged as they are farther removed from it; but towards the tail a few of the last joints again become diminished in size. The extremity of the body is terminated by a small semicircular joint, which has no opening in it.

The external parts of this animal are clothed with a fine membrane resembling cuticle; immediately under which there is a thin layer of fibres, lying parallel to each other, and running in the direction of the length of the animal's body: these fibres arise from a dense, white, opaque line of substance, which connects the individual joints together; and the layer of fibres, having clothed both the flatted sides of the joint, is inserted into the same kind of ligamentous substance which connects the next succeeding joints together.

The motions of this animal's body are always in the direction of these fibres, and from hence we may conclude that they perform the office of muscles. It may be worthy of remark, that these
fibres

fibres are not at all vascular, which shews that the actions of muscles are not necessarily connected with vascularity.

The head of this animal is composed of the same kind of materials as the other parts of its body; it has a rounded opening at its extremity, which is considered to be its mouth. See TAB. 25. fig. 1, 2. This opening is continued by a short duct into two canals; these canals pass round every joint of the animal's body, and convey the aliment, fig. 3. Surrounding the opening of the mouth are placed a number of projecting radii, which are of a fibrous texture, whose direction is longitudinal. These radii appear to serve the purpose of tentacula for fixing the orifice of the mouth, as well as that of muscles to expand the cavity of the mouth, from their being inserted along the brim of that opening: see fig. 2. After the rounded extremity or head has been narrowed into the neck, as is represented in fig. 2, the lower part becomes flattened, and has two small tubercles placed upon each flattened side; the tubercles are concave in the middle, and appear destined to serve the purpose of suckers for attaching the head more effectually. The internal structure of the joints composing the body of this animal, is partly vascular, and partly cellular; the substance itself is white, and somewhat resembles in its texture the coagulable lymph of the human blood. The alimentary canal passes along each side of the animal, sending a cross canal over the bottom of each joint, which connects the two lateral canals together. See fig. 3.

I have often injected three feet in length of these canals with coloured size, by a single push with a small syringe. The injection will not however pass from below upwards along these canals; I could never make it go in this direction beyond two joints, and it appeared to be stopped by valves in the lateral canals, situated

immediately below the places where the cross canals are sent off. The alimentary canal, as it is here described, is continued into the extreme joint, where it becomes impervious, there being no opening analogous to an anus. The individual joints have each a vascular structure occupying the middle part (see fig. 4.), which is composed of a canal passing from the top of the joint to the bottom, and from its sides are sent off a number of lateral canals nearly at right angles; these vessels contain a fluid like milk, which is also globular, and after the death of the animal it is found coagulated. When injecting this middle vascular structure, I have often made the injection pass into the alimentary canals, by a number of very small openings; but could never, on the contrary, inject the central vessels from the alimentary canals; it would seem as if there were a valvular apparatus fixed at the outer extremities of those radiated canals. The remaining part of the body is composed of a cellular substance.

The mechanism of those parts of this animal which are subservient to its subsistence being now described, it remains for us to take a general view of the manner in which the animal is nourished.

The materials composing even the most simple animals not being permanent, but suffering continual waste and growing unfit for their purposes, it becomes necessary to replenish this waste by taking substances into their bodies, called food; and this food afterwards becomes a part of the solids of the animal. The food which *Tænia* feed upon, perhaps requires little change before it becomes a part of the animal's body. It is taken in by the orifice which we have called the mouth, and being propelled into the alimentary canal, it is made to visit, in a general way, every part of the animal's body.

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The central structure of vessels placed in each joint seems calculated to absorb the fluid from the alimentary canal, for the immediate purpose of sustaining and repairing the parts of the body in their vicinity, which is probably done by deposition, but there still remains a great deal of cellular substance into which no vessels enter*. Such parts of the bodies of these animals are possibly nourished by transfusion of the alimentary fluid into their cells, or it may be effected by the capillary attraction of their fibres. It appears that there are animals totally destitute of vascularity, as some species of Hydatids, Polypi, &c. in which transfusion of fit matter, or capillary attraction by their fibres, seems to be the only source of nourishment. As *Tænia* have no excretory ducts, the decayed parts of their bodies are, most likely, dissolved into a fluid which transudes through the skin like perspiration, and with this view the skin of this animal is extremely porous.

The senses of these animals are few, but still are sufficient for their purposes. I have never seen any thing resembling brain or nerves in the *Tænia*; but as they are highly sensible to stimuli, it is most reasonable to conclude, that they have a considerable portion of nervous matter in the composition of their bodies, that is, of such matter as is susceptible of stimuli. Indeed we can hardly conceive how any animal can exist without such matter in its compo-

* The *Tænia* seems to be one of the most simple vascular animals in nature, and its central structures of vessels appear to be more like reservoirs for the nutritious fluid, than circulating vessels, for the contained fluid can only be pushed out of one canal into another, and even then it will not have visited all the parts of the animal's body. Probably this kind of construction enables these animals to live for a considerable time without food, which their situation and imperfect form may render necessary. As this animal has no anus, it would appear that the whole of its alimentary fluid is fit for nourishment, and that no part of it is excrementitious.

tion*. *Tæniæ* have no particular organs of sense; the sense of touch is therefore the only evident source of intelligence which they possess.

The mode of increase or propagation of these animals appears to be principally by ova. Linnæus and many other naturalists speak confidently of the ova of *Tæniæ*, mentioning their shape, size, &c.; but I have never seen any thing like ova, which I could decidedly say belonged to these animals, excepting some globular bodies, which I saw by a powerful magnifying glass, in the ducts that open into the lateral oscula; see fig. 6. There is every reason to believe that *Tæniæ* produce ova, and that their ova, as well as those of other intestinal worms, are so constructed as to be very little perishable. From this circumstance they may pass along the circulating vessels of other animals, without having their lives destroyed. We cannot easily explain the phenomena of worms being found in the eggs of fowls, and in the intestines of a foetus before birth, except by supposing their ova to have passed through the circulating vessels of the mother, and by this means been conveyed to the foetus.

The openings in the edge of each joint composing the body of the *Tænia Solium*, are sometimes placed alternately on the opposite sides, and at other times are placed on the same side for three, four, or even five successive joints. These openings, which have been called oscula, are little concave, shallow cups, formed by the projection of the surrounding edges, which are thickened like lips; at the bottom of these cups there is a small opening leading into a canal,

* After I had written this essay, I learned that Mr. Hunter has entertained a similar opinion to that which is now stated, and which he applies to many of the lower tribes of animals. I also understand that he has adduced something similar to this in his lectures; and as I have attended those lectures, I cannot say that such hints (although at present lost to my recollection) may not have given rise to the opinion here adduced.

which crosses halfway over the body of the joint, and then turns downwards; here it ends, and does not communicate with any of the neighbouring vessels, as I have found by repeated injections.

The uses of these oscula seem first to be that of suckers or tentacula, for attaching the long body of this animal to the inner coats of the intestines; I have seen them serving this office, and it appears that the external lips and cup are chiefly employed in it.

The second use of the oscula appears to be subservient to generation; and the canals, see fig. 6. seem to be the oviducts. In a *Tænia* of this species, which I obtained before it was dead*, I observed at one part where it had formed a knot upon itself, that two pairs of these oscula were in contact with each other, and were agglutinated together by a viscid mucus. I was not at that time aware of the possible nature of this connection, and neglected preserving them in that state. I now suspect, however, that they were in the act of copulation, and that a mutual influence takes place previous to the formation of ova. From hence it appears that each joint is an individual, yet dependent upon the head and other parts for its subsistence, the means of propagation being as much in the power of every joint as it is in the power of a common snail, which is an hermaphrodite.

The chance of an ovum being placed in a situation where it will be hatched, and the young find convenient subsistence, must be very small; hence the necessity for their being so prolific.

If they had the same powers of being prolific which they now have, and their ova were afterwards very readily hatched, then the multiplication of these animals would be immense, and become a nuisance to the other parts of the creation.

* From a young woman in Hermitage-street in the year 1789.

Another mode of increase allowed to *Tæniæ* (if we may call it increase) is by an addition to the number of their joints. If we consider the individual joints as distinct beings, it is so; and when we reflect upon the power of generation given to each joint, it makes this conjecture the more probable. We can hardly suppose that an ovum of a *Tænia*, which at its full growth is thirty feet long, and composed of four hundred joints, contained a young *Tænia* composed of this number of pieces; but I have seen young *Tæniæ* not half a foot long, and not possessed of fifty joints, and still were entire worms. We have also many reasons to believe, that when a part of this animal is broken off from the rest, it is capable of forming a head for itself, and becomes an independent being. The simple construction of the head makes its regeneration a much more easy operation than that of the tails and feet of lizards, which are composed of bones and complicated vessels; but this last operation has been proved by the experiments of Spallanzani and many other naturalists.

I have seen a disjoined part of a *Tænia*, one of whose extremities had begun to put on the appearance of a head; the extreme joint had become rounded, and the broken end had assumed the form of a deep cup, of which the margin was platted in a radiated manner, and the surface of the torn stump was much smaller than it must have appeared when first broken. These circumstances corroborate the opinion of this second mode of increase, and indeed something very analogous is evident both in hydatids and in many vegetables. In Dr. Hunter's collection there are hydatids which are found in cysts of the liver, on whose internal surface are visible a number of small pearl-like vesicles, which are attached to it; this seems to be the mode of increase peculiar to these bodies. Chains of individuals having a mutual connection are very common in the vegetable kingdom: the common *Mentha* has a running root, which

which ties together a number of plants that are in other respects independent of each other: they become perfectly independent, and continue their existence without any inconvenience, after these connecting roots are divided; in this circumstance there appears to be some analogy between these plants and the tape worm. In the common potatoe there is a mode of increase, by forming a number of bulbs at the root, which is totally independent of sexual generation; these bulbs become separate individual plants after a year, and are then independent of their parent. Something similar takes place in the Tulip, and in the *Sempervivum globiferum*, where there is a mode of increase by forming clusters of leaves that in time are pushed off by succeeding leaves; these bulbs of leaves, having each a small root, take hold of some neighbouring earth, and become distinct beings: this natural operation is something like the artificial mode of increasing vegetables by cuttings.

When intestinal worms produce a diseased state of the animal's body which they inhabit, various remedies are advised for removing them, many of which are ineffectual, and others very injurious by the violence of their operation. Draftic purges seem to operate upon *Tæniæ*, partly by irritating the external surface of their bodies, so as to make them quit their holds; and partly by the violent contractions produced in the intestine, which may sometimes divide the bodies of *Tæniæ*, and even kill them by bruising. I would here propose the trial of a simple remedy, which (a priori) promises to be successful; I mean small shocks of electricity passed frequently through the regions of the abdomen; the lives of the lower orders of animals seeming to be easily destroyed by such shocks of electricity as do not injure the larger and more perfect animals.

In Mr. Goeze's very elaborate and important History of Worms, he has represented many species of *Tænia*. The heads are drawn very accurately, and elegantly engraved; but he has represented

the vascular structure of *Tæniæ* to vary exceedingly in the different joints of the same animal: this is a mistake, and arises from his not having injected those vessels, but drawn them as they appear naturally. In this state the vessels are seldom all filled with the coagulated fluid, and those which remain empty are invisible: thus, in proportion to the number and relative situations of those filled canals, the structure will appear different; by injection, however, I have found them to vary extremely little in the different joints of the same animal.

In another instance Mr. Goeze appears to be mistaken; he supposes the lateral oscula to be connected by a duct with the middle structures of vessels. I have found, by repeated careful injections, that this never happens. Mr. Goeze seems also to have taken the middle structures of vessels for ovaria or oviducts, and has accordingly described the globules in the fluid which they contain as the ova: but this fluid being found coagulated after the animal's death makes it appear much more of the nature of blood, and, besides, I have seen it tinged with bile. In the delineations of the heads of *Tæniæ*, in Mr. Goeze's book, he has exhibited the fimbriæ placed round the mouths as evidently calculated to serve the purpose of tentacula, in the *Tænia Felis* particularly. Vide Goeze Eingew. pl. 24. fig. 3, 4.

Explanation of the Figures, TAB. 25.

THE drawings have been made from such portions of the worms as appeared best suited to illustrate their structure, more especially the formation and functions of those parts which seemed destined to serve the purposes of nourishing the animal's body, and of procreation.

The



Tenia.

The different vascular structures were in most instances injected, and often dissected, to shew more clearly the arrangement of those vessels.

The parts are in general represented of the bigness which they appear to the naked eye, when contained in bottles of fine spirits. The heads are in most cases drawn from views through a magnifying glass. Representations of the heads and structure of other species are given by way of illustration; and the *Fasciola hepatica*, fig. 17, is exhibited to shew the great affinity (in structure) between that and *Tæniæ*.

Fig. 1. Shews the head of the *Tænia Solium* magnified: at its upper extremity it forms a circular plane, in the centre of which is a round opening, represented by the dark-shaded circle; this opening is the mouth, which leads by a duct into the lateral or alimentary canals. The mouth is surrounded by projecting radii, whose fibres run lengthways. From the extremity downwards there is a rounded narrow part which may be called the neck, below which it becomes flatted and broad, and two hollowed tubercles appear upon each flatted side; these are represented by the two dark-shaded spots.

Fig. 2. Is the same head, of its natural bigness, and which belonged to a *Tænia* twenty feet in length.

Fig. 3. Shews the alimentary canals, in a portion of the same *Tænia*, of their natural bigness. The dark-shaded undulating lines are the alimentary canals, which are seen to their full extent in this portion of the worm.

Fig. 4. Shews the middle system of vessels, in two joints, which are represented by the dark lines.

Fig. 5. Shews two joints, from one side of which a flip was torn down to shew the vessels underneath, and also the direction of the fibres in the flip, which are accumulated into little fasciculi like muscular fibres.

Fig. 6. Exhibits three joints, having the ducts leading from the lateral oscula injected; the dark transverse lines leading from each osculum, shew the size, direction, and extent of these ducts.

Fig. 7. Shews the edge of two joints turned forwards, and the appearance of the oscula in this point of view.

Fig. 8. Represents the whole of these canals in their relative situations.

Fig. 9. Exhibits a view of the head of a *Tænia* from the Dog*. The head is bent upon the neck, and presents a geometrical view of its face, which is flat, and has four tubercles situated at equal distances from each other; there are here two sets of radii surrounding the mouth, the innermost of which probably serve to open the mouth, whilst the outermost act as tentacula.

Fig. 10. Is the same head, of its natural size.

Fig. 11. Is the head of a *Tænia*† from the Cat, magnified. Here the radii project beyond the circumference of the head, and are aptly constructed for the purpose of tentacula; the tubercles are here four in number.

Fig. 12. Shews a portion of the *Tænia lata*, the oscula of which are situated in the middle of each joint.

* *Tænia canina*, Gmelin's Syft. Nat. Linn.

† *Tænia Felis* of Gmelin's edition of the Systema Naturæ.

Fig. 13. Shews the lateral alimentary canals of the *Tænia lata*, which have no cross canals, and the central vessels are of a star-like form, and extend only into a small part of each joint.

Fig. 14. Is the tail-extremity of the *Tænia lata*, which is destitute of any aperture*.

Fig. 15. Is a *Tænia* from the Ox†, having oscula on each edge of each joint. In this figure are represented the lateral canals as in the *Tænia lata*; but the central vessels are formed by radiated canals, which issue from a middle canal, running transversely over each joint.

Fig. 16. Shews ducts leading from the lateral oscula, which terminate in little annular canals; in these canals I have seen small opaque globular bodies: this is a portion of the last-described *Tænia*.

Fig. 17. Is a representation of the *Fasciola hepatica*, found in the bile-ducts of Sheep: the upper extremity is terminated by a narrow neck, having an opening at its end; this opening is the mouth. At the root of the neck is shewn a tubercle with a triangular cavity in it; this tubercle is partly for attaching the body in different situations, and partly for the purposes of generation.

Fig. 18. Shews a duct leading from the mouth into a convo-

* I was favoured with the following account of a perfect *Tænia lata*, which is preserved in Mr. Watfon's museum. The account is transcribed from his catalogue.

Mr. Tatishcheff, a Russian gentleman, had been long troubled with *Tæniæ*, and had sometimes voided portions of them, but was never perfectly free from them until he applied to a noted woman in Switzerland, who gave him a medicine, with much parade and secrecy, at bedtime, and the next morning he voided the above-mentioned worm, which he afterwards presented to Mr. Watfon.

† *Tænia ovina*, Gmelin. Syst. Nat. Linn.

luted canal, which has much the appearance of intestine: this canal terminates in two vessels which are seen passing down the middle of the animal's body, and giving off a number of small ramifications; these pass towards the edges of the body, where they terminate, and the injection pushed by a syringe into the mouth fills the whole of these vessels. There is nothing like an anus.

Fig. 19. Represents a duct leading from the triangular opening in the tubercle: this duct is analogous to the oviduct of the *Tænia*, and doubtless serves the same purpose; it has no communication with the other vessels.