Some Parasites in the Museum of the School of Tropical Medicine, Liverpool

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ON SOME PARASITES IN THE MUSEUM
OF THE SCHOOL OF TROPICAL
MEDICINE, LIVERPOOL

ON
SOME PARASITES IN THE MUSEUM OF
THE SCHOOL OF TROPICAL MEDICINE,
LIVERPOOL

BY

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WITH A CONTRIBUTION ON

A CASE OF DISTOMIASIS OF THE LIVER AND
THE RECTUM

BY

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During a visit I recently paid to the School of Tropical Medicine in Liverpool Dr. STEPHENS showed me a number of parasites which had been sent to the Museum of the School from various places. Unfortunately, some of the bottles bore no indication whatever as to the locality from which the specimens were obtained; others were labelled, but an inspection of their contents with the naked eye or a pocket lens raised within me strong doubts as to the correctness of the respective identifications. To make things sure Dr. Stephens kindly agreed that I should take with me, of those forms of which several were present, a few specimens for a more careful examination and possible identification of the species. The results of this investigation are given in the following pages.

Fasciolopsis buski (LANK.), 1857.

About a dozen specimens from Hong-Kong in a jar labelled "Distoma crassum." Rather large and fleshy, apparently some what contracted worms of about 30 mm. in length, 13 to 16 mm. in breadth and nearly 4 mm. in maximum thickness. Body moderately elongated, rather regularly oval, its surface marked with numerous fine transverse ridges brought about by contraction. Both suckers very close to the anterior end of the body; opening of the anterior sucker

minute and completely ventral, opening of the posterior sucker very wide, transversely oval, about 2 mm. in its largest diameter. The same is the average distance between the centres of the two suckers. In some cases the part of the body containing the anterior sucker was found separated from the rest in the shape of a minute but quite distinct cone resembling that which characterises the members of the genus *Fasciola*. Immediately in front of the ventral sucker there is a transverse slit indicating the position of the genital aperture. All round the margin of the body, the colour of the worms is considerably duller than in the middle and in most cases this duller tint projects twice on each side in an angular fashion into the lighter central area, this latter thereby assuming the shape of three successive but incompletely separated discs. All these characters discernible by naked eye inspection suggested *Fasciolopsis buski* (LANK.). A comparison of the internal organisation—so far as this could be made out from cleared entire individuals—did not reveal any noticeable difference from the description recently given of the species by ODHNER (1902). The determination *Distoma crassum* is therefore correct, for the name *Distoma crassum* (COBB), 1877, is only a synonym of *Fasciolopsis buski* (LANK), 1857.

Distoma pancreaticum (JANSON).

A bottle from Hong-Kong, without label, contained a number of medium-sized flukes which in their outward appearance recalled the pancreatic fluke of ruminating animals in Eastern Asia. On closer inspection it could be seen even with the naked eye that there were two varieties present in this material, a larger form with very wide and projecting suckers and a somewhat smaller in which the suckers were well developed also, but much smaller and less prominent. Both varieties were represented by evidently completely mature individuals; there were, in addition, numerous young specimens of different size of the second variety, but no immature specimens of the first. Two specimens of the first variety and four adults of the small kindly given to me by Dr. STEPHENS form the basis of the present description.

After clearing, the chief points of their internal organisation could fairly well be made out in entire specimens; the details observed were in full agreement with the descriptions given of the *Distoma*

pancreaticum by the earlier writers. There were, however, between the two varieties in addition to the differences mentioned above in the size of the suckers several other slight internal discrepancies which leave no doubt that the two forms must be considered as two distinct species. Both are closely allied to each other and members of the same natural genus. The generic name hitherto usually adopted for *Distoma pancreaticum* is *Dicrocoelium*; indeed, the principal features of the anatomical structure are the same in *Distoma pancreaticum* and *Dicrocoelium lanceatum* (ST. and HASS.), the type species of the genus. But besides this similarity in the main structure there are also certain differences which to my mind forbid placing *Distoma pancreaticum* in the genus *Dicrocoelium* itself, that is to say as it is represented by its type *lanceatum*. One of the most conspicuous of these differences lies in the thickness and the considerable breadth of the body which latter allows the testicles to take a distinctly lateral position at about the same level, whereas in *Dicrocoelium* sensu strictiori, owing to the narrow spindle-shaped outline of the body, the testicles are placed obliquely one behind the other. In *Lyperosomum* which is also closely related to *Dicrocoelium* the two cross diameters are still more reduced, the members of this genus presenting to the observer an almost filiform body of about equal breadth and thickness in which the genital glands are found in a straight line one behind the other. In addition to the peculiar shape of their body the two *Distoma pancreaticum* differ from *Dicrocoelium* by the more complicated structure of their excretory vesicle and the stronger development of their copulatory organs. On the whole, therefore, there is sufficient reason for creating a new genus for the two forms under discussion.

The question as to the correct denomination of the *species* was somewhat difficult to decide. *Distoma pancreaticum* was discovered in Japan, and became first known in Europe during the Paris Exhibition in 1889, where the Agricultural School of Komaba exhibited a series of parasites among which there was a "*Distoma pancreaticum* from the pancreatic duct of sheep," and a "*Distoma pancreaticum* var. from the pancreas of sheep." The new parasite was referred to in subsequent years by RAILLIET (1890) and JANSON (1893 and 1895); the respective papers deal with the anatomical structure and the pathological significance of the parasite, they emphasise its

resemblance to *Dicrocoelium lanceatum* but do not—so far at least as I can personally consult them at present—contain any decisive statement from which one or the other of the two Hong-Kong species mentioned above might be recognised. In 1897, GIARD and BILLET, apparently ignorant of the existence of the *Distoma pancreaticum*, described a *Distoma coelomaticum* which the latter author had found plentifully in the pancreas of an ox killed at the slaughter-house of Cao-Bang (Tonkin); there had at first been some mistake as to the habitat of the parasite—which led to the denomination *coelomaticum*—but this mistake was corrected afterwards upon a suggestion of RAILLIET. The details given in GIARD and BILLET'S description are sufficient to show that *Distoma coelomaticum*, also structurally resembles *Dicrocoelium lanceatum* and *Distoma pancreaticum*, but there is again no statement which would be indicative of one of our two species in contradistinction from the other.

The latest description of *Distoma pancreaticum* is given by RAILLIET and MAROTEL in 1898. The specimens upon which their paper is based were collected by Dr. GOMY, a French veterinary surgeon, from the pancreatic ducts of cattle and Indo-Chinese buffaloes in Saigoon (Cochin-China), a locality therefore which is not so far distant from the place at which GIARD and BILLET'S material was taken. This time, the description is more complete; the worms are said to measure from 7 to 10 mm. in length and from 4 to 4.5 mm. in breadth; their suckers are of about equal size, the posterior of 0.75 to 0.95 mm. in diameter being only slightly larger than the anterior which presents a diameter of 0.7 to 0.9 mm. The distance between the two suckers varies from 1.3 to 2.4 mm., that is to say, it amounts to about a quarter of the total length of the body. As will be more fully seen hereafter, all these measurements apply very well to the smaller of the two Hong-Kong species and among the anatomical details given by the authors there is none moreover which would not quite well fit in with its organisation. I thus think it perfectly safe to assume that this smaller Hong-Kong species is the same as the *Distoma pancreaticum* described by RAILLIET and MAROTEL in 1898 from Saigoon cattle. But RAILLIET in the same paper (p. 32) also states that he has satisfied himself *de visu* of the specific identity of this Cochin-Chinese pancreatic fluke with the parasite found in Tonkin by BILLET. This latter parasite had first

been described under the name of *Distoma coelomaticum* and the question now arises: is this *Distoma coelomaticum* of Indo-China really the same form as the *Distoma pancreaticum* of Japan? If this were so, then the smaller Hong-Kong form would have to be identified as the genuine *Distoma pancreaticum*, the name *coelomaticum* would have to be definitely dropped as a synonym and a new specific name would have to be given to the larger Hong-Kong species with the strongly developed suckers.

As I have already pointed out, the data given in the printed description of the original Japanese pancreatic fluke are not sufficient to decide the question. I possess, however, in my collection a number of specimens of *Distoma pancreaticum* which I owe to the kindness of Professor JANSON, of Tokio. They were collected from the pancreatic ducts of cattle in Japan and I think there can not be any reasonable objection to the assumption that they are specifically the original Japanese *Distoma pancreaticum*. It is true that the first specimens of this species exhibited in Paris were labelled as collected from sheep, but I am not inclined to attribute a great importance to this difference in the host, because it is a well-known fact that many parasites of cattle and buffaloes occur not only in sheep but in other ruminating animals also. A comparison of this Japanese material has now shown, first, that there is only *one* species present in it and, second, that this species is identical with the larger species of the Hong-Kong material. On the ground of these facts I feel justified in considering this latter species as the genuine *Distoma pancreaticum* of JANSON; for the smaller species I readopt the name *coelomaticum* of GIARD and BILLET, the suppression of which was, in the sense of the nomenclatural rules, a mistake based upon an erroneous identification of the species.

Eurytrema, nov. gen., *Dicrocoeliidarum*,

Differs from *Dicrocoelium* especially by the following particulars: Body rather thick and considerably broadened, with the exception of the hindmost part which retains its original shape and appears as a small triangular appendage sharply set off from the rest of the body; it is repeatedly referred to in the descriptions of the earlier authors as resembling in outline the cephalic part of *Fasciola hepatica*. Suckers very large and prominent, the oral sucker completely ventral and

surmounted by the anterior margin of the body. Excretory vesicle composed of a median stem which divides into two at about the middle of the total length, the transverse branches, in the neighbourhood of the intestinal caeca, dividing again each into an anterior and a posterior branch which run for the greater part outside of the intestinal caeca, and terminate in the neighbourhood of the anterior and posterior extremities of the body. Testicles lateral, at about the same level but far apart from one another. Copulatory organs well developed; cirrus pouch thick, almost cylindrical, containing a long but rather thin seminal vesicle and an equally long and thin ejaculatory duct which both describe a number of coils within the pouch. Vagina corresponds in length and arrangement to the ejaculatory duct. Structure of the remaining organs as in *Dicrocoelium*.

Type: *Eurytrema pancreaticum* (JANSON) 1889.

Eurytrema pancreaticum (JANSON),

(nec *Dicrocoelium pancreaticum*, RAILLIET and MAROTEL, 1898).

The two Hong-Kong specimens at my disposal are fairly well extended and measure 13 and 14 mm. in length; their maximum breadth of 6.5 and 7 mm. is reached immediately behind the ventral sucker. Thence the body narrows more quickly towards the anterior extremity than posteriorly but ends rather truncatedly owing to the large size of the oral sucker above which the margin of the body projects in the shape of a thick lip. The small tongue-like appendage of the posterior end is very conspicuous. The thickness amounts to almost 2 mm. in the median line of the anterior half, but gradually decreases towards the edge. The Japanese specimens are somewhat more contracted and thicker throughout, varying in length between 9.5 and 16 mm., in breadth between 5.5 and 8.5 mm.—in such a way that the longer specimens are generally less broad and vice versa. There are, however, also two apparently mature individuals 9.5 and 10 mm. long, but only 5.5 mm. broad. Skin, thin, without armature. Suckers very large and prominent, the anterior one with an average diameter of 2.1 mm., noticeably larger than the ventral which presents a diameter of 1.45 to 1.65 mm., but is in some specimens found more or less everted reaching thereby a size of 1.9 mm. In the two smallest specimens mentioned above the ratio of the suckers is 2.1 to 1.4 and 1.8 to 1.3 mm. respectively. They are, therefore, even in these

smallest specimens considerably larger than in the *Distoma coelomaticum* of the same size. The ventral sucker is always found near the end of the anterior half of the body; the distance between the centres of the two organs varying in the larger specimens from 4.5 to 5.7 mm. and being in the two small specimens 3.9 and 3.3 mm., that is to say it amounts to at least a third and is usually but little less than half of the total length. The genital opening has its position about halfway between the two suckers and is sometimes found slightly raised above the level of its surrounding. In one of the specimens the penis is seen everted, apparently to its full length, for the larger part of the seminal vesicle is located in it; it represents an organ 3.4 mm. in length and at its base 0.37, at the free end 0.24 mm. wide. Its surface is smooth.

The internal anatomy agrees with the descriptions given by the earlier writers. The small pharynx of 0.47 mm. length and 0.54 mm. width is usually so much displaced dorsally that it is not visible from the ventral aspect; behind it there follows a short oesophagus which, as a rule, runs straight down towards the ventral side and may thus more or less entirely disappear from view. The intestinal caeca of proportionally insignificant calibre quickly diverge and follow a zigzag course which becomes especially pronounced behind the testicles. Their blind terminations lie about as far as the length of the tongue-like end-portion of the body in front of the base of that portion and usually not quite on the same level, the left branch being as a rule (but not always) the shorter. The full extent of the excretory vesicle could not be made out in any of the specimens at my disposal, owing to the thickness of the body and the strong development of the uterine coils. The main parts described in the generic diagnosis are usually seen and followed without much difficulty; but, in addition to them, one may observe in some places isolated portions of similar tubes which seem to be ramifications of the anterior and posterior lateral branches. There are two running forwards on either side of the ventral sucker, and two running backwards and towards the median line amidst the uterine coils in the posterior half of the body. Although they appear as if they were parts of the excretory vesicle, I cannot tell with certainty whether or not they really belong to that organ. The terminations of the main anterior branches of the vesicle lie close to the oral sucker at about the level of its centre, those of the

posterior branches at, or slightly in front of, the two notches which separate the terminal triangular tongue from the rest of the body.

The position of the genital aperture has been given above; it lies always a little behind the bifurcation of the intestine. The thick muscular cirrus pouch, usually somewhat curved in the shape of a sausage, presents a length of 2.2 to 3 mm. and an average width of 0.6 mm. Its posterior end rests upon the anterior slope of the ventral sucker, but there are some variations in its length in connection with the contraction of the body and the fulness of the seminal vesicle. This latter occupies the posterior half of the pouch, describing, within it, a proportionally large number of small coils. The pars prostatica is short and the number of glandular cells surrounding it limited. The ejaculatory duct is at first rather narrow, but widens somewhat towards its free end; its coils are proportionally numerous also. The dimensions of the evaginated penis have been given above. The fairly large testicles are normally found at the same level somewhat behind the ventral sucker, but may in strongly contracted specimens be more or less completely shifted to its sides. They have in the greater number of my specimens a distinctly lobed shape, but exceptionally the lobes may be so short and broad that the glands appear to possess a merely notched outline. The number of lobes (or notches) seems to be constantly four for one (usually the left) and five for the other testicle. These conditions are inverted in the cases of "sexual amphitypia" which are not unfrequently met with in this as well as in the following species.

The small ovary is usually found a short distance behind the testicles, on the left—in cases of sexual amphitypia on the right—side of the body. It has in all the specimens with lobed testicles a distinctly lobed shape also, the number of lobes being three. In those specimens, on the other hand, in which the testicles show the notched outline only, the ovary, too, loses its lobed outline more or less and appears compact with some irregular bulgings of its surface. The oviduct starts from its near side and almost immediately enters into a well-developed shell-gland which in cleared specimens appears as an opaque sharply outlined body by the side of the ovary and close to the ventral surface. There is also a fairly long LAURER'S canal of an average diameter of 0.04 mm. which opens to the outside in front of the ovary. It carries a small seminal receptacle which I have never been able

to discover in entire specimens, but clearly saw in a series of sections. The receptacle represents in the sectioned specimen a globular body of about the same size as the ovary (0.4 mm. in diam.) and lying close to its dorsal surface. It communicates with the LAURER'S canal by a distinct thin duct, but does not contain many spermatozoa, a fact which renders the seminal receptacle very transparent in unstained specimens. This insufficient filling in combination with the particular position of the seminal receptacle is obviously the reason why it escapes observation in entire worms.

The yolk-glands are only little developed; they are composed of rather numerous acini of a slender club shape collected into more or less distinct groups, the number of which seems to vary between ten and twelve. In extended specimens the groups lie in a nearly straight line one behind the other and are fairly well discernible; in contracted individuals they become more closely packed together and some of them—especially those in the middle—may be shifted laterally in such a way that for a certain distance there appear to be two irregularly alternating rows of groups. In this latter case some of the follicles are pushed below the intestinal caeca, otherwise, the yolk-glands lie as a whole between these and the body margin, usually the gland on the side of the ovary somewhat farther in front than that of the opposite side. Their extent varies a little individually and with the contraction of the body. In the greater number of specimens they commence somewhere at the outer border of the testicles and their posterior ends lie halfway between the posterior border of the ventral sucker and the base of the tongue-like end-portion of the body, but may in strongly contracted specimens also be found further forward. The transverse yolk-ducts originating, on each side, by the union of an anterior and a posterior tributary arise from the glands at about their middle; they join near the ovary (the left transverse yolk-duct being thus shorter than the right) and then enter the complex of the shell-gland from behind. There is no distinct widening of the unpaired part of the yolk-duct into a yolk reservoir. The coils of the uterus are very numerous but do not, as a rule, appear to the observer in the shape of regular loops, but rather as loose tubes branching and sometimes anastomosing in an irregular manner. Occasionally only, i.e. in individuals in a certain state of contraction, one may perceive the picture which is so characteristic of the uterus of *Dicrocoelium*

lanceatum and in which the descending and ascending stems of the uterus cover each other in such a way as to appear as a straight main stem from which lateral ramifications are branching off. As far as the branches of the intestine extend backwards, it is only exceptional to see one or the other uterine coil cross them towards the margin of the body; behind their blind ends the coils extend much nearer to the margin and the terminal small triangular appendage is, in perfectly mature specimens, almost completely filled with them. Anteriorly the coils are limited by the testicles and the ventral sucker; the uterus then passes between the latter and the right testicle (i.e. the testicle opposite the side of the ovary) and in front of this still forms some small convolutions before entering into the long and thin, but rather muscular vagina which accompanies the cirrus pouch while describing a number of narrow coils.

The eggs have a striking likeness to those of *Dicrocoelium lanceatum*; they are slightly larger than these showing, on an average, a length of 0.05 mm. and a width of 0.034 mm.—but apart from that, they present the same oval shape and the same thick shell of deep brown colour as these and contain, in addition, a miracidium which, when fully developed, shows the same two enigmatical strongly refractive bodies which are peculiar to miracidia of *Dicrocoelium lanceatum*.

Eurytrema coelomaticum (GIARD and BILLET) 1892.

(Synonym: *Dicrocoelium pancreaticum* RAILLIET and MAROTEL, 1898).

The largest specimens at my disposal attain a length of 10 mm., and a maximum breadth of 5.5 mm.; younger (immature) specimens measure 7.5 by 4, 7.5 by 3.5 mm., &c. The outline of the body is almost regularly oval, and there is no marked narrowing towards the anterior extremity. The triangular terminal portion ("languette triangulaire" of RAILLET) is fairly conspicuous. The maximum thickness of the body does not seem to exceed 1 mm. In the four large (mature) specimens which I have for examination the oral suckers present diameters of 0.95, 0.88, 0.85 and 0.83 mm., the ventral suckers diameters of 0.98, 0.91, 0.85 and 0.83 mm. respectively. These

measurements agree fairly well with those given by RAILLIET who, in the Saigon specimens, found the oral sucker to vary in diameter from 0.75 to 0.93 mm., the ventral sucker from 0.7 to 0.9 mm. The distance between the centres of the two organs which RAILLIET gives as 1.3 to 2.4 mm. is in the four above mentioned specimens, 2.5, 2.97, 2.7 and 2.72 mm.; the suckers are therefore, in *Eurytrema coelomaticum*, proportionately much nearer to each other than they are in *E. pancreaticum*, for the ventral sucker lies in the former species with the greater part of its mass still in the anterior third of the body and the distance between the two always remains less than a third of the total length. The size and relative position of the suckers represent, apart from the general shape of the body, the most conspicuous of the specific characters of *Eurytrema coelomaticum*.

The internal anatomy has been so fully described by RAILLIET and MAROTEL that I have nothing of importance to add; it is moreover essentially the same as that of *E. pancreaticum*, as may be seen by a comparison of the data given above with the description of the French authors. There are nevertheless the following differences in detail which I am inclined to consider as of specific value, although some of them are not absolutely constant. In *E. coelomaticum*, the genital glands never present the lobed appearance of those of *E. pancreaticum*, but always show a compact shape with irregular bulgings of their surface instead of lobes; the apparent rule that one testicle has four the other five bulgings seems however to be preserved here too. The yolk-glands which, in *E. pancreaticum*, were composed of ten to twelve groups of follicles, show in *E. coelomaticum*, only six to eight; the glands are therefore as a whole shorter than in the preceding species and they also begin somewhat farther backwards, viz. at the same level with the posterior margin of the testicles. In spite of that, their posterior terminations appear much more distant from the end of the body than in *E. pancreaticum*, a fact due to the considerable difference in the relative position of ventral sucker and genital glands in the two species. In *E. coelomaticum*, finally, it is not so uncommon to see one or the other uterine coil pass beyond the intestinal branches laterally.

The eggs, in shape, aspect and structure of the miracidium, closely resemble those of *E. pancreaticum*, but are somewhat smaller, namely

0.042 to 0.046 mm. long and 0.023 to 0.027 mm. wide. This size, by the way, is the same as that of the eggs of *Dicroc. lanceatum*.

Gastrodiscus secundus n. sp.

A small jar containing about a dozen specimens and a label on which there was written in pencil: "Gastrodiscus Sonsinonis Cobb. from mule." They were collected by GILES in Assam, who states that they are also found in equines throughout India. In their external appearance they absolutely resembled the African *Gastrodiscus aegyptiacus* (COBBOLD) 1877 (= *Diplostoma aegyptiacum* COBBOLD 1877, = *Gastrodiscus polymastos* LEUCKART 1877, = *Gastrodiscus sonsinoi* COBBOLD 1877), with the sole difference that all of them were noticeably *smaller*. Three specimens at present at my disposal show a length of 7, 8 and 8 mm., and a maximum breadth of 4.5, 5 and 5 mm.; the corresponding measurements in *Gastrodiscus aegyptiacus* being 10 to 13 mm. and 7 to 9 mm.

The body shows the characteristic division into two parts: the cylindrical or slightly depressed cephalic portion, and the broad oval disc, at the end of which the second sucker is placed. In the specimens under discussion the former is about 1.35 mm. long and at its base 1.6 mm. broad. Near its top, there appears on the ventral surface the mouth opening, about 0.37 mm. wide. In its neighbourhood the cuticle shows a large number of small circular or oval thickenings which project externally in the shape of small tubercles. They are apparently tactile papillae similar to those found round the mouth opening in allied forms. Behind the mouth the ventral surface of the cephalic cone is slightly excavated along the median line. The abdominal disc is apparently much contracted, for its free edge is rolled inwards to such an extent that the ventral surface and the terminal disc are visible in part only. The ventral surface is, so far as it lies open to the observer, densely covered with the well-known "papillae," or "pseudo-suckers" bearing on their summits small slit-like openings. Some of these organs are everted and, in this state, represent small knobs projecting somewhat over their retracted neighbours. On inspecting the worms with a magnifying glass, a small circular hole surrounded by a somewhat raised brim becomes visible in the midventral line about 1.35 to 1.5 mm. distant from the base of the cephalic cone. It was present at the same place in all the

specimens and therefore a normal structure, probably the genital aperture. If the latter was true then the worms could not belong to the species *aegyptiacus*, for in this, the genital aperture is placed immediately behind the cephalic cone, at the very base of the projecting edge of the disc.

A close microscopical examination of the three specimens kindly given to me by Dr. STEPHENS has confirmed this presumption; the parasites represent a new and at the same time a true member of the genus *Gastrodiscus*. It appears superfluous to give a description of its internal structure here, for this would mean nothing but a second description of the structure of *Gastrodiscus aegyptiacus*. It may therefore suffice to point out the differences between the two species. They are chiefly given in the position of the genital aperture and the extension of the yolk-glands. The former has already been mentioned; it is a circular or transversely oval opening about 0.3 mm. wide, and leads into a genital atrium of 0.3 mm. in cross diameter, the muscular wall of which is of considerable thickness and much more conspicuous than in the African species. The floor of the atrium is again raised in the shape of a conical papilla on the top of which the male and female genital ducts open close by one another in minute pores. The yolk-glands show a richer development than in *Gastrod. aegyptiacus*. In this species, it will be remembered, they are located in the ventral half of the body, between the intestinal caeca and the free margin of the disc, and it is rather exceptional to find some folliculi extending below the caeca into the space between these and the median line of the body. In *Gastrodiscus secundus*, the yolk-glands trespass on the intestinal caeca in such a manner that their loosely grouped follicles occupy, in the ventral half of the body, all the space left free by the other organs. A minor difference is afforded by the size of the suckers. The oral sucker which, in *Gastrod. aegyptiacus*, presents a cross diameter of 0.8 mm shows, in *G. secundus*, a diameter varying, according to the size of the specimens, from 0.55 to 0.65 mm.; the posterior sucker, in *G. aegyptiacus* about 2 mm. wide, in *G. secundus* scarcely reaches 1.2 mm. in size. The uterus, in the body of the new species, principally takes the same course between the organs as in *G. aegyptiacus*, but, although it is, in the two larger individuals at my disposal, thickly filled with ova, it seems that it does not form so many secondary loops as in the older species. The ova

which, in the latter, show a length of 0·17 to 0·19 mm. and a width of 0·11 mm., are, in *G. secundus*, somewhat smaller namely 0·15 to 0·16 mm. long and 0·09 to 0·1 mm. wide.

Opisthorchis sinensis (COBB.) 1875.

Several worms of a rusty yellow colour contained in a jar of unknown origin and labelled "*Distoma sinense* COBBOLD" struck me at once by the fact that they were considerably larger and stouter than any others I had seen of the species up to that time. I therefore had no hesitation in expressing the opinion that these worms could not be the true *Opisthorchis sinensis*. Since the number of specimens was limited, I took two specimens only with me, an unhurt one and another which was broken into two pieces. About a fortnight after my visit to Liverpool I paid a visit to the "Institut für Schiffs-und Tropenkrankheiten" in Hamburg. Dr. FÜLLEBORN very kindly showed me round and, during an inspection of the collection of human parasites, I was rather surprised to recognise under the designation "*Opisthorchis sinensis*" the same large form which I had seen a short time previously in Liverpool. There were about a dozen individuals, part of them kept in spirit, others mounted as microscopical preparations. They had all been collected from one case, a Chinaman who had died in the Seamen's Hospital in Hamburg. Besides these large specimens, there was one microscopical preparation of an ordinary small specimen such as those I had alone seen before. This specimen was *not* derived from the case from which the large worms had been obtained. Dr. FÜLLEBORN was kind enough to confide this whole material to me for comparison with the Liverpool specimens. On my return to Egypt, four weeks later, I learned that a short time previously, a great number of "liver flukes" had been found at the post-mortem examination of a Chinaman who had died in the British Hospital of Port Said. Suspecting a case of Opisthorchiosis I wrote to Dr. E. H. ROSS, Public Health Officer of the Town and Port of Port Said, to ask for some specimens of the worms. Thereupon, Dr. CUFFEY, who had had the patient under his care and had made the post-mortem examination, most obligingly placed at my disposal all the preserved material of the case. He was also kind enough to write a short abstract of it which I insert in full here

because of some interesting particulars it contains.* The preserved material sent to me consisted of about 200 loose worms, and many others were still seen densely packed in the bile-ducts of some preserved pieces of liver. Among the loose worms there was again not a single specimen of the ordinary small variety, but all were the large form. I had thus, within a very short lapse of time, thrice come across a variety of the Chinese liver-fluke which I had never seen before, and in all these three cases this variety had been present alone, quite unmixed with individuals of the usual smaller variety.

I had not the least doubt that this new form would prove to be an independent species and that it would be easy to delimit it anatomically from its smaller congener. I was therefore somewhat disappointed, when after a most minute and thorough comparison of the specimens with those I possessed of the small "*Distoma sinense*," I could not, apart from the size of the body and the ratio of the suckers, find any constant internal differential character between them. Even of the characters mentioned the last-named is by no means conspicuous, and I had almost made up my mind that the two varieties must be considered as one and the same species, when, on reconsidering all the factors involved, I came to the conclusion that

* A CASE OF DISTOMIASIS OF THE LIVER AND THE DUODENUM.

Too-ting, a Chinaman, aged 25, was admitted to the British Hospital, Port Said, on May 10th, 1906, suffering from Lumbar Abscess. He was landed from a ship proceeding from China to England. The abscess was pointing in the lumbar region, posteriorly, $2\frac{1}{2}$ inches from both the middle line of the back and the crest of the ileum. It was opened and about 300 grms. of bile-stained pus were evacuated. The walls of the abscess were explored and the transverse process of one of the lumbar vertebrae was found to be necrosed. But no connection could be found between the abscess and the liver. The cavity was washed out and stitched up. Subsequently a drainage tube had to be inserted, for the pus collected again; but the man's condition rapidly improved, and the wound over the site of the abscess healed completely.

On June 21st, the man suddenly developed pneumothorax, affecting the lower part of the right side of the chest. As he was thought to be suffering from an abscess of the liver, this organ was explored again, but no pus was found. Oedema occurred over the lower part of the right side of the chest and still no pus could be found on exploration. The patient rapidly became worse, and died on June 25th.

Post Mortem.—The abscess in the lumbar region had healed completely. No reason for it could be found beyond the necrosed vertebra.

Liver: The liver was enlarged and contained numerous abscesses in both lobes. They varied in size from that of a small pea to a tangerine orange. On section the liver presented hundreds of liver flukes in the bile-ducts. The hepatic ducts, common bile duct, and gall-bladder all contained numbers of these flukes.

They were also found free in the duodenum, but not in the ileum.

There were no flukes in the abscesses.

No cause for the pneumothorax could be found, and no connection between it and the liver was apparent. All the other organs were normal.

(Signed) EDWARD CUFFEY,
Medical Officer, British Hospital,
Port Said.

such a ruling would be less defensible than the other alternative, viz. to declare them as separate species.

I am pretty certain that many of my fellow-helminthologists will think I am pushing things too far, and that what I am about to do here is nothing but "species-manufacturing." In order to meet this reproach as far as I can, I may be permitted to give my reasons somewhat in detail.

To begin with, it is a fact acknowledged by all observers who have dealt with this particular group of parasites (BRAUN, LUEHE, MUEHLING, LOOSS) that the members of the genus *Opisthorchis* are in many instances by no means easily to be distinguished. As one out of several examples I will mention the case of *Opisthorchis felineus* and *Opisthorchis geminus*, a case observed by myself. The former species is in Europe a rather common parasite in the liver of certain beasts of prey, and especially in cats, and is in eastern Europe even a not uncommon occasional parasite of man. *Opisthorchis geminus* inhabits in Egypt the liver of certain birds (*Milvus aegyptius*, the common Egyptian kite, *Circus aeruginosus*, a glede, and *Anas boschas fera*, the wild duck). It resembles *Opisthorchis felineus* anatomically to such an extent that the two forms are hardly distinguishable from one another without knowledge of host and locality. Their internal organisation, therefore, would not furnish unobjectionable reasons for separating them specifically; nevertheless, they must be considered as specifically different on biological grounds—or else we must admit as true certain circumstances which are almost impossible to comprehend. Among the hosts of *Opisthorchis geminus* *Milvus aegyptius* is a true Egyptian who never leaves the country and thus must acquire his parasites in it. But if *he* does, it would be inconceivable why dogs, cats and even Man—hosts that in Egypt actually *share* other species of parasites—should not pick them up also and become infected as they do in Europe, *if* the parasite of the Egyptian birds and that of the European mammals were indeed one and the same organism. Never, however, have I in Egypt found any trace of an *Opisthorchis* form in canine or feline animals, wild or domestic; nor in Man, although I have purposely looked for them whenever there was an occasion; nor have the professors of pathology who within the last ten years have made the post-mortem examinations at Kasr-el-Aini Hospital noticed anything of the sort. It can therefore

be considered as certain that no *Opisthorchis* species occurs in mammals and Man in Egypt and the inference therefrom *must* I think be that the Avian *Opisthorchis* which is indigenous in this country cannot be the same species which inhabits mammals and Man in Europe—all the resemblance they show in their internal organisation notwithstanding.

The case of *Opisthorchis felineus* and *Opisthorchis geminus* is not the only one known; but this as well as the corresponding instances tend to show that, in the case of the two *Opisthorchis sinensis*-forms also, the internal similarity must not necessarily be a proof of their specific identity—the less so, as in the size of their bodies and the ratio of their suckers characters are given which practically allow a differentiation of the two forms.

A second point which seems to me very important is the fact that the two varieties of *Opisthorchis sinensis* not unfrequently occur quite separately. It has already been pointed out that the large variety was present alone in the three cases mentioned above; but the same fact may be inferred from some earlier cases on record. The parasite was discovered in 1874 by MCCONNELL; the measurements given of the worms by the author are $\frac{7}{10}$ in. for the length and $\frac{1}{7}$ in. for the breadth. This would correspond to 17.8 and 3.63 mm. respectively and is, as may be mentioned here in anticipation, exactly the size of the specimens I at present possess of the large variety.* The author

* It is perhaps not out of place here to draw attention to the fact that the size of preserved specimens of parasitic worms is within certain limits influenced by the methods of preservation on the one hand, and by their own condition at the moment of preservation on the other. If specimens are collected from a living or recently killed host, they are still alive; if they remain in the organs after the death of their host they will die, too, after a shorter or longer time; the same thing happens when living parasites are brought into water, which is very harmful to them and destroys certain species very quickly. Before death they stretch themselves to their full size, and the commencing decomposition even makes them swell somewhat. Living parasites, when preserved immediately after removal from their natural habitat, always react by a contraction, which is the stronger the slower the preserving reagent acts upon them. Specimens which have died—in water or in the organs of their hosts (as is usually the case in post-mortem examinations made some time after death and in warm climates)—do no longer contract, but may shrink more or less according to the dehydrating power of the preserving fluid. All these factors, therefore, have their influence upon the dimensions the specimens exhibit after preservation, and it is necessary to remember this fact when the size of a certain species is used as one of its distinctive characters. However, the changes due to preservation always keep within certain narrow limits, and can even be fixed by actual observation. The parasites of the Port Said case were obviously dead when they came into contact with the preserving fluid, for they are not contracted. The fluid used had been formaline, which does not dehydrate; thus, the specimens show an average length of 16 to 18 mm., which is about their natural length at full extension. Some of them were afterwards most carefully and gradually transferred into alcohol; when the strength of this had reached 90 per cent. the worms had shrunk to a length of 14 to 16 mm., but could be made to very nearly assume their former length again by placing them back into formaline.

adds that the breadth is very constant in all the specimens, whereas the length presents slight variations from $\frac{6}{10}$ in. to $\frac{8}{10}$ in. (= about 15·3 to 20 mm.). In 1877, the parasite was recorded by MACGREGOR as the possible cause of a peculiar form of paralytic disease, of which he had seen three fatal out of eight cases. The observations were made in Port Louis, Mauritius, but all the patients were again Chinamen. I have at present no access to MACGREGOR'S original article, but the parasites found and described by him were subsequently examined by COBBOLD and recognised as identical with those of MCCONNELL. In 1878 MCCONNELL himself describes a second case observed by him in Calcutta; "the subject was, curiously enough, again a Chinaman," and the distomata found "were quite identical with those originally found." Comparing these earliest observations we see that in all cases the bearers had been Chinamen, and that the parasites must have been of about the same size for no allusion is made to the existence among them of any noticeably smaller individuals.

In 1883, the presence of flukes in the liver of Man was reported from Japan, first in a paper written in Japanese ("Observations on Distomes in the Lung and Liver") by KIYONO, NAKAHAMA, SUGA and YAMAGATA, acting physicians in the hospital of Okayama, and a short time later by BAE LZ in a paper "Ueber einige neue Parasiten des Menschen." Unfortunately, I have at present no access to this paper which is one of great importance for the question I am now discussing; thus I can here refer to its contents so far only as they are reproduced by later writers. According to these, BAE LZ recognises two distinct species of liver-flukes, a *Distoma hepatis endemicum* sive *perniciosum*, and a *Distoma hepatis innocuum*. They are distinguished from one another (see LEUCKART, 1876, p. 338), first and foremost by their quite different size, *Dist. innocuum* attaining a length up to 20 mm., whereas *Dist. endemicum* does not exceed 8 to 11 mm. Of the other differential characters given by BAE LZ the following seem to me to be worth mentioning: *Dist. innocuum* has (1) a uterus of lighter colour but larger volume, (2) slightly larger ova than *Dist. endemicum*, and (3) possesses in its excretory apparatus and body-parenchyma numerous black granules. The exact measurements of the ova are, according to BAE LZ, in *Dist. innocuum* 0·021 to 0·036 mm. length by 0·018 to 0·002 mm. breadth, in *Dist. endemicum* 0·02 to 0·03 mm. length by 0·015 to 0·017 mm.

breadth. From the names given to the species it may be inferred that the small variety is very common in the country ("endemic") and harmful to its host ("pernicious"), presumably because of its occurrence in large numbers, whilst the larger is rarer, i.e. not present in large numbers and therefore comparatively harmless ("innocuous").

In subsequent years the Japanese liver-flukes were the object of repeated scientific investigation. It was soon recognised that they bore a close anatomical resemblance to the Chinese liver-fluke discovered by McCONNELL; as a matter of fact, all later authors are agreed in declaring them more or less definitely as identical with one another as well as with the *Distoma sinense*. A comparative study of the papers published by these authors, however, reveals an interesting fact, namely that so far as specimens of Japanese origin are concerned these authors, with one exception, do not seem to have ever again seen the large variety, i.e. the *Dist. innocuum* of BAEZ. Thus in 1886, IJIMA, when describing *Dist. endemicum*, gives the average length of the body as $11\frac{3}{4}$ mm., whilst the largest specimens measure 13, the smallest 8 mm. in length; the breadth is 2 to $2\frac{3}{4}$ mm. LEUCKART who named the *Distoma sinense* of COBBOLD *Distomum spathulatum*, examined part of BAEZ'S original material and specimens sent to him by IJIMA; he found the worms to vary in length from 10 to 13 mm. and in breadth from 2 to 3 mm. I saw this material myself at the time and do not remember having noticed any remarkable difference in size of the specimens. In 1900, KATSURADA published a very exhaustive paper based upon 76 post-mortem examinations in which altogether an enormous number of parasites were found; in 21 cases indeed their number exceeded 1,000 and in five there were between 2,000 and 5,000. It may be mentioned here in passing that KATSURADA for the first time states that in cases of strong infection the parasites also occur in the pancreatic ducts causing there sometimes no perceptible changes, but generally a dilatation of the ducts combined with a thickening of their walls; occasionally, one may even observe inflammatory infiltration and hypertrophy of the connective tissue in the neighbourhood which seems to lead to atrophy and degeneration of the glandular substance.

With regard to the question which interests us here, it is to be regretted that KATSURADA does not give exact measures of individual specimens, but averages only derived from measurements of a certain

number of worms found in separate cases. Thus, five individuals measured of one case gave an average of 11.0 mm. length by 2.50 breadth; 21 individuals of another case gave an average of 9.78 mm. length by 2.40 mm. breadth; and 35 individuals of a third case gave 14.06 mm. by 3.88 mm. Nothing need be said concerning the two first cases; in the third, however, it is almost certain that large individuals of 16 to 18 mm. length have been present, although the author does not mention it especially. KATSURADA explains the variations in the size of the worms by circumstances such as size of the host, number of parasites actually present at the same place, &c., and says that "in cases where few worms only inhabit a full-grown man many of more considerable size are found among them; whilst, on the contrary, in children, dogs and cats the worms are generally smaller."

This view, by the way, which was still very generally adopted not so many years ago, is not supported by actual observations. I have for several years paid special attention to this question, but all my experiences tend to show that every species of parasite has a size of its own. There *may* occasionally be individual specimens which trespass the normal size of their race more or less markedly (just as this occurs in Man and higher animals), but, as a rule, their size is very much the same, whether they live in a large or in a small host. A full-grown *Ascaris lumbricoides* is as large in a child of one year's age as it is in an old man of seventy; and the common liver-fluke is not smaller in a goat or a sheep than it is in a cow, nor is it, when full-grown, smaller in a narrow bile-duct than in a wide one. In the above mentioned case of *Distoma sinense* observed by Dr. CUFFEY, the worms thickly crowded the bile-ducts of medium calibre; nevertheless, not a single small specimen could be detected among the loose ones. The small *Distoma endemicum*, on the other hand, retains its specific size quite irrespective of the number in which the individuals may be present in a given host.

The observations so far spoken of had all been made on material collected in Japan. During the same time, however, the parasite had also been discovered in subjects coming from other parts of the Extreme Orient, such as Corea, Tonkin, and the island of Formosa. I do not possess the special literature on these earlier cases, but may refer the reader to an article by R. BLANCHARD, "Note sur quelques

vers parasites de l'homme (1891)" in which the necessary references are given. In this same article BLANCHARD also records three new cases from which the parasites obtained had been submitted to him for examination. The material consisted of two bottles containing each several hundreds of *Distoma sinense* which had been collected at the post-mortems made of two Annamite soldiers in the military hospital of Hanoï. A third bottle from Hanoï contained, in addition to a piece of liver, an extraordinary number of parasites; so many indeed that the author says that without the positive affirmation given it would have been hard for him to believe that they had actually been derived from one and the same autopsy. At another place (1901, p. 581), he says that one might estimate the number of these worms as being rather above ten thousand. The statements BLANCHARD makes with regard to the external aspect of the parasites are so interesting that I reproduce them in the original language (1891, p. 5). "Dans l'un des deux flacons reçus de Mr. le Dr. TREILLE (i.e. those mentioned above in the first place), tous les Distomes sont de grande taille et semblables entre eux. Dans le second flacon, ainsi que dans celui que j'ai reçu du Dr. LOYE (the third bottle), on remarque au contraire des Vers de deux sortes: les uns, d'aspect très foncé, longs de 14 millimètres, larges de 3 mm. 2; les autres, beaucoup plus clairs et mesurant seulement 8 millimètres sur 2 millimètres."

Thus, there was again one case in which the large form was present alone, whereas in the other two both were represented, but so clearly recognisable from each other that the author immediately goes on saying: "A première vue, on dirait qu'il s'agit de deux espèces distinctes . . ." The conclusions drawn by BLANCHARD from these observations will be discussed later on; on the present occasion, I wish to draw attention to the fact that the large specimens were "d'un aspect très foncé," or, as I interpret it, strongly pigmented, whilst the smaller specimens were "beaucoup plus clairs," that is to say without pigmentation. The size of the worms recorded by BLANCHARD is somewhat below the average for both varieties, very probably, therefore, they are somewhat contracted owing to the action of some stronger reagent.

Reviewing now what has been recorded on the preceding pages we have the following facts:—The original *Distoma sinense* of McCONNELL and COBBOLD has up to now chiefly been found in

Chinese and is at present the only species of liver-fluke known from this race. It reaches an average size of 18 by 3.5 mm. and has a more or less opaque body owing to the presence within the body parenchyma of granules of a dark pigment. In Japan, similar flukes are also very common in the liver of Man and certain animals; but here they vary, especially in size, to such an extent that one of the first observers (BAELZ) felt justified in establishing two distinct species. One of them coincides in size with the *Distoma sinense* and also possesses the pigment granules in its body parenchyma. It is, in Japan, apparently not very common, for some observers subsequent to BAELZ have not come across it at all during their investigations, whereas BAELZ himself considered it as harmless—presumably because he never saw it in large numbers—and KATSURADA explains the large size of the specimens he saw in certain of his cases by the fact of few individuals only being present at the same place. The second species is markedly smaller, attaining an average size of 11 to 12 by 2 mm. only; it is not pigmented and appears to be very common in Japan as indicated by the name “endemicum” and, furthermore, by the fact that several observers saw this form alone during their researches. There are finally the three cases recorded by BLANCHARD; in one of them only large worms were present, in the two others, a large and a small variety were found, the former remarkable by its dull colour, the latter much lighter.

From these observations I cannot but draw the conclusion that in the two differently sized varieties of the *Distoma sinense* we actually have to deal with two independent forms. One of them (the larger) is indigenous on the Asiatic continent, especially China, but is occasionally also found in Japan (and probably the other islands of Eastern Asia), the other is indigenous in Japan and common also in Annam and Tonkin (possibly all along the sea-shore in the Far East).

This view differs from the conclusion arrived at by BLANCHARD. As quoted above, his first impression on seeing the two different sizes was that he had two distinct species before him; a close comparative examination, however, convinced him of the contrary. “La disposition anatomique est la même dans les deux cas; la structure et les dimensions de l’oeuf sont également identiques. On constate simplement que les plus petits individus ont les vitellogènes moins

développés et l'utérus chargé d'oeufs en moins grand nombre. Cette observation démontre donc que les petits individus sont des jeunes, non encore parvenus à toute leur croissance ; elle explique en même temps leur aspect plus clair." I may confess that for a certain time I held a similar view ; but it cannot be upheld any longer for the following reason : Supposing that the small individuals were indeed young, i.e. in the beginning of the period of their sexual activity, one ought to expect that the large individuals would be without exception perfectly sexually mature and full of ova. But this is actually not the case. In the Hamburg material I have for examination there are two immature specimens, both with a uterus developed to its full length but containing, in the first specimen, only spermatozoa (the seminal receptacle containing nothing but a number of egg cells), and in the second specimen a number of loosely grouped ova which are still far from filling the coils as they do in ripe individuals. Nevertheless, these worms are unmistakeable representatives of the large species, for they measure, the first 13.5 by 2.5 mm., the second 12.5 by 2.75 mm. ; they show, in addition, the size of the suckers and the brown pigmentation distinctive of that form. One similar specimen was found in the material from the Port Said case. For all of them, the explanation alluded to above does not hold good ; they prove, on the contrary, that the large species when the period of its sexual maturity begins has already reached, or even exceeded, the maximum size of the small form. Unfortunately, the scant material I possess of the latter does not contain any young individuals ; but the fact just recorded suffices I think to show that the two forms cannot be one and the same species.

If they are different the question arises, whether they are to be considered as full species or as mere varieties. I suppose that many of my fellow-helminthologists, regarding, in the first place, the almost perfect similarity of the internal organisation, as compared to which the differences in size, &c., appear insignificant, would find the latter alternative quite sufficient to cover the facts, assuming perhaps so-called "local varieties." I unhesitatingly proclaim the former view as being more logical and more consistent. The chief character of the species, in contradistinction from the variety, lies in the constancy with which it preserves its specific peculiarities. The variety is inconstant in a larger or lesser degree and alternates with typical specimens of the

species. A similarity in the internal organisation, even if it is very close, is not decisive for a variety, for otherwise it would be a simple logical necessity to consider for instance the cat as a mere small variety of, let us say, the leopard or the rat as a large variety of the mouse. Both cat and leopard, and rat and mouse, are internally almost absolutely alike and yet they are no varieties but genuine species, for cat and mouse preserve their specific peculiarities through generations, and never will one of their offspring suddenly be a leopard or a rat, nor will the offspring of a leopard or a rat ever become cat or mouse, although, hypothetically, a simple enlargement (or reduction in size) of their bodies and internal organs combined with some changes in colour, &c. would suffice to transform the one into the other. With regard to these animals, therefore, (and to almost all others as well) the size and some external features, like colour, &c. are not considered as determinative of varieties, but of species, and it is only the higher classificatory units such as genera, sub-families, &c. which become determined by the greater or lesser similarity in the internal organisation. Such principles of classification are, so far as I can see, universally followed by systematists with regard to the larger animals, and I do not see any reason, why they should not be applied to parasitic worms also; so much the more so, as careful observation and comparison reveal among them quite a similar gradual increase (or decrease) of structural differences as exists among the larger animals. I thus hold that it is simply logical and consistent to consider the two *Opisthorchis sinensis*-forms as two distinct species rather than as varieties of one species.

I have in the above explained the reasons for my opinion at some length, because the question what in helminthology is to be considered as a species still needs being definitely settled. It appears that quite a number of writers, zoological and medical, on helminthological subjects still cling to the old assumption that there exist comparatively few species of parasites only, but that these species are capable of varying in size and organisation to a considerable degree according to host, locality, &c. It is my firm conviction that this view must be altogether abandoned if helminthology is to become an exact science based on facts rather than on preconceptions inherited from our forefathers. Neither is it justifiable any longer to declare all at once two forms as identical simply because they agree in their general structure,

nor is it sufficient to-day to give of new forms of parasites a superficial account of some general characters, if such descriptions are to be of real scientific value. It would not be a difficult thing to enumerate dozens of modern papers of this sort; they look and read quite nicely, but nothing would have been lost had they never been published at all. I will not mention any names, nor is it my intention to blame or to offend those who do not share my scientific convictions, but I desire to convince them, in the interest of our particular branch of science, that by this time certain views considered as almost axioms by our predecessors can no longer be upheld.

The question as to the denomination of the two species of *Opisthorchis sinensis* in accordance with the modern rules of scientific nomenclature is easy to decide. There is no doubt that the large form is the same as originally found and described by MCCONNELL; it must therefore retain the specific name *sinensis* COBBOLD. The smaller species is, unmistakeably again, the same as first recognised by BAELZ and distinguished under the designation *Distoma endemicum*; I therefore re-establish this specific name for it. Both species are members of a natural genus which might have been created before this on the ground of the peculiar configuration of the testicles, but becomes now more distinctly separated from *Opisthorchis* by the fact that two different forms exhibit the same character.

Clonorchis, n. g., *Opisthorchiidarum*.

Differs from *Opisthorchis* sensu strictiori by the fact that the testicles are not notched or lobate, but distinctly ramified, the branches, crossing the intestinal caeca on their ventral side and extending very near to the body margin. Another difference seems to lie in the shape of the excretory vesicle. In *Opisthorchis* s. str. this is Y shaped with a very long stem running in the form of an S through the space between the testicles and bifurcating at the posterior border of the seminal receptacle into two rather short branches from the tops of which the main excretory vessels arise. In *Clonorchis*, the Y shape of the vesicle is no longer clearly recognisable; the unpaired tube simply becomes somewhat widened at its anterior end assuming sometimes, but not always, the shape of an irregular triangle the two upper angles of which might be considered

as the homologues of the branches in *Opisthorchis* s. str. The main excretory vessels do not arise from these angles, but somewhat farther backward, at about the lower angle of the triangular widening of the tube (see fig. 4).

Type: *Clonorchis sinensis* (COBBOLD) 1875.

Clonorchis sinensis (COBBOLD) 1875.

(Synonym: *Distomum innocuum* BAELEZ 1883.)

Full grown specimens vary in length from 13 to 19 mm. and in breadth from 3 to 4 mm. At the commencement of the period of sexual activity the body has attained 12 to 13 mm. in length and 2.5 to 3 mm. in breadth; such specimens are recognisable by their uteri in which the ova are comparatively scarce in number and loosely grouped, i.e. with more or less wide empty spaces between the individual ova. The oral sucker averages 0.6 mm. in transverse diameter; the lowest figure I have found in one specimen (of about 60 measured) was 0.52 mm., the largest which is not uncommon 0.63 mm.; usual measurements between 0.58 and 0.62 mm. The ventral sucker averages 0.47 mm. in transverse diameter; lowest figure found in one case 0.39 mm., highest figure observed once also 0.52 mm.; usual measurements between 0.45 and 0.49 mm. The ratio of the suckers thus varies in the main between 15 : 12 and 16 : 12. The pigmentation, i.e. the deposit within the body parenchyma of numerous fine granules of a yellowish or brown substance, is very characteristic of this species. Sometimes it is so little developed that the preserved worms appear white and the pigment granules are only detected in cleared specimens with the microscope, yet may in other specimens assume such an extent that the parasites become perfectly opaque and of a rusty yellow, greyish, or brownish tint throughout. In cases of little pigmentation, the granules accumulate more especially behind the oral sucker in the sides of the pharynx and at the posterior extremity of the body; in a lesser degree along the intestinal caeca and round the outlines of testicles and seminal receptacle. The ramifications of the testicles are fairly long, in accordance with the greater breadth of the body; it may not unfrequently be recognised that in the anterior testicle the branches arise from four, in the posterior testicle from five main stems. All of them lie in about one plane which runs parallel to

the ventral surface of the body; there are however very often, in one testicle or in both, other branches or, more precisely, bulgings of one or two main stems which project towards the ventral surface and appear as thick, compact bodies with irregular outlines. They were already seen by McCONNELL, but interpreted as the whole testicles, whereas in truth they are only parts of them, and are not even constant in their presence. The ovary is usually trilobate, but very often shows, in addition to the large lobes, three to six smaller ones which are sharply separated from the former. The yolk-glands vary somewhat in their extent. They normally reach from the level of the ovary to the ventral sucker, but it is not at all uncommon to see them, on one side or on both, commencing and ending somewhat farther forward or somewhat farther backward of the usual place. They present in *Cl. sinensis*, a striking peculiarity inasmuch as almost constantly a certain number of the groups of follicles of which they are composed remain undeveloped; sometimes one only on one side, sometimes more, on one side or on both; the bands represented by the glands as a whole showing thus one or several interruptions by empty spaces. In perfectly mature specimens the seminal vesicle extends about as far back as the middle of the uterus. The remaining organs do not show any peculiarities.

The average dimensions of the eggs are 0.029 mm. length and 0.016 mm. width; the limits of the former being 0.026 and 0.03 mm., and of the latter 0.015 and 0.017 mm.* In many specimens of the species the eggs show a distinct narrowing towards the anterior extremity, and their rather high lid is marked off by a sharply projecting brim. I have however also seen specimens in whose ova these peculiarities were but little pronounced (see fig. 7).

An interesting variation chiefly observable among the specimens of the Port Said case concerns the colour of the uterus as a whole. In some individuals, this is only a light yellowish-brown, even in the most anterior coils of the organ, whereas in other individuals the whole

* There exist, of course, among the immense number of ova in an individual worm always some which are either larger or smaller than the rest, or even evidently misshapen. In my opinion it is of no use to carefully record the measurements of these eggs also. For the description and definition of a species it is much more important to select for measurement those ova which appear to be normal and to present the size and shape typical for the species. It may be added in passing that young worms with few ova in their uterus usually do not afford normally-shaped and normally-sized ova.

uterus, with the exception of a few of the hindmost loops, appears almost black. As there is otherwise not the slightest difference between the examples of these two extremes—neither in the size of the body, nor in the size of the suckers, &c.—I do not quite know how to account for these variations. To a certain degree, they are evidently due to the number of ova contained in the coils, but to another degree just as evidently to a darker shade of the egg-shells themselves. Since the two extremes described above are not sharply separated, but connected with each other by numerous intermediary tints it is perhaps not unjustifiable to assume that the shell-substance elaborated by the shell-glands becomes darker with the growing age of the parasites, and it may be noted in this connection that the latter live in, and feed on, a coloured substance, the bile.

Clonorchis sinensis is chiefly a parasite of Chinese, but occurs rarely also in Japan—i.e. according to what we know at present. For it is not at all improbable that the worm will be oftener found as soon as attention is paid to its existence; it appears also not unlikely that it may be restricted to certain localities. Up to now it does not seem to have been found in animals.

Clonorchis endemicus (BAELZ) 1883.

This species practically takes the place of the true *Clon. sinensis* in the literature published after 1883 and is at present the one usually described in text books, &c. as "*Opisthorchis sinensis*." Its measurements are given by the authors as 10 to 13 mm. length and 2 to 3 mm. breadth. The smallest specimen actually at my disposal (it comes from the Annamite case described by BLANCHARD) is somewhat contracted and measures 6 by 1·8 mm.; my largest and fairly well extended specimen (of Japanese origin) measures 13 by 2·6 mm.; the remaining individuals range in size between these extremes. The oral sucker averages 0·43 to 0·45 mm. in transverse diameter; smallest diameter observed (in the smallest specimen mentioned above and another one (11 mm. long and 1·6 mm. broad) 0·37 mm.; largest diameter found (in a specimen 10·8 mm. long and 2·3 mm. broad) 0·5 mm. Ventral sucker averages 0·37 to 0·40 mm.; smallest diameters observed 0·33 mm. (in the smallest specimen) and 0·34 mm. (in another long 8 mm., broad 1·7 mm.); largest diameter observed 0·45 mm. (in the largest specimen above mentioned). The ratio of the

suckers varying between about 13 : 12 and 15 : 12 is therefore fairly similar to that in *Clon. sinensis*, but in actual size the suckers are quite different. Among the specimens at my disposal there is none with pigment-granules in its parenchyma. The yolk-glands normally have the same extent as in *Clon. sinensis*, but present similar variations in regard to the relative position of their anterior and posterior terminations as in that species. It may also happen that of the groups of follicles of which they are composed some remain undeveloped, but this occurs, so far as may be inferred from my limited material, much more seldom and the actual state of things is perhaps best described by saying that the absence of one or several groups of follicles is the rule in *Clon. sinensis*, and the exception in *Clon. endemicus*. The seminal vesicle ends (so far as visible) at about the limit between the first and second thirds of the length of the uterus; this character, however, had better not be considered as distinctive because it may vary.

The eggs have about the same length as those of the preceding species (0.026 mm.), but their width is decidedly somewhat smaller, amounting on an average to 0.015 mm. with the lower limit at 0.013, the upper at 0.016 mm. The narrowing towards the anterior end is in the main not so marked and the margin of the rather *flat* lid not so sharply projecting as in *Clon. sinensis* (see fig. 8); but these differences are on the whole very slight and not recognisable in every specimen. With regard to the colour of the uterus as a whole, variations may be found similar to those described in the preceding species.

Clonorchis endemicus, according to existing records, is very common in Japan, and presumably so in Annam and Tonkin too. In Japan the localities especially stricken with the parasite are situated on the sea-shore; it is possible therefore that its geographical range chiefly extends along the shore in the other localities also.

Apart from Man, the species is reported to have been found in certain animals of Japan, such as cats, dogs and hogs. Several specimens taken from the latter host, which I owe to the kindness of Professor JANSON, of Tokyo, are indeed *Clon. endemicus*, for they present all the peculiarities of this species. I am, however, somewhat doubtful with regard to the statement that it inhabits the liver of the cat also—at least as a normal parasite of this animal. In 1886, IJIMA after an examination of specimens derived from this source

writes that the worms "from the liver of cat showed slight differences inasmuch as they possessed very fine spines in the skin and were of smaller size than the former (viz. *Clon. endemicus* of the human liver). Perhaps this cat-distome from Okayama is to be considered as a distinct species, but I firmly believe that in Tokyo, *Dist. endemicum* does sometimes inhabit the liver of cats" (1886, p. 49). This latter possibility can certainly not be denied and is even most probable, but in cases of this sort *Clon. endemicus* appears to be merely an occasional parasite of the cat, whilst the smaller form mentioned by IJIMA probably represents one of its normal parasites. I have examined several cat-specimens which were sent from Japan to Professor LEUCKART in Leipzig years ago (by whom I do not know) and of which Professor CHUN kindly allowed me to take some in exchange for other parasites. They are unfortunately in such a poor state of preservation that not very much is left to be seen in them; the general impression they make upon the observer is certainly rather different from that of the genuine *Clon. endemicus*. If one considers, moreover, their small size (those in my possession do not exceed 4.5 mm. in length and 0.9 mm. in breadth, but are as it seems not yet quite full grown) the presence of fine spines in their skin as reported by IJIMA there is no doubt left that they cannot be *Clon. endemicus*.

A possibility worth being borne in mind in the examination of later cases of human Opisthorchiosis is that this Feline *Opisthorchis* (it cannot as yet be said whether it is an *Opisthorchis* or a *Clonorchis*) may occasionally occur in Man also, just as *Clon. endemicus* is occasionally picked up by cats and hogs. I am even inclined to think that certain statements in KATSURADA'S paper (1900, p. 481) alluding to three worms found in a young man of seventeen from the province of Saga, which presented an average length of 5.16 and an average breadth of 0.96 mm. only, may be explained by such occasional infection with the Feline species.

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EXPLANATION OF FIGURES

REFERENCE LETTERS.

<i>App.</i> —Lateral pouches of the oral sucker.	<i>P.ex.</i> —Excretory pore.
<i>C.ex.</i> —Lateral excretory vessels.	<i>P.Gen.</i> —Genital aperture.
<i>C.P.</i> —Cirrus pouch.	<i>Phar.</i> —Pharynx.
<i>D.ej.</i> —Ejaculatory duct.	<i>P.P.</i> —Pars prostatica.
<i>Disc.</i> —Edge of the ventral disc.	<i>R.sem.</i> —Seminal receptacle.
<i>Gr.</i> —Retracted grooves ("pseudo-suckers").	<i>r.Test.</i> —Right testicle.
<i>Gr'.</i> —The same organs, everted.	<i>Sh.Gl.</i> —Shell gland.
<i>Int.</i> —Intestine.	<i>Ut.</i> —Uterus.
<i>L.C.</i> —LAURER'S canal.	<i>Vag.</i> —Vagina.
<i>l.Test.</i> —Left testicle.	<i>V.ex.</i> —Excretory vesicle.
<i>Met.</i> —Metraterm.	<i>V.ex.lat.</i> —Lateral branches of the excretory vesicle.
<i>Nerv.</i> —Nervous system.	<i>Vit.</i> —Yolk glands.
<i>Oes.</i> —Oesophagus.	<i>Vit.D.</i> —Unpaired vitelloduct.
<i>Ov.</i> —Ovary.	<i>V.sem.</i> —Seminal vesicle.

Fig. 1.—*Eurytrema pancreaticum*. Specimen from Japan seen from the ventral aspect. Enlargement about 11.

Fig. 2.—*Eurytrema coelomaticum*. Specimen from Hong-Kong seen from the ventral aspect. Enlargement about 11.

Fig. 3.—*Gastrodiscus secundus* seen from the ventral side. Enlargement about 11. The opening in the anterior part of the ventral surface leads into the genital atrium from the bottom of which the papilla bearing on its top the male and female genital openings arises.

Fig. 4.—*Gastrodiscus secundus*. Median sagittal section; the organs cut in it have been completed from the neighbouring sections so as to give a general picture of the internal organisation. Enlargement about 16.

Fig. 5.—*Clonorchis sinensis*. Specimen from the Port Said case. Ventral aspect. Enlargement about 9.

Fig. 6.—*Clonorchis endemicus*. Specimen from Okayama, Japan. Ventral aspect. Enlargement exactly the same as that of the preceding figure so as to allow of an appropriate comparison. The unequal length of the intestinal caeca visible in this specimen is accidental and not present in other individuals.

Fig. 7.—*Clonorchis sinensis*. The chief forms presented by the eggs, each egg taken from a separate specimen of the worm. Enlargement ca. 990.

Fig. 8.—*Clonorchis endemicus*. Eggs figured in the same manner and under exactly the same enlargement as in the preceding drawing so as to allow of comparison.

Fig 1.

Fig 2.

Fig. 4.

Fig. 3.

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Fig. 5:

Fig. 6.

Fig. 7.

Fig. 8.