

Remarks on Sanguinicola.

By

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With a Note by

W. N. F. Woodland.

With 2 Text-figures.

IN volume 67 of this Journal (Part II, pp. 233-42, Pl. 18) W. N. F. Woodland has published the interesting discovery of *Sanguinicola* in the blood of Siluroids from the Sudan, collected by the late Dr. A. J. Chalmers at Khartum. Leaving the specific identification of this form aside, the author thinks by his material of some thirty-four specimens to be 'enabled to venture to correct and amplify in some respects the descriptions supplied by Plehn¹ and to furnish some additional evidence in connexion with the possible affinities of this organism'.

As the results of Woodland stand in the strongest contradiction to the conception of this most important type, published by me in 1911,² I asked the author for the loan of a part of his material; with this desire he complied in the most courteous way, for which I wish to express to him my very best thanks.

As the result of my investigation of some toto-preparations and of a good series of horizontal sections, I wish to state the following facts, for the correctness of which I think I can warrant referring to my previous work on Trematoda begun in 1898.

1. For the orientation as to dorsal and ventral side it must of course be decisive on what side the oesophagus is bridged over by the central nervous system. Miss Plehn has in her

¹ The first description of Miss Plehn, where she regards *Sanguinicola* as an entoparasitic Turbellarian, is to be found in 'Zoolog. Anzeiger', vol. 29, 1905, the second one in the same periodical, vol. 33, 1908; in the latter she re-describes the animal as a monozoic Cestode.

² My paper, where I give the proofs for the Trematode nature of the worm, is printed in 'Zoolog. Anzeiger', vol. 38, 1911.

first paper (1905, fig. 4) given a somewhat schematical longitudinal section which shows the genital openings to be dorsal from this point of view. I also clearly perceive the same with help of a powerful lens in one of the toto-preparations: the genital pores are dorsal, as is also the case in the nearly related blood-parasite *Aporocotyle* Odhn. from the blood of flounders. The male pore is situated on the left, the female one on the right. The argument of Woodland upon which he bases his opposite orientation that 'it is usual in both Turbellaria and Trematoda for the sexual openings to be situated ventrally', has of course no power of evidence at all, as there are several indubitable exceptions to this rule in both groups. Thus the 'groove' formed by the inturning of the edges of the body becomes ventral and corresponds to a state of contraction which is exceedingly common among the Trematoda.

2. As in the European *Sanguinicola*, according to the second description (1908) of Miss Plehn, the female genital glands consist of an ovary situated immediately behind the testes, and of vitellaria occupying the sides of the body; by Woodland all these glands are regarded, with some reservation, as ovaries, as he admits of having not been able to distinguish separate vitellaria. The ovarium forms two symmetrical more or less aciniform wings which in their whole extent are placed behind the testicular field. The vitellaria extend on both sides from a point not far from the anterior end to the level of the anterior border of the cirrus pouch overreaching the ovary backwards. In my opinion there can be no difficulty in discriminating the ovary and the vitellaria both topographically and by their characteristic histological structure, although Woodland has failed in doing so, as did also Miss Plehn in her first description (1905), which by Woodland is generally regarded as the more correct one.

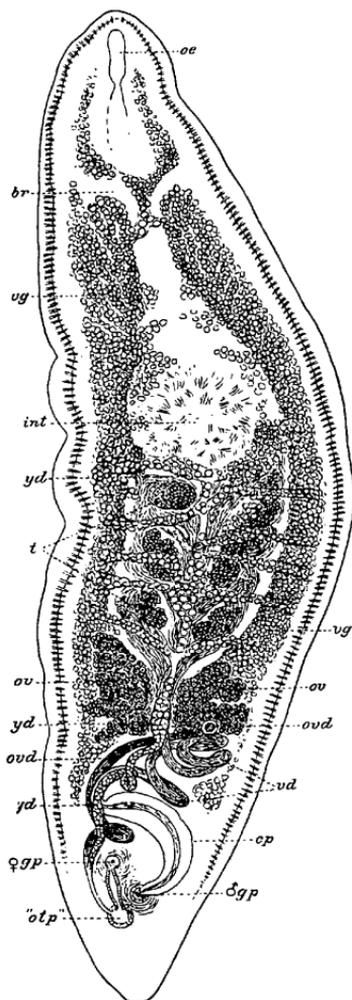
3. In the horizontal sections there are clearly to be seen two different female ducts running closely parallel in the hindmost part of the body, and uniting to a short common duct which enters the bulbous structure designated by Woodland in fig. 8 with the letters *OTP*. One of them is crowded with mature vitelline cells and is by this 'injection' also easy to

distinguish in several toto-preparations ; this is of course the distal part of the vitelline duct. The other duct is in the sections at hand partly filled with spermatozoa ; in one toto-preparation (Text-fig. 1) this duct is to be seen in almost its whole length (except the most distal part) to be crammed with deeply stained spermatozoa as described by Miss Plehn in her second paper (p. 431). In this same preparation the main vitelline duct is also to be clearly traced by its very different contents : it runs in the median line of the testicular field close to the ventral surface,¹ receiving long transverse secondary ducts from both sides ; the main duct takes its origin at the hind margin of the gut-sac by the union of paired ducts coming from the vitellaria in the anterior part of the body and partly embracing the gut-sac ; in its continuation backwards the duct crosses both the ovary and the oviduct ventrally, and can be followed by its contents all the way to the distal end of the oviduct, where the union of both ducts takes place according to the sections. The departure of the oviduct from the ovary is also to be seen ; the sperm-injection reaches in the preparation represented by me nearly to this point. Woodland has declared it to be 'absolutely certain that a second female duct does not exist'.

4. A rather inexplicable error of Woodland is that he regards the masses of spermatozoa which fill the vas deferens, and also more or less of the oviduct, as muscles in the walls of these ducts. 'The main vas deferens', says Woodland (p. 240), 'is conspicuous in stained preparations by reason of its longitudinally striated muscular walls.' The same 'longitudinal striation' he also finds in some portions of the oviduct, and 'this striation, seen in optical or actual section in slides stained with haematoxylin, bears a superficial resemblance to a mass of spermatozoa', which he believes to have misled Miss Plehn, when she, in her second paper, states the existence of a second female duct, earlier overseen by her, but visible in some preparations by means of its sperm injection.

¹ This has been correctly observed by Miss Plehn in her first description (fig. 4), and is also to be seen in the transverse section of Woodland (*ovd.*, fig. 2).

TEXT-FIG. 1.



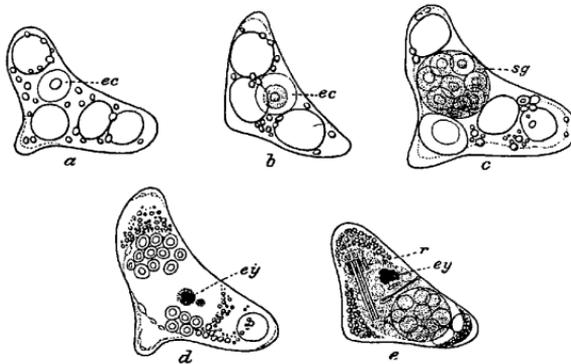
Sanguinicola chalmersi, n. sp., from *Auchenoglanis occidentalis*, viewed from the ventral aspect and drawn from one single preparation. *br*, location of brain commissure; *cp*, cirrus pouch; *gp*, genital pore; *int*, gut-sac, the outlines of which are not seen in this preparation; *oe*, oesophagus; '*otp*', 'hypothetical ootype' of Woodland; *ov*, ovary; *ovd*, oviduct; *t*, testes; *vd*, vas deferens; *vg*, vitelline glands (vitellaria); *yd*, vitelline duct.

5. If Woodland had really considered the contents of my paper in 1911, he would have been saved, I suppose, from the error of regarding the isolated yolk- (and perhaps also germ-) cells as the mature eggs devoid of a shell; this also in accordance with the first conceptions of Miss Plehn. In the paper in question I have published five drawings from the hand of Looss representing different stages of development of an egg of most extraordinary form, which had been found by Looss in Leipzig in the gill-capillaries of goldfishes attacked and killed by great masses of the peculiar Trematode larva *Cercaria cristata* La Val. According to his notes Looss had established the connexion between these eggs and the Sanguinicolae which he found in the heart of the same fishes. This connexion was, furthermore, put beyond any doubt by myself at Vienna in 1911, as is stated in the second postscript to my paper. Any one who is familiar with the flat worms will at the very first glance at the figures of eggs represented here (Text-fig. 2) understand that such an egg cannot exist without having a shell giving to it its constant peculiar form, and further that such a 'compound' egg containing both a germ-cell, the segmentation of which is shown in Text-fig. 2 c, and besides some 'vesicles' and many granules, which must be of vitellarian origin, presupposes of necessity the existence of ovary and vitellaria or at least of germo-vitellaria. If Woodland nevertheless needed to have the existence of a shell expressly stated, this fact appears clearly from my remark on p. 45, where I say that the eggs of *Sanguinicola* are devoid of an operculum ('Deckel'), as is also the case with the eggs of *Aporocotyle* and *Bilharzia*, which of course implies that the eggs in question have inoperculate shells as those of *Bilharzia*.

6. On p. 241 Woodland says: 'in Odhner's sketch of the possible life-history of the German *Sanguinicola* he omitted to offer any suggestion as to how the fertilized eggs reached the Molluscan intermediate host postulated by him from the fish.' This suggestion is in fact given and repeated no less than three times in my paper, twice (pp. 39 and 44-5) as my own supposition, and once (p. 44) in a quotation of the

notes made by Looss at the time of his never published experiments with the infection of goldfishes and carps. Looss and I are both presuming that the eggs of *Sanguinicola*, which we have found conveyed in immense quantities from the heart to the gill-vessels, must there break through the walls of the capillaries and reach the outer world in the same way as

TEXT-FIG. 2.



Eggs of *Sanguinicola* in different stages of development, drawn by Looss (from Odhner, 1911, p. 43). (*a-b*) egg-cell, *ec*, unsegmented; (*c*) egg-cell in segmentation, *sg*; (*d*) miracidium in development, *ey*, eye-spot; (*e*) egg containing mature miracidium with eye-spot, *ey*, and some peculiar refractive rods, *r*.

the *Bilharzia* eggs are pressed out from the small veins of the bladder and rectum.

7. When Woodland finally requires further confirmation of the infection experiments of Looss, before accepting the *Cercaria cristata* as the larva of *Sanguinicola*, and at the same time as the definite proof of the Trematode nature of the worm, I can possibly understand his views a little better than those expressed in the rest of his paper. It must of course be admitted that the development in question has not yet been followed in any detail. The facts stated by the keenest observer in the whole history of helminthology are as follows. Goldfishes and carps were placed in an aquarium together with

specimens of *Limnaea auricularia* containing the curious *Cercaria cristata*, a furcocercous cercaria devoid of a pharynx. The fishes were attacked by numerous cercariae and finally killed by them. On the gills and on the mucous membrane of the mouth of the goldfishes 'the young worms' were found in hundreds. Concerning one of the carps it is stated that the whole interior of the mouth, the gills, the skin, and the fins were beset by innumerable worms, which, however, were not yet sexually differentiated. 'In the capillaries of the gills eggs of a most peculiar form were found, in one case also one of our worms besides. In the heart sexually mature worms, to which the eggs were stated to belong.' So far according to the notes of Looss from 1892-3. That he had really to do with *Sanguinicola* is proved by some of his sketches, and still better by the fact already pointed out, which I later confirmed at Vienna in 1911, that the peculiar eggs figured by Looss were the real eggs of *Sanguinicola*.

A real study of the further development of *Cercaria cristata* has thus by no means yet been made. But, on the other hand, every probability seems to me to point in favour of the truth of Looss's and my suggestions. Woodland at least has not succeeded in putting forward against them any arguments of value. The *Bilharzia cercariae*, the existence of which and penetration through the skin into the body of the final host were in the most explicit way predicted by me in 1911 in the last lines of my *Sanguinicola* paper, have all proved to be furcocercous cercariae devoid of a pharynx, in other words belonging to the same group as *Cercaria cristata*. The only possible weak point in the suggested life-history of *Sanguinicola* would be, if there existed in the blood of the European Cyprinidae a second related Trematode blood-parasite, of which *Cercaria cristata* were the larva. Looss did not, however, find in the blood of the fishes used in his infection experiments any other parasite than *Sanguinicola*.

8. What is called by Miss Plehn the male copulatory organ and by Woodland the penis, is the distal part of the vas deferens surrounded by a cucumber-shaped cirrus pouch, in which,

however, no muscular fibres are to be perceived with certainty. This part of the vas deferens shows no special differentiation. In the proximal end of the cirrus pouch some curious large cells are to be seen. In the testicular field the median main stem of the vas deferens receives the side branches generally obliquely from before; the whole giving the impression of a ramifying tree. Farther backwards the vas deferens passes in the median line between the dorsally situated ovary and the ventrally situated yolk-duct, crosses the oviduct on the ventral side and penetrates, after some by no means constant convolutions, into the proximal end of the cirrus pouch.

9. As to the question of the specific name of the Sudanese *Sanguinicola*, it seems a priori to be more likely that the genus has developed different species in European Cyprinoids and in Nile Siluroids. That this also really is the case seems to me to be specially proved by the rather different form of the ovary: according to the figures of Miss Plehn this organ is in the European form shaped as the wings of a butterfly embracing the hind part of the testicular field; in the African form the ovary is, as pointed out, wholly situated behind the testes and of a more or less aciniform structure. It is further to be remarked that in the latter form the vitellaria reach beyond the ovary backwards, and that the gut-sac is undivided. For these reasons it seems to me most appropriate to regard the African form, which at present is more thoroughly investigated than the European one, as a species of its own, which I name after its late discoverer, *S. chalmersi* n.sp. The form and size of the still unknown eggs may perhaps give further specific characters.

To summarize the results of this paper, my investigations of the African *Sanguinicola* have proved the correctness in every detail of my interpretation (1911) of the second and on the whole much better description of Miss Plehn.

ADDENDUM.

The above paragraphs 5-7 could have been replaced by a simple reference to the paper of Scheuring published February 1, 1923 ("Der Lebenszyklus von *Sanguinicola inermis*

Plehn", in 'Zool. Jahrbücher, Abt. f. Anat.', vol. 44), and not observed by me when I wrote my paper a year ago. This author confirms my observation that the peculiar eggs in the blood of the carp belong to *Sanguinicola*; he has, further, succeeded in infecting the snails and in rearing in them a cercaria of the *cristata* type. As he was not able to procure any carp not infected by *Sanguinicola*, he could, however, not close the life-cycle by infecting the fishes with the cercariae. As to the adult worm, he confirms my conception of its anatomy; further, he puts beyond doubt the existence of two different species in Europe, viz. *S. armata* Plehn and *inermis* Plehn, the former living in tench, the latter in carp. That the African form is specifically different from the latter one, which is the one treated by Plehn and Scheuring, is evident; not to speak of the marginal spines, the other anatomical differences pointed out above are all confirmed by the somewhat schematical figure of Scheuring. Of the anatomy of *S. armata*, on the other hand, we know nothing at all, and thus no comparison between this species and *S. chalmersi* can be made.

NOTE ON SANGUINICOLA FROM THE SUDAN:
A CORRECTION.

BY W. N. F. WOODLAND.

In describing the European form of *Sanguinicola*, with fresh material at her disposal, Dr. Plehn gave on different occasions two distinct versions of the arrangement of the genital ducts, and later Dr. Odhner so re-interpreted the nature of certain of these ducts that his description may be regarded as a third version. These facts indicate that these ducts of *Sanguinicola* are not easy to observe, even in good first-hand preparations. In a paper on an Egyptian form of *Sanguinicola* recently published in this Journal I concluded, from a study of second-hand and not very well-stained material, that Dr. Plehn's first description of the ducts was the correct one, and I laid considerable emphasis on the supposed fact and drew certain conclusions. At Dr. Odhner's request I sent him my preparations and, as is recorded in the paper by this author preceding this, he states that I have, like Miss Plehn, failed to observe the second female duct.