

A REVISION OF THE GENUS *FASCIOLA*.

WITH PARTICULAR REFERENCE TO *F. GIGANTICA* (COBBOLD)
AND *F. NYANZI* (LEIPER).

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(With Plate III and 4 Text-figs.)

THE material which is the subject of this paper was obtained from the following sources.

One tube of flukes collected by Dr H. H. Marshall at Bassein and Rangoon, British Burmah (referred to below as "Rangoon specimens")¹; two tubes sent by Mr H. E. Hornby at different times from Northern Rhodesia (referred to as "Rhodesia specimens," "1st collection" and "2nd collection" respectively); and two tubes (Nos. 29 and 65) from the Veterinary Pathology Laboratory, Nairobi, British East Africa, collected by Mr R. E. Montgomery (the former referred to as "Nairobi specimens")¹; in all comprising 40 species. I am very much indebted to Dr C. L. Boulenger, F.Z.S., Professor of Zoology at Lahore, for entrusting me with the description of this material.

The tubes contained elongated flukes of the genus *Fasciola*. It was found on examination that all the specimens (with the exception of those contained in the tube, Nairobi, No. 65) were related to *Fasciola gigantica* (Cobb.) and the question of the relationship of the various elongated flukes, that have been described from time to time under different specific names, with Cobbold's species and these new specimens, was thus raised again.

The question may be stated thus—do all these forms belong properly to *F. gigantica* (Cobb.) or should they be split up into more than one species? The history of the matter can briefly be told². *F. gigantica* was described by Cobbold (1856) from specimens found in a giraffe belonging to a travelling menagerie.—Railliet (1895) communicated the discovery of an elongated fluke in Senegal cattle, slaughtered at St Louis and provisionally named it *F. hepatica* var. *angusta*.—Looss (1896) described a fluke from cattle slaughtered at Cairo that he named *F. hepatica* var. *aegyptiaca*, but which he considered a distinct species in 1899.—Blanchard (1896) suggested that both these varieties were in reality the same as Cobbold's *F. gigantica* but he gave no evidence or figures to support this suggestion.—Looss (1902) returned to the subject after examining a large number of specimens from

¹ Received from the Quick Laboratory, Cambridge.

For detailed discussion of the earlier history and complete bibliography see Stiles 1894-95.

the Cairo abattoirs. He accepts Blanchard's suggestion and withdraws the species *aegyptiaca*, not entirely without misgivings¹, and further suggests that the *gigantica* type of fluke is an African form in the same way as *F. magna* may be looked upon as an American form. In this note he gives, however, no anatomical details and no figures.—Braun (1906), without adding any original observations, is willing to accept the identity of *F. angusta* and *F. aegyptiaca* with one another but is sceptical of their identity with *F. gigantea*.

The prevailing uncertainty on the subject is largely due to the imperfect description of *F. gigantea* given by Cobbold and the fact that it has not been added to or revised since his time. By the courtesy of Dr Arthur Keith, F.R.S., I was given facilities for examining the original specimens in the Royal College of Surgeons, and am able to record all that the state of preservation of the specimens will allow to be contributed towards the elucidation of this matter. The specimens are three in number and quite extraordinarily different. They will be described in order of size:

COBBOLD'S *FASCIOLA GIGANTICA*.

Specimen No. 1 (Text-fig. 1). 76 mm. long by 5 mm. at broadest part. Cone cylindroconical and mounted on sharply projecting "shoulders," the left in this specimen being more anteriorly placed than the right. The ventral sucker is large and prominent with an irregular triangular aperture. The greatest breadth of the body is attained just behind the right "shoulder" and it narrows so slightly that it has only decreased 1 mm. at the posterior end of the testis area—a length of 35 mm. from the mouth. The tail is bluntly pointed and the last 41 mm. of the body are entirely occupied by yolk glands and alimentary canal. Narrow strips of yolk glands continue laterally to the "shoulders." The testes occupy the usual position and are coarsely lobed. The shell gland is visible 12 mm. from the anterior end and the uterus is long and loosely coiled. The gut cannot be made out in detail and no ramifications of the lateral diverticula can be seen. Yolk glands appear to spread on both sides of the gut. Spines are not visible. Proportion of length to breadth, 15.2 to 1.

Specimen No. 2 (Text-fig. 2) is 59 mm. long and 7 mm. broad. The cone passes into the body insensibly, there being no distinct "shoulders." The sides are almost parallel, tapering ever so slightly towards the tail, which is bluntly rounded. The testes occupy more space than in No. 1 and are coarsely lobed. The remainder of the organs which can be made out are typical, or as figured by Cobbold. I make out, however, more than 8–10 branches of the gut diverticula and indeed Cobbold's statement conflicts with his figures in this respect. Size of eggs: length 0.145 mm. to 0.150 mm., breadth 0.082 mm. to 0.088 mm. Proportion of length to breadth over 8 to 1.

¹ "...Ich wüsste gegen die Berechtigung seines Vorgehens gegenwärtig nichts mehr einzuwenden, und ziehe *F. aegyptiaca* als selbständige Species zurück."

Specimen No. 3, 23 mm. long by 3.5 mm. broad, is a small fluke of similar proportions to No. 2, but the cone is larger in proportion to the body. The condition of the specimen makes it difficult to determine. The uterus is

large and with few coils; it contains some eggs. The space occupied by the testes is unusually large, from the mouth to the posterior border of the testis area measuring about 18 mm. The ventral sucker is not prominent. It is not possible to make out the alimentary canal. The yolk glands are normally arranged and the median commissures to the shell gland are visible. Proportion of length to breadth under 7 to 1.

Specimen No. 2 is a type of the specimen figured by Cobbold but somewhat longer in proportion to the breadth than his figure. The average length of his specimens is given as 2 inches and as this type specimen is nearly $2\frac{1}{2}$ inches it may be taken as slightly larger than the average. In the largest specimen (No. 1) the proportion of length to breadth is amazingly larger than any known fluke, and in the other specimens it is remarkably large. One can only look on the classing of these three worms in one species with grave suspicion until similar specimens are again found in the giraffe and their anatomy is accurately described.

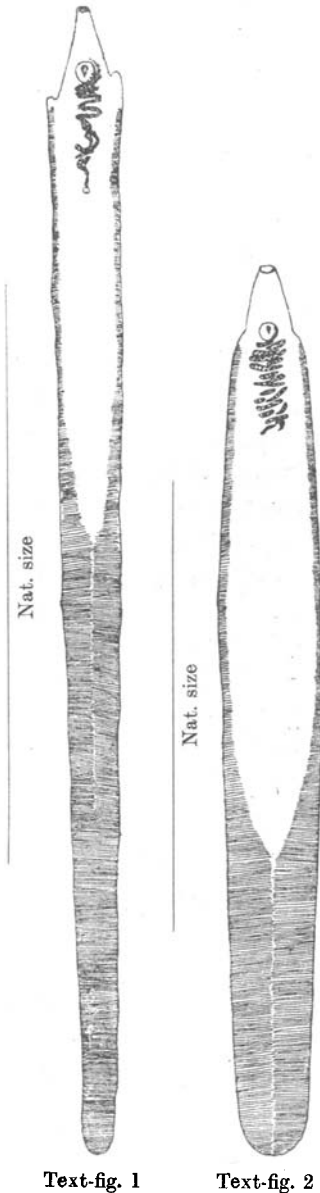
In the meantime the medium sized specimen (No. 2) must be taken as the type of *Fasciola gigantica*.

The material in my possession which bears on the specimens under consideration is described below, but only the important features are recorded.

RANGOON SPECIMENS (Pl. III, fig. 1).

Largest 45 mm. by 12 mm. Narrowest 8 mm. by 34 mm. Shortest 29 mm. by 9 mm.

The large cone passes insensibly into the body; in no case are "shoulders" more than slightly indicated. The body in every specimen tends to expand slowly to its greatest width at or about the posterior border of the testis area and ends in a very bluntly rounded tail. The ventral sucker is round and



prominent and its lumen is produced posteriorly into a triangular pouch. The pharynx is long and the oesophagus very short, the diverticula of the gut are very strongly branched externally and internally, and the internal branches are ramose. Yolk glands spread on both sides of the alimentary canal. The testis area is moderately large, its posterior margin being about one-third of the entire length from the tail. The ovary is on the right side and, as in all other points of the histology and finer anatomy, is similar to *F. hepatica*. The body is very flat dorsoventrally and covered with moderately large spines. The eggs are of sizes lying between 0.140 mm. to 0.160 mm. in length and 0.060 mm. to 0.100 mm. in breadth. Average proportion of length to breadth 3.2 to 1.

Locality. Cattle, Bassein and Rangoon.

RHODESIA SPECIMENS (Text-fig. 3). *1st Collection.*

Longest 39 mm. by 11 mm. Shortest and narrowest 36 mm. by 10 mm. Broadest 12 mm. by 37 mm.

These resemble the Rangoon specimens in general form, but the body reaches its greatest length nearer to the anterior end and tapers very gradually to a blunt tail. The ventral sucker has a triangular aperture and is slightly pouched posteriorly. The general anatomy is as above. The body is very flat dorsoventrally and the spines are moderately large.

Eggs: length 0.150 mm. to 0.170 mm., breadth 0.070 mm. to 0.085 mm. Average proportion of length to breadth 3.3 to 1.

Locality. Cattle, Northern Rhodesia.

RHODESIA SPECIMENS (Text-fig. 4) *2nd Collection.*

Longest 37 mm. by 9 mm. Widest 13 mm. by 26 mm. Shortest 25 mm. by 10 mm. Narrowest 8 mm. by 36 mm.

The majority of these specimens are more slender than any described above. The slenderness of the body gives the cone an appearance of large size—it is perhaps larger in proportion to the body than in the specimens already described. The “shoulders” are very slight. The body soon reaches its full width and retains it for one-third of its length, tapering posteriorly to a bluntly pointed tail. The anatomy is as above.

Eggs: length 0.130 mm. to 0.175 mm., breadth 0.075 mm. to 0.090 mm. Average proportion of length to breadth 3.7 to 1. In many specimens the proportion is over 4 to 1.

Locality. Cattle, Northern Rhodesia.

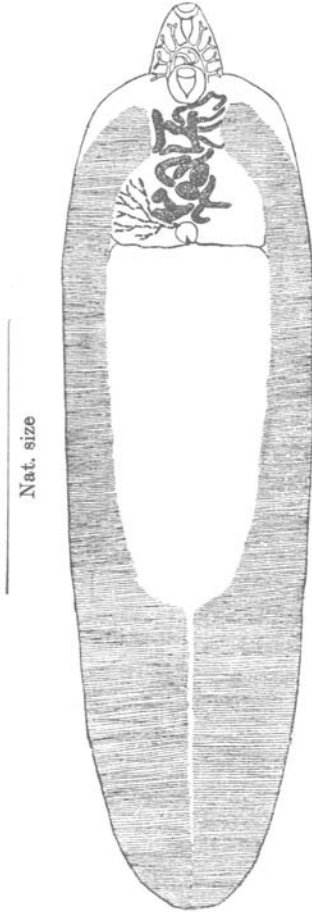
NAIROBI SPECIMENS (Pl. III, fig. 2).

Three specimens measuring 33 mm. by 7 mm., 35 mm. by 6 mm., and 34 mm. by 6 mm. and differing in slight points from those described above. The body is very slender and the large cone is, at its base, as wide as the body, no “shoulders” being present. It expands slightly for about one-third

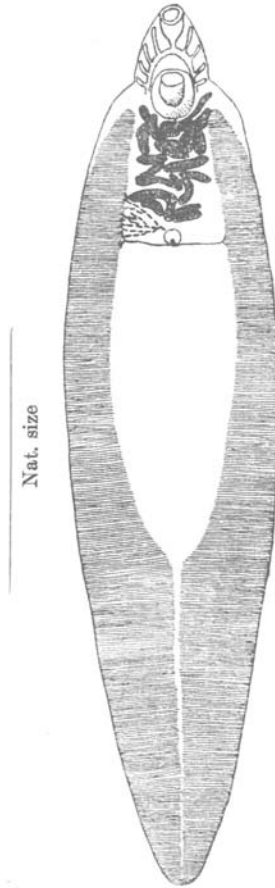
of its length and then tapers to a bluntly pointed tail. The ventral sucker is very large and protuberant and has a deep posterior pouch. The oesophagus is about half as long as the pharynx. Large spines cover the body, and smaller ones the cone. Average proportion of length to breadth 4·7 to 1. The anatomy is as above.

Eggs: length 0·125 mm. to 0·155 mm., breadth 0·075 mm. to 0·095 mm.

Locality. Ox, British East Africa.



Text-fig. 3



Text-fig. 4

DISCUSSION AND CONCLUSIONS.

The relationship of the flukes described above to those already described by Railliet and Looss admits of little doubt.

The Rangoon specimens can be seen at once to correspond in almost every detail with Looss' *F. aegyptiaca*; the only difference to be found is in the slightly narrower proportions, on the average, of Looss' specimens.

Similarly the Nairobi specimens can be referred to the variety originally described by Railliet under the name of *F. hepatica* var. *angusta*, from which they only differ in the slightest degree. The Rhodesian flukes possess no character which would separate them from either, the first collection coming nearer to the Rangoon specimens and the second collection to the Nairobi specimens.

The bridge between the two forms being thus complete, it may be taken that *F. angusta* and *F. aegyptiaca* are one and the same species.

Their relation to *F. gigantica* is less obvious. The great size of Cobbold's specimens may partly be accounted for by the undoubted maceration they had undergone before examination. Goddard (1919) records cases of extreme alterations in *Fasciolopsis*, measured immediately after evacuation and after standing a few hours in water. Shape and size cannot count for a great deal in the delimitation of species in these forms, owing to the distortion inevitably produced by maceration and fixation, unless coupled with distinct anatomical differences.

The anatomy provides us with little on which to base a separation. The alimentary canal is provided with the ramose internal branches of the diverticula, which have been shown to be characteristic of all the forms described above.

Cobbold's figures do not distinctly show the proportion of pharynx to oesophagus, but it is indistinctly indicated (it was not possible to make out the point in the original specimen I examined) that the oesophagus is quite as long as the pharynx. If this is correct—and the mobility of the muscular pharynx makes the character at least of doubtful value—it makes a point of difference from these recent specimens. The testes are similar and occupy a similar proportion of body space. The remaining organs are similar. The parasite comes from the same continent as all the elongated forms (except the Rangoon specimens) that have been hitherto described.

The eggs—length 0.145 mm. to 0.150 mm., breadth 0.082 mm. to 0.088 mm. lie within the limits of those of the specimens described above.

On the whole therefore the differences amount to so little that we may, without much hesitation, refer all these forms to the species *Fasciola gigantica* (Cobbold).

The descriptions given above may now be combined to make the following diagnosis of *F. gigantica*.

F. GIGANTICA (COBB.).

Body elongated and at least three times as long as broad. Cone passing almost insensibly into the body, prominent "shoulders" always being absent. As a rule the sides of the body are roughly parallel and the posterior extremity is bluntly rounded or more rarely bluntly pointed. The ventral sucker is large, often protuberant and its cavity is usually prolonged backwards into a blind pouch. The pharynx is longer than the oesophagus. The external branches of

the diverticula of the alimentary canal are as in *F. hepatica*, the internal branches, however, are numerous and always ramose to a greater or less extent. The yolk glands are present on both sides of the alimentary canal. The testis area is shorter in relation to the rest of the body than in *F. hepatica*.

The eggs are larger than those of *F. hepatica*, varying from 0.125 mm. to 0.175 mm. in length to 0.060 mm. to 0.100 mm. in breadth.

Habitat. Liver of ruminants.

Looss' observation that in this species we have to do with an African liver fluke in the same way as *F. magna* may be called an American fluke, must be looked upon with caution, until it is known whether the Rangoon specimens indicate a wider distribution than he had reason for suspecting.

FASCIOLA NYANZI (LEIPER) (Pl. III, figs. 3 and 4).

This fine species was found by Leiper in the bile ducts of the liver of a hippopotamus taken in Uganda and described by him under the above name (1910). His specimens were somewhat macerated and he was therefore unable to describe the species in every particular. Among the material from Nairobi (tube No. 65) I fortunately found a number of well preserved specimens of this species and I am able to add to Leiper's original description.

None of the specimens were as large as the largest described by Leiper, the longest being 59 mm. by 9 mm., the broadest 13.5 mm. by 49 mm. and the smallest specimen 35 mm. by 4.5 mm., but the remarkable general form was unmistakably as he described it. The species is especially noticeable for the great breadth of the "shoulders," the large cone and the long tapering body, almost entirely occupied by yolk glands.

The worm is thickly covered with spines, of a moderate size on the body and smaller and more closely set on the cone. The oesophagus is exceedingly short and the paired diverticula of the gut approximate behind the level of the shell gland and for the rest of their course lie very close together. The internal branches of the diverticula are fairly numerous, but small and infrequently branched. Branches from opposite sides frequently pass across one another or lie close together, giving a superficial appearance of anastomosis. The testes are confined to the anterior third only of the body. The ovary lies on the right hand side of the animal and is a typical branched body. The uterus is short and its coils are close behind the ventral sucker. Laurer's canal is present; it is very small and in the specimens examined had no contents. The yolk glands extend rather further forward into the "shoulders" in my specimens than in Leiper's, and lie exclusively (except for a stray branch or two) on the ventral side of the gut. It shares this interesting feature with *F. magna* in the genus *Fasciola*. The point is particularly easy to make out in the cleared specimens; viewed from the dorsal surface the alimentary canal is sharply outlined against a background of yolk glands.

The excretory and nervous systems are as in *F. hepatica*.

The eggs vary considerably in size in different specimens, and the size

given by Leiper (0.150 mm. by 0.070 mm.) must be taken as a minimum. Extracted from the uterus and measured in 70 per cent. alcohol the eggs lie between 0.150 mm. to 0.190 mm. in length and 0.070 mm. to 0.110 mm. in breadth. Measured from balsam preparations the eggs are on the average smaller (through shrinkage) than those extracted and measured in the medium in which the flukes are preserved.

SUMMARY.

1. The specimens in the material here dealt with make a series of forms connecting *F. angusta* (Railliet) and *F. aegyptiaca* (Looss).

2. No important character separates any of these flukes from *F. gigantica* (Cobbold) and they must accordingly be all identified with this species.

3. The following key represents the simplest method of distinguishing between the species of *Fasciola* at present described. (For detailed diagnoses see the literature referred to below and this paper.)

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| (1) | { | Yolk glands ventral to gut | 2. |
| | { | Yolk glands on both sides of gut. | 3. |
| (2) | { | Body very large and thick; cone not very distinct; oesophagus one and a half to three times as long as pharynx | <i>F. magna</i> . |
| | { | Body slender and awl shaped; cone very large and distinct; oesophagus exceedingly short | <i>F. nyanzi</i> . |
| (3) | { | Body at least three times as long as broad; "shoulders" absent or indistinct; internal branches of gut numerous and branched | <i>F. gigantica</i> . |
| | { | Body broad and leaf shaped; cone sharply set off from body on wide "shoulders"; internal branches of gut few and little if at all branched | <i>F. hepatica</i> . |

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EXPLANATION OF PLATE III.

The lateral extent of the yolk glands is shewn in each figure by shading. Only the broad plan of the external branches of the diverticula of the gut is indicated, the fine terminal arborisations being omitted.

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| Fig. 1. | <i>Fasciola gigantica</i> (Cobbold). | Ventral view. |
| Fig. 2. | „ „ „ | Ventral view. |
| Fig. 3. | <i>Fasciola nyanzi</i> (Leiper). | Anatomy, from ventral view. |
| Fig. 4. | „ „ „ | External features; ventral. |

EXPLANATION OF LETTERING.

a.s.—anterior sucker and mouth; *ov.*—ovary; *ph.*—pharynx; *sh. gl.*—shell gland; *T.*—testis area; *ut.*—uterus; *v.s.*—ventral sucker; *y.g.*—yolk gland area.

