On the

Bilharzia Haematobia

By George Sandison Brock, M.B., C.M.,
District Surgeon, Rustenburg,
Transvaal, South Africa.
On the Bilharzia Haematoica

<table>
<thead>
<tr>
<th>Section</th>
<th>Sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Synonyms.</td>
<td>1</td>
</tr>
<tr>
<td>II. Discovery and Geographical Distribution</td>
<td>2</td>
</tr>
<tr>
<td>III. Etiology</td>
<td>5</td>
</tr>
<tr>
<td>IV. Anatomy</td>
<td></td>
</tr>
<tr>
<td>A. The Ovum</td>
<td>10</td>
</tr>
<tr>
<td>B. The Adult Worm</td>
<td>20</td>
</tr>
<tr>
<td>V. Pathological Effects</td>
<td>23</td>
</tr>
<tr>
<td>VI. Symptomatology</td>
<td>28</td>
</tr>
<tr>
<td>VII. Diagnosis</td>
<td>33</td>
</tr>
<tr>
<td>VIII. Prognosis</td>
<td>34</td>
</tr>
<tr>
<td>IX. Treatment</td>
<td>36</td>
</tr>
<tr>
<td>X. Prophylaxis</td>
<td>40</td>
</tr>
</tbody>
</table>
I. Synonyms.

*Bilharzia haematobia* (Cobbold).
*Dictyocaulus haematobium* (Bilharz).
*Bilharzia Capensis* (Harley).
*Gyracophorus haematobius* (Diesing).
*Schistosoma haematobium* (Loeppland).
*Thecosoma haematobium* (Djouma-Pandon).

From these various synonyms and one or two more that have been proposed for the parasite I have preferred to select the name conferred upon it by D. Cobbald, since that title has the merit of commemorating the discoverer, D. Bilharz; while it avoids the irregularity of placing an unisexual entozoan in the same genus as the bisexual parasites ordinarily included among the Dytomidae, an objection to which the name Dictyocaulus haematobium is open. D. Harley's name of *Bilharzia Capensis* is
Note for Printers

All references to literature marked with red letters at the end of sections to be put in as foot notes.
On the
Bilharzia Haematoobia

George Sandison Brock, M.D. Edin.
District Surgeon, Rustenburg,
Transvaal, South Africa.

This forms part of an M.D. Thesis for
which a gold medal was awarded in
the University of Edinburgh.
of the various synonyms that have been proposed for the parasite I prefer that conferred upon it by Dr. Cobbald. *Bilharzia haematobia*, since that name has the merit of commemorating the discoverer Dr. Bilharz, while it avoids the irregularity of placing an unisexual entozoon in the same genus as the bisexual parasites included amongst the *Dintomidae*, an objection to which the name *Dintoma haematobium* is open. Dr. Harley's name of *Bilharzia Capensis* is
further objectionable as implying a limit to the geographical distribution of the parasite since he gave it under the erroneous impression that the animal found by him in patients from the Cape differed from that discovered by Bilharz in Egypt. Diesing's name of *Gynocephalus haematobius* is very appropriate expressing the most distinctive peculiarity in the creature's anatomy as well as in its lifehistory, but neither this nor any of the remaining synonyms has found general favour, and the name of *Bilharzia haematobia* is rapidly superseding all others in the later writings of helminthologists.
II. Discovery and Geographical Distribution

Although the haematuria symptomatically associated with the presence in man of the Bilharzia haematobia must have called the attention of many physicians to the disease and although in various parts of Africa and its neighbouring islands, but more especially in Egypt, the prevalence of a peculiar form of endemic haematuria had long been observed, it was not until little more than 40 years (1851) that Bilharz in carrying out, in conjunction with Griesinger, an investigation in regard to the diseases of Egypt, discovered the fact that this haematuria was but one of the symptoms of a very formidable helminthiasis due to the presence of a trematode worm and...
and its ova in various parts of the body. In 1857 Cobbold discovered a similar parasite in the portal vein of an African monkey, *Cercopithecus fuliginosus* or Sooey Monkey, proving it not to be confined exclusively to man. In 1864 a paper by Dr. John Stanley was read before the Medico-Chirurgical Society of London announcing the discovery by him in connection with endemic haematuria at Port Elizabeth and Uitenhage in the Cape Colony of the ova of a parasite to which he then gave the name of *Dietomum Capense*, but which Dr. Cobbold pointed out at the time was no other than the fluke previously described by Dr. Bilharz as the cause of the endemic haematuria of Egypt. At various times subsequent to this
this the existence of the parasites has been reported from different places in South Africa by Henderson, Allen, Attiestone and others in the Cape Colony and Natal, and from Nosse Be', Madagascar and Mauritius, as well as by Guillemand and Castle from Central East Africa. I have now to report the same complaint as very common in the Rusterburg district of the Transvaal (South African Republic), especially along the slopes of the Magaliesberg and Pilansberg Mountains and in the valleys of the Eland, Hex, Magalies, and Crocodile Rivers, where it is no exaggeration to say that nearly all the male population, black and white, are or have been sufferers from it. It seems likely as our knowledge of the Continent and its diseases becomes more precise, that the
the discoveries of Bilharz and Harlay will be gradually supplemented until the whole length of Africa between Cairo and Port Elizabeth is ultimately included in the territory subject to the ravages of this very formidable parasite.

The question of the identity of Holley's Ditetomum Capense with the Bilharzia haematobia, if it still admits of any dispute, would be finally settled if it be found that the minute anatomy of the embryos described in this paper corresponds in all its rather complicated details with that of the embryo of the Egyptian parasite. Differences in the clinical history of the disease in the two countries seem to exist but they are more of degree than of kind and may be accounted for by differences in the climatic conditions to which the vector is subjected during its development, or more probably in the racial
racial characteristics of its human hosts.

Rayer. "Maladies des Reins" Vol. IV.
Each of the above authors quotes cases of endemic haematuria in the Isle of France, its doubt caused by Bilharzia.
Dr. Todd's description in his work on Urinary Diseases, 1861, page 62, quoted by Dr. Harley gives an accurate clinical picture of the Bilharzia disease, except that no mention is made of the ova which were doubtless overlooked.
(6) Bilharzi's account is preserved in the Zeitschrift fur wissenschaft. Zoologie Bd. IV, and Gesing's in his Klinische

Sie als "Deutum haematoicum, und sein Verhältniss zu gewissen pathologischen Veränderungen der menschlichen Dermorgan von Dr. The. Hilhag in Cairo" (Wiener Mediz. Wochenschrift, No. 4-5).

(c) "Haematuria in East Central Africa" by A. F. Castle M.D. Camb. Med. J. Vol. 25, 1871.

(d) Among the Dutch Boers in these places it is familiarly known as the "Blood-water" (blood-water) or "Blood-gravel" (blood gravel).

III. Etiology

It still remains uncertain in what manner the Bilharzia gains access to the human body; our knowledge of the stages of its development from the embryonic condition to its mature state, unlike that in regard to the other trematode worms, is almost nil. In spite of many attempts by such able inquirers as the late D. Spencer Cobbold and Prosper Soucino of Paris to follow the subject out experimentally as well as clinically, as yet therefore we can only go upon hypotheses of which there are several, chiefly founded upon analogy drawn from the life history of other trematodes, which, in completing their life cycle, take up a temporary abode in water as pec swimming embryos, or in the bodies of various invertebrate hosts, before they find an environment congenial to
to them in their mature condition.

Griesinger suggests (loc. cit.) that the larvae of the Bilharzias exist in the river water, and the fishes frequenting it, or even in bread, grain, or fruit. Todbold thinks it more probable that they will be found in gastropod mollusces, (in the form of cercariae, rediae, and sporocysts,) proper to the localities from whence the adult flukes have been obtained, and that it is by the ingestion of these adhering to edible vegetable that infection is prone to occur. Sousins thinks that anything would tend to prove that the worm gains access to the human subject by means of impure drinking water in which the larvae exist either in a free state or embedded in other organisms which are swallowed with the water, a view he claims to rest upon two orders of facts:

1. That the embryos when expelled from the
the human body, being ciliated, offers the very best conditions for aquatic locomotion, and thus may reasonably be supposed to gain by means of water entrance to the body of a host suited to its subsequent transformations.

2. That whereas the agricultural classes in Egypt who are in the habit of drinking the impure water of stagnant pools or running streams are most frequently subject to infection from the parasite, this is much less frequently the case among the inhabitants of Cairo, who generally make use of purified water; while it is very rare among the European community who filter the water before using it.

The same observer puts forward with much plausibility the contention, also upheld by Hailey, that infection having once taken place, the disease may be fed by so-called auto-infection, exceptional circumstances enabling the embryos to remain and complete.
complete its various stages of development in its original host. This is a theory, however, which has many facts against and very few to support it.

The theory of infection by drinking water finds many supporters. Fritsch asserts that of all the possibilities put forward there remains but one which obtains everywhere wherever the worm shows itself, viz., the use of impure drinking water, particularly from stagnant pools. Dr. Allen, Dr. John Harley (cf. cit.), and others have suggested the possibility that the larvae find entrance during bathing by the small superficial veins or by the urethra or rectum.

My own inquiries on this point have led me to the conclusion that bathing is in this neighbourhood at any rate, the most fruitful source of the infection. I cannot recall one exception among several hundred instances to the rule that all who suffer from the parasite have
have been in the habit of bathing. Moreover
it is among the boys who are fondest of
swimming that the symptoms earliest
make their appearance; indeed I believe
it would be hard if not impossible
to find one boy much given to bathing
in the streams above mentioned and
their tributaries who is not or has not
been a subject of the disease. Only
on this theory too is explicable the fact
noted by various observers in South Africa
that the female sex is rarely attacked
by Bilharzia. If it be the case as
Sousins so positively states that females
are quite as liable as males to contract
the disease it is hard to explain in
any other way the almost total im-
munity which the female sex actually
does enjoy in this district. Among
the many patients with Bilharzia
whom I have treated here in the East
three years there is not one of the female sex, and only once or twice have I heard of cases of haematuria in females which probably had their origin in the presence of the parasite. It cannot fairly be urged, as is done by Fritsch, that this difference in frequency in the two sexes is due to the greater purity of the drinking water used by females, for at the early age at which Bilharzia is commonly contracted, boys and girls are placed under much the same conditions as regards the quality of water which they drink. But in the use of water for bathing it is otherwise. The country population of this district consists almost exclusively of Boers, who in the Transvaal are very negligent about personal cleanliness. Neither sex indeed ordinarily washes more than the hands and feet for the purpose of cleansing, and the Boer girls rarely indulge in bathing. The boys n
the other hand are constantly in the water, often remaining in it for hours at a time during the warm days of summer, a season when the Cercaria of the Bilharzia are presumably most active. New comers even if they are adults who venture to bathe frequently in the streams soon contract the disease while others who avoid doing so escape. The immunity in the latter case may however be the result of care in other respects as those who are aware of the danger naturally avoid every suspected source of infection.

That the drinking of impure water is a common factor in the process of infection there is no lack of evidence; indeed it would be unreasonable to think otherwise if the bathing hypothesis be well grounded. But other things being equal the chances of the infection occurring will be greater from the large quantity of water which must...
come in contact with the body in bathing, than from the comparatively small amount conveyed into the stomach by drinking; so that pointing the larvae to have the power of penetrating by some means the bodies of batters we should expect to meet with a much larger proportion of cases among such persons than among those who only drink the infective water.

In connection with this I may mention that those who bathe in the stream skirting the town of Rustenburg complain of severe itching on emerging from the water. I have never had any occasion to notice the occurrence here of the superficial sores described by some and attributed by them to the irritations caused by attacks of Bilharzia larvae. Here as elsewhere in South Africa there are cases of boils and sores due to larvae but those I have known have been from the larvae of a species of musca which lays its eggs in the
the skin of children, and there is no evidence that persons suffering from Bikhazia have been affected with boils and sores more than others.

My inquiries into the manner of infection of the Bikhazia have not led me to suspect the presence of the Carvae in grain, vegetables, or fruit. Wheat and very large numbers of oranges are exported from this district to Kimberley, Johannesburg, and Pretoria without so far as I have heard ever carrying the disease thither, while salads are rarely used by the Boers among whom the disease is so common.

There is no evidence whatever that infection can take place by contagion. It has never been known for example to have been conveyed by a husband to his wife.

The question of how infections occur will however only be satisfactorily solved when we succeed in tracing the development of
of the parasite through all its stages. Unfortunately very little progress has so far been made with this problem, as it presents at its very outset difficulties that have baffled the ingenuity of the most accomplished helminthologists.

(a) On the Development of Bilharzia haematoobia

(b) Ricercle sullo sviluppo della Bilharzia, per il dottore Prosperi Sosnino
(Giornale della R. Accademia di Medicina di Torino - Agosto 1884)

(c) Entoidea; an Introduction to the Study of Helminthology. By J. Spencer Cobbold. p. 36

(d) Zur Anatomie der Bilharzia haematoobia (Cobbold) von Gustav Fritsch

(e) La Bilharzia haematoobia et son rôle pathologique en Egypte, par le Dr. Prosperi Sosnino (Arch. Gen. de Med. Num de juin 1876.

Anatomy
IV. Anatomy

A. The Ova of the Bilharzia may be seen in the orifice of the mature worm but I have only been able to study them as they appear in the urine of patients suffering from Bilharzia. In this situation they may however be seen in all stages of development, and in enormous numbers. They are embedded in thousands in the cells of blood (Fig. 1) and in the mucos (see copy of Harley's Plate Fig. 1 and 2) so often passed in this disease from the urinary passages, and they are also found plentifully, lying free in the urine.

The most immature ova have a simple envelope with a short spine at one end, and are filled with granules of various sizes. They are about \( \frac{1}{1000} \) inch in length and about \( \frac{1}{600} \) inch in breadth. (Fig. 2)

In older specimens segmentation may
be seen in different stages of development, and by searching among the cor one may trace step by step the development from the simple chaotic fomal mass represented in Fig. 2a, through the various stages until the embryo attains the very definite and comparatively complex structure shown in Figs. 4, 6-10.

The fully matured ovum has usually the shape of a hen's egg and measures from \( \frac{1}{160} \) to \( \frac{1}{160} \) in length and about \( \frac{3}{32} \) in breadth. There is, however, much irregularity noticeable even in mature specimens both in size and shape. Some are a little larger, others a good deal smaller than these measurements, and some are long and narrow while others are shaped more like a pear or boy's kite. (Fig. 3.)

The outer envelope or shell is so clear and smooth as scarcely at all to interfere with our view of its contents. By reflected light it appears shiny and of a brownish or pinkish neutral tint. It is soft and delicate.
delicate and very thin, but its double contour can readily be made out under a high power. At the narrower end of the egg there is placed a sharp projecting spine (Fig. 4, b) of varying length, into which the main cavity of the shell generally extends. This spine is often very short and sometimes altogether absent. Its average length is about 2500, or 10 of the total length of the egg. According to Cobbold it is the homologue of a very much larger structure in certain other trematoidea, where it serves as a "holdfast" by which the eggs attach themselves to the body of their host. In the Bilharzia its use for this purpose, if it have any, must, from its straightness and trifling length, be very slight. In eggs which have been voided through the rectum it is said that these spines are often placed laterally. I have never been able to observe this, but can confirm Horley's assertion that those from the urinary passages never

---

\( \text{(b), (c), (d), (e)} \)
never present this peculiarly.

Living the interior of the shell and intervening between it and the embryo is a delicate granular membrane (Fig. 4, c) best seen during and after the extraction of the embryo (Fig. 6, f). The space (Fig. 4.) between this granular membrane and the embryo varies much in width, according to the size of the latter, before whose escape from the shell it becomes filled with numbers of bright granules (Fig 5, g) extruded from the interior of the embryo through certain lateral apertures previously to its being described. These granules exhibit Brownian movements, and are often further agitated by the action of the cilia with which the body of the embryo is covered.

The next come to the embryo itself (Fig. 4, e) which, until the time draws near for its obtaining its liberty, lies quiescent in its shell, only now and then moving its head from side to side, or occasionally drawing its whole body upwards with a jerking movement. Atcursor...
glance shows what at first appears an almost structureless sarcotic mass roughly corresponding in shape to the surrounding envelope. Closer examination however shows this apparently simple mass to be a creature of considerable complexity of structure.

The cephalic end of the embryo (at p, Fig. 2) which is sometimes placed at the end of the shell which terminates in the spine, and sometimes at the other (Fig 3), is distinguished from the caudal end by its shape, which is that of a truncated cone with the extremity further prolonged into a kind of anot, the oral papilla (Fig 4, p). The whole body with the exception of this papilla is covered with cilia (Fig. 4) arranged both longitudinally and transversely in beautifully regular lines. The regularity of their arrangement is only interrupted by at two places by the two coronal series of apertures (Figs 5 and 7, a and b) to be afterwards
afterwards described, which divide the surface of the body into cephalic, caudal, and intermediate zones. Close to the base of the papilla the cilia are very short, but further back they gradually increase in length until, at a point where the anterior series of apertures open, they reach their extreme length of about 1/200 of an inch. The cilia of this cephalic zone are stronger and more active than those of the intermediate- and caudal zones. They are nearly always in motion even before the embryo escapes from the shell, and are the last to retain their movement when the embryo is dying. Those of the caudal and intermediate zones are pretty uniform in length and very delicate and easily injured. One circular row of them placed at the junction of the zones (beside the posterior series of apertures) has the peculiarity of frequently standing straight out from the body, vibrating.
vibrating slightly or quite motionless, while all the other cilia are moving rapidly.

Both the envelope and the body substance of the embryo are very transparent so that no obstruction is presented by them to a complete view of its interior. The transparency is indeed so great as to become rather a hindrance than a help in discovering their disposition and relations. With care most of them are distinguishable even before the shell is discarded, and by the examination of many different specimens both in and out of the shell I have been able to obtain satisfactory views of nearly every detail.

Before speaking of the structure of the interior of the body I must first refer a little further to certain orifices on its exterior. The mouth of the embryo is placed in the centre of the oral papilla (Fig. 4.) at the extremity of the caudal end, where
the anus might be looked for, a slight depression is generally to be found. I have not been able to find any connection between it and the alimentary canal and have never seen anything being extended from it. It is probably therefore only a rudimentary structure; or it may be that it is an open "foramen candidum," as the outer vascular system of vessels of the two sides are connected to one another very close to it. The function of an anus seems to be performed by the two series of lateral apertures already referred to. These are placed coronally, at about an equal distance from each pole of the embryo and from each other, the distance however varying a good deal in different specimens. The anterius series (Fig. 3 and 4) merge into one another externally so as to form a coronal slit in the ciliated covering of the animal, into which the excretory ducts probably open. The posterior
series (Figs. 5-27, b) is much more distinct and consists of some thirty apertures, between each of which stands a single large cilium. From both series extruded matters are often seen emerging (Figs. 4, A, 5, a and b, and 11) in the shape of globules and granules. The pameles previously mentioned as filling the space in the ovum between the embryos and its inner or membranous envelope (Fig. 5 g) are chiefly if not entirely from is derived. The globules as they emerge may frequently be seen clinging to the sides of the embryo on or between the cilia situated near the apertures—(Fig. 14, also shows, my highly magnified various parts of the growing object).

These lateral apertures on the embryos have not been noticed by any other observer so far as I am aware. Nothing similar to them is mentioned by Cobbold as existing in any of the embryos of the other genera.

The body of the Bilharzia embryo consists of contractile pseudoplasmon through which
which refractile granules and globules of various sizes are interspersed. It is furnished with a digestive and a water-vascular system, and contains other structures as well, the function of which is not clear. There is a distinct cephalophorus (Fig. 4, f, and Fig. 14 et cetera) terminating anteriorly at the oral papilla in a somewhat dilated funnel-shaped end with transverse markings upon it, which give it the appearance of being ringed, and entering posteriorly the large oesophagus which occupies part of the middle division of the embryo and terminates behind in a tube. This tube (Fig. 4, i) is very indistinctly differentiated from the surrounding sarcode, and consequently very difficult to trace. After a very short course, almost immediately on leaving the stomodeum, it appears to bifurcate. This appearance of bifurcation I have observed in so many specimens that I feel pretty sure
Sure of its actual occurrence in all cases I cannot say what becomes of the branches into which the tube divides but considering the manner in which secretion takes place, it is at any rate unlikely that they terminate at a single anus at the posterior extremity of the body. In one specimen I saw the appearance represented in Fig 11, where the branches seem to run back nearly to the tail, approaching one another posteriorly as if about to reunite. Here they unfortunately became so indistinct that it was impossible to trace them any further.

The presence in the embryo of a water vascular system was noticed by Bobbeld and described by him in his paper "On the Development of the Bilharzia Species in" already referred to. (a) Without being aware of this I had satisfied myself of its existence and made out with great distinctness in many specimens all that
he there describes, besides certain other points of great interest—which he appears to have overlooked. The water-vascular system is best seen after the embryo has escaped from the shell and been swimming about for some time in water. It begins in the oral papilla, round the base of which there seems to be a circular vessel, and one branch passes down either side of the body until the two branches meet one another and unite near the depression previously noticed at the caudal extremity (Fig 4, 0, 0). In their passage downwards they give off several anastomosing branches which ramify over the whole body of the embryo, but which especially concentrate and arrange themselves around four particular points (Fig 4, K, K, K', K') placed in pairs, one pair lying in the anterior half, the other in the posterior half of the body. If the embryo be alive there will
will always be seen at these four points a rhythmical contractile movement varying in rapidity from one to three or even nine beats per second. The movement appears to take place in a short tube near the dorsal surface of the embryo, and it is rapid or slow according as the embryo is lively or the reverse. It has nothing to do with the movement of the cilia which are often quiescent while the contractile organs are active. The members of each pair are situated symmetrically on either side of the body about 200 apart in the middle division of the embryo trace of the anterior pair usually lying at the interval between the sides of the stomach and the two pyriform muscles to be described further on, and those of the posterior pair in the caudal division a little way behind the plane of the posterior series of apertures. (Fig 14) Placed in the centre of a complicated network of tubes, and exhibiting such well marked contractile movements always in a constant
constant definite direction, these organs can hardly be other than circulatory in their function, probably serving to propel a nourishing fluid through the water-vascular system, and perhaps also to establish communication between that system and the fluid in which the embryo swims. An appearance can often be seen of a blunt tube passing from each contractile organ to the nearest lateral aperture, the anterior pair of contractile organs apparently communicating with the anterior series of apertures, and the posterior pair with the posterior series. I have however entirely failed to detect any circulation either in the tube immediately surrounding the contractile organs or in any of the numerous branches of the water-vascular system which are distributed elsewhere in the body; but this failure I attribute to the transparent character of the circulating fluid.

The most prominent of the structures
in the interior of the embryo yet remain to be described, namely, two rounded masses (Fig. 4, m) lying in the anterior half of the embryo, one on either side. Their shape is often pear-like (Fig. 10) and they therefore called by Sobold "pyriform bodies", but they are more usually rounded (Fig. 4, m) irregularly, frequently with a notched or pentagonal border of quadrilateral in contour (Fig. 9). They are roughly granular bodies measuring \( \frac{1}{8} \) in diameter with a bright double outline and containing in their interior one or more prominent nuclei (Fig. 14). They are situated one on either side of the stomach about the junction of the anterior and middle thirds of the body, nearer to the dorsal than the ventral aspect of the latter (Fig. 16). From their anterior (Fig. 4, n) and outer side two stalk-like processes pass forward, one on either side of the esophagus, which has just room to pass between and below them, and terminate in two small points projecting slightly beyond the surface of the integument in the
the sides of the oral papilla. These stalk-like processes have been described by Harley as tubes but I have not been able to see any appearance of their being hollow, and believe both them and the masses from which they spring to be solid structures. They are of much firmer consistence than any other part of the embry and are often seen lying with the masses attached, outside the body of the embry, when the latter has been injured by pressure on the cover glass. They are also very easily displaced from their natural positions, the least rough usage of the embry serving as it were to dislocate them. It is difficult to imagine what the function of these structures may be, and their morphological significance is equally obscure. It may be that the peduncles are muscular organs helping in the movements of the head, giving at the same time more rigidity to the „neck“. I find these two pedunculated
pedunculated masses invariably present in the mature ovum. Cobbol speaks of them as varying in number, but he was probably looking at them in profile when he saw only one (Figs. 11 and 16), and indeed his whole description gives only a vague idea of their position and relations. (Figs. 15, 16, 17.)

After the ovum is voided with the urine certain changes go on in it if it be mature resulting in the rupture of the envelopes and escape of the contained embryo. The cilia of the cephalic zone first begin to move rapidly, and the creature pushes and turns its head about in all directions as if endeavouring to free itself from the attachments which exist between it and the inner envelope and which are especially strong near the base of the papilla. At the same time numbers of papules and spherules of various sizes, as also probably fluid, are poured out from the lateral apertures.
into the space between the embryo and the inner envelope so as to distend it and so assist in the separation of the attachments. All the cilia are soon at work creating a great commotion amongst these particles, vigorous contractions of the body taking place the while by means of which the latter is considerably increased in breadth and pressure upon the sides of the shell. The oral papilla is also used with great vigour as a prosthetic to rub against the investing membrane in all directions, the creature twisting itself about, drawing itself up, and even turning complete somersaults in the shell (Fig. 10). The shell meanwhile grows more and more thin and delicate, until at last a longitudinal lateral rupture takes place by which the embryo promptly emerges, presenting in different ways the cephalic or the caudal end (Fig. 6.a.). The envelope either remains behind
behind in the outer shell (Fig 6, a) or protrudes through the slit (Fig 6, b). If the wine be heating or have previously been replaced by pure water, the escaped embryo relieved from the confining pressure of the shell assumes its natural elongated "torpedo" like shape and scurries away with great rapidity (Fig. 9). If the weather be cold, or there be much impurity in the surrounding fluid, or the embryo have been prematurely launched into it, strange and unnatural shapes are assumed (Fig. 8b) a very common form being that of an "Hour-glass" (Fig 8, a).

The time required for hatching varies very much according to the state of development of the embryo, and also according to the temperature to which the latter is exposed after being voided with the urine. It may occur within a few hours or be delayed for several days.

Goebold
Bobbold, Cousins, and others have made
so many attempts to keep alive the
liberated embryos for the object of tracing
its development; but after a few days,
before any great change has taken place,
the death of the animal defeats the inquiry.

Mooney states that very soon larvae
make their appearance by means of a
sort of internal budding in the embryo
which dies and is ruptured in order
to be delivered of them. But going upon
an analogy it is most probable that the
larvae become encysted or in some aquatic
animal, possibly passing through more
than one phase and more than one
heat before attaining their perfect de-
velopment in the human system. They
have been experimentally brought in
contact with different species of fishes,
mollusca, crustaceae, larvae of other in-
xsects, etc., but have in no instance been

found
found to attack any of them.

(a) "On the development of Bilharzia Haematobia" by T. Spencer Cobbold M.D. This paper contains the most accurate account of the ovum which I have been able to obtain. No mention is made in it however of several important points in the anatomy of the ovum, as for instance the lateral excretory apertures and the four contractile organs, structures which I believe I am now the first to describe. The measurements of certain parts of the ovum made by Cobbold I have accepted as correct and added to my description to make it more complete.


(c) "Article on Bilharzia Haematobia" by Dr. V. Belloli in "Le Progrès Medical" 25 Juillet 1885 p. 54.

(d) "Ricerche sullo sviluppo della Bilharzia Haematobia," P. Sondini. Gion. R. Acc. Med. Torino. (From which the plate annexed is taken.)
B. The Adult Worm. As I have been unable to procure any specimens of the adult Bilharzia, it has not been possible for me to make any original observations upon its anatomy. The subject has however been exhaustively worked out by Bilhary, Leuckart, Küchenmeister, Coblentz, Süsskind, and others, and lately very fully by F. Frisell in the article already quoted. I shall therefore confine myself to a short description taken from these authors of the animal's chief anatomical features.
and peculiarities. Annexed is a plate from Frisch's paper in which will be found representations of the animal. In Fig 1, the male and female are depicted in the copulatory act, the female lying partially embedded in the "gynecostomie canal" of the male. In Fig 2 is shown a female worm drawn to the natural size, Figs 3 and 4 being magnified views of her anterior and posterior portions respectively.

The Bilharzia as already stated differs from all other digenetic species in that the male and female reproductive organs occur in separate individuals. The broad posterior portion of the body of the male worm is rolled or curled all along its length so as to form a cylinder with an open longitudinal groove or passage on the ventral aspect for the reception during copulation of the body.
of the female which is embraced by its middle portion, the extremities of her body especially the posterior projecting considerably from either end of it. It is in this position that the two sexes are usually found in the adult stage, but occasionally a male is found alone, or more rarely a female, for after fertilisation the latter leaves the male and finds its way into the minute blood vessels of the intestinal and vesical walls, there to deposit its eggs. The male owing to its smaller bulk cannot do this.

The male is white in colour, usually about half an inch long and as thick as an ordinary pin. Its body is covered everywhere except near the anterior extremity and siphonophoric canal with micropapillate tubercles. The female though nearly half as long again, is no thicker than a very fine silk thread. Its body especially posteriorly has fine prickles-like
prickle-like projections and is of a dark colour. Both male and female are provided with two suckers of which the anterior constitutes the buccal cavity whilst the ventral one serves as an organ of fixation. The alimentary canal is unlike that of the other dictyostelids in this respect that the bifurcated intestine instead of ending separately in two blind extremities, as is usually the case in that genus, reunites posteriorly to terminate in one single one which in the female after running spirally down the body terminates blindly near the point of the tail, but in the male opens near the posterior extremity of the body at a minute excretory pore. The genital organs are very elementary consisting, in the male, of the testes and seminal vesicles (?) placed not far from the ventral sucker, with the duct opening in the bottom of the gynacocephalic
gynecophoric canal near its anterior end, and in the female of vitellariaum and germinariaum, the former placed on either side of the termination of the intestine, the latter situated further forward at the point where the two branches of the intestine rejoin to form a single tube. The vitelligenic and germigene canals then combine in a singleoviduct which running forwards expands to form the uterus. The ova are generally to be seen in a single or double row arranged along the oviduct. The external opening of the genital apparatus, placed close to the posterior margin of the acetabulum, communicates by a short tube with the uterus, if which indeed the tube is but the contracted forward continuation. The spines of the ova are directed backwards, so as to form an obstacle to the free passage of the egg along the oviduct (Sousins).
The minute anatomy of both sexes is very fully described by Fritsch in the article referred to, so transcribe which would however be superfluous here.

(a) Fritsch. But other authors have also observed this reunion in the male room.

Bibliography.

Leuckart, Die menschlichen Parasiten
schaftliche Zoologie. Bd 11.


Sousins z. Op. C.

V. Pathological Effects

The adult worm is found most frequently in the portal vein and its branches and roots, e.g. the splenic, and in the vesicle veins, adhering to the inner coat of the vessels or in the blood clots contained in them post mortem. Soares has only once found it in the vesicle veins. It does not appear that the parasites themselves by their presence cause much trouble; it is their eggs which directly give rise to the lesions in various organs which have been observed in connection with the Bilharzia helminthiasis.

The fact of the adult worm being found in the portal vein is a strong proof of the truth of the hypothesis that at any rate one method by which the animal gains entrance to the body is through the stomach. The occurrence of the worm in the systemic as well as the portal circulation may be explain...
plained by the different anastomosis which exist between the two systems especially the free anastomosis in the rectum between the haemorrhoidal bands of the inferior mesenteric root of the portal vein and the middle and superior haemorrhoidal branches of the internal iliac, or it may be as Henley first suggested that the canals enter the systemic circulation directly by the superficial veins during bathing, a method of infection which my own inquiries have led me to think highly probable. Why the abdominal veins in that case should alone lodge the parasite is difficult to understand, but it is also hard to see how the eggs of worms that have been introduced by the portal system should find their way mainly to the urinary tract, whose circulation is only... connected
connected by small anaestomosing vessels with that system. Harbey has also suggested that the cancer may enter the bladder directly through the urethra during bathing. However this may be it seems certain that once in the blood the female worm, after fecundation, finds her way into a small vein, where, becoming encysted, she lays her eggs in such abundance that the vein is burst and the eggs set free into the tissues or cavities in its neighborhood. The organs in which most organs are found are the bladder, ureters, vesicles seminales, mesenteric glands, and rectum. They have also been found in the liver, kidneys, and prostate, by Kastulic (c) in the lungs, by Mackie and Miers (d) and even in the left ventricle of the heart by Friesinga. The cavities into which the escape most
generally are those of the urinary apparatus,—pelvis of kidney, ureters and bladder, when they of course mix with the urine and are mostly passed with it; but they also escape into the rectum to be passed out with the feces. When the case thus breaks through the mucous membrane into any of these cavities, the rupture is accompanied by hemorrhage, which is sometimes the only symptom noticed by the patient while it is always the most constant and most noticeable of the clinical phenomena of the Bilharzia disease, giving it the name by which it was formerly vaguely known, of Induric Hemorrhagic. Among the more ignorant of the people of this district it is not uncommon to hear the complaint referred to as if the appearance of blood in the urine of boys were little
little more than a physiological fact, to be expected as a matter of course.

By Bilharz, the anatomico-pathological effects caused by the eggs of the Bilharzia have been divided into three varieties: 1. Induration. 2. Polyoid Vegetation. 3. Ulceration. Of these the last is rarely met with except in small erosions visible by the aid of a simple lens. By Cousin's six types are enumerated under the generic name of infarctions, "infarctus vesiculare, hemorrhagique, granuleux, avec incrustation, ulcereux, vegetant." In the rectum, in account of the vascularity of its mucous membrane, he finds only the hemorrhagic form and vegetation: in the bladder the granular (termed by Bilharz the "sandy"). In the ureters and vesiculae feminulae, the granular form is common, whilst the vesicular is usual in the bladder and ureters. Incrustations of carbonat.
of lime are frequent on the shells of the ova. In the numerous autopsies made in Egypt by Billary Kriesigk, the chief seat of pathological changes was found to be the bladder, but these also frequently extended to the ureters and even to the substance of the kidneys. They consisted in the formation of infiltrated congested pedal and ecchymosed patches varying in size from a quarter to half-an-inch in diameter, covered over with slimy mucus or soft yellow exudation, and placed most frequently, sometimes exclusively, on the posterior surface of the bladder mucous membrane of the bladder, often a thick, soft, granular material, usually with an encrustation of lime salts had become deposited on the mucous membrane, which was itself often affected with a chronic inflammation or had become the seat of warty outgrowths or vegetations.
The appearances in the uterine and renal pelvis were similar, but in them the effects were much more serious owing to obstruction to the flow, often resulting in pyo- or hydro-nephrosis, and even in destruction of the renal substance itself. In the bowel similar changes were observed. During life these lesions had given rise to symptoms of chronic inflammation of the mucous membrane taking the form, in the case of the urinary organs, of cystitis or pyelitis, and in the case of the intestines in diarrhoea or a kind of dysentery.

The presence of foreign particles such as the cor of the Bilharzia in the bladder and pelvis of the kidney leads as might be expected to concretions being formed by precipitation of the urinary salts, normal and pathological, upon them. In the calculi thus originated a careful examination will usually discover
discover a nucleus of Bilharzia egg shells. I have been able to verify this fact in two instances, with stones passed after attacks of renal colic. Sometimes calculi of very large size, so originated have been found in the bladder both during life, and post mortem.

New growths—papillomata, adenomata and even cancer also occur in the rectum and bladder, presumably caused by the irritation of the Bilharzia eggs, the shells of which have been found embedded in them.

It is not surprising that the ex-treme and other grave effects brought on by such lesions should lead in many cases to a fatal result. In Egypt this happens frequently, the direct cause of death being pneumonia, a depended the former probably septic in origin. In South Africa the pathological changes
have not been sufficiently investigated owing to the difficulty of obtaining autopsies but they are doubtless of a much less severe kind than those met with in Egypt since they appear very rarely to cause death.

Other pathological effects of the Bilharzia disease shall be described under Symptomatology.

(a) La Bilharzia Hematoïde et son Role Pathologique a. Egypte par L. S. P. Sommio
Skr. des Arch. gen. de Med. le juin 1876 p 7
(b) Quoted by Hilleiri Frage in his Principles of Practice of Medicine Vol II p 703.
(c) Memoirs in Brochan's Archive Vol xciv 1885 by Dr. Kartulis
(d) C. H. Sykes in Lancet Oct 1 1887 p 657 and Albert Ruthe in "Le Peoples Medical"
July 25 1885 p 37

c) Distomum Kromatikum und sein Verhältniss zu gewissen pathologische Veränderungen.
der menschlichen Hamorgan, von O²
No. 4-5.
(f) Op: Ch:

Symptomatology
VI. Symptomatology

The passage of blood per rectum is usually the first indication to the patient invaded by the Bilharzia that he has become affected; although sometimes uneasy sensations, seldom amounting to pain are complained of in the lumbar region or about the perineum, before any blood is noticed. As the patient is usually a child the disease may have been present a long time before attention is called to it by the detection of blood (which is perhaps first noticed on the child's clothes), and it is often impossible in any given case merely to say when invasion has taken place, but even to fix the date on which the first outward manifestations of the disease made their appearance. The period required for the Helminthiasis
to develop to such an extent as to cause haemorrhage is thus difficult to determine with precision. It probably varies in different cases according to the individual attacked and the number of parasites present. From observations on some cases of adults, who were attacked after their arrival in the district of Rustenburg, I have gathered the impression that a period of two to four months is sufficient. Anticipations may relieve beforehand. The blood is not as a rule mixed uniformly with the urine but is almost always passed at the end of micturition, the quantity varying from a few drops to a tea or even tablespoonful. After exercise such as lifting heavy weights, running or dancing, or after riding on horseback, the amount is markedly increased. In some instances all the urine is deeply tinged with blood.
but in such the last passed always contains meat. The blood would thus seem to be chiefly vesical in origin. It may be fresh, brightly colored, or dark, and is often found away in clots which fill the urethra and only come away with difficulty. After attacks of renal cystic clots may be noticed that from their form have evidently come from the ureters. In some cases again there is so little blood in the urine that it can only be seen by means of the microscope. Lastly the haematuria may be intermittent, blood appearing perhaps only after some unusual exertion.

A long time may elapse before pain becomes a prominent symptom but eventually this usually happens. It is chiefly caused by the passage along the ureters of clumps of mucous 

lueses
pieces of coagulated blood, or, in cases of lying standing, of small calculi which have formed in the renal pelvis. Dull achings pain or less frequently, sharp shooting pains may be complained of. They may be felt in the small of the back in the kidney region, over the course of the ureters, in the bladder, along the urethra, and are doubtless the accompaniment of the irritation and inflammatory mischief produced by the parasite and its eggs in these organs.

Irritability of the bladder is a frequent symptom and micturition is generally preceded accompanied and followed by a burning sensation, and followed by the feeling of straining.

When severe and long continued the disease gives rise to catarrh of the urinary tract, evidenced by the presence of quantities of
of mucus in the urine; and later still the more serious symptoms of cystitis, inflammation of the mucous membrane of the ureters, and pyelitis, are apt to develop. These affections severely or together produce pyrexia, anaemia, and other effects of a general kind sometimes alarming in their severity. One of these is severe epistaxis due probably to the impoverished state of the blood.

The complaint is chiefly confined to boys of from 6 to 15 years of age. At the latter period the haematuria generally disappears and the other symptoms in prove so greatly that the patient regard himself as cured. But a careful examination of the urine will often reveal the presence of ova for many years afterwards although quite unsuspected by the patient.

Subsequently
Subsequently there tend to form in the kidney and bladder oxalate and uric acid calculi, and in the bladder and rectum the new growths already referred to. Renal calculi are particularly common, giving rise to the usual symptoms of acute pain, nausea, etc. With their passage to the bladder commanders occur, and hematuria, etc. Other sequelae—pyuria and hydronephrosis are less common but more serious. They are accompanied by the symptoms proper to these several lesions, and it is to them, and others of the same serious nature that a fatal result when it occurs is due.

Although most of the cases one sees are in boys of the age stated, yet the disease is not infrequent even in the hematuric stage among men of all ages. Harley records a case in an old man of seventy, etc. As previously mentioned, several

[Signature]
instances have come under my notice where young adults lately arrived in
the district of Rustenburg have contracted it. If it occurs among females there to any
extent, it must do so without often causing haematuria, and I have not as yet met
with such a case.

The condition of the urine in the Bilharzia disease calls for special notice
as upon it usually rests the clinical diagnosis of the complaint. The presence of blood
is to the naked eye the most striking ab-
normality, the urine in some cases being
quite opaque from the large quantity
it contains. Most often the upper strata
in the urine glass are clear, the blood
quickly sinking to the bottom, especially when,
as so often happens, it has been passed
in the form of clots at the end of mictur-
ition. On testing by boiling and the
addition of nitric acid, albumin is an
amount depending on the admixture of 
leucia sanguinics is precipitated. If the 
case be one in which the haematuria 
has only recently appeared nothing else 
abnormal may be discovered by naked 
eye examination or chemical tests. 
By the aid of the microscope however 
there may be seen either lying free in 
the urine, or more usually, entangled 
in the meshes of the fibrin of the blood, \( \text{Fig 1} \) 
or embedded in stringy masses of mucous \( \text{Fig 2} \) 
the characteristic ova of the Bilharzia haematuria, 
often in enormous numbers. If the 
case be a more advanced one complicated 
by catarrhal inflammation of the 
mucous membrane of the urinary tract 
other changes will be met with. The 
urine will generally be found to be 
very acid, its specific gravity rather 
high, the quantity of blood much less, 
perhaps not at all visible to the naked
eye; on standing it will deposit a copious sediment of urinary crystals often with shreds of tissue amongst them, and microscopically in addition to Hel-"zarzia ov, which are especially numerous in these shreds (Fig 13), there will be found mingled with the blood and mucus, pus cells, uro acid and oxalate of lime crystals, and large numbers of epithelial cells from all parts of the urinary tract. In old cases where there has been a long standing cystitis or pyelitis, pus, and not blood, forms the principal abnormal constituent of the urine, which is then apt to become dark in colour, of lower specific gravity and less acid reaction. Shreds of mucous membrane containing embedded ov in great numbers are now still more frequently passed, sometimes when a case has
apparently been cured and blood is no longer present. The ova may after a time entirely disappear and nothing may remain to show that the patient has been a subject of the disease except the presence of uric acid in excess and oxalate of lime crystals, or the evidence of some complication which has persisted such as pyelitis or cystitis, or of some sequela which has supervened, such as renal or vesical calculi. Or, when the disease has been slight and of short duration, the urine may return in every respect to its normal condition.

 marginalized copy

(b) Copies of plates illustrating Harley's paper are annexed.

Diagnosis
VIII. Diagnosis.

The detection of the ova of the Belhazia in the urine or feces is the only certain indication clinically of the presence of the worm in the body. Usually there is no difficulty in finding the ova, as they are present in such immense numbers in the urine, particularly in cases where the latter contains a good deal of blood. In some cases there is more difficulty; a trace of albumin, or the presence of oxalate of lime crystals, or an excess of uric acid may be all that leads one to suspect the presence of the parasite, and repeated examinations of the urine may have to be made before any ova are discovered.

With ordinary care these ought therefore to be little fear of confusing this disease with any other. Without
A proper examination of the urine, it is apt to be overlooked, especially in those who, having contracted it in infected districts, consult medical men elsewhere who are unacquainted with the appearance under the microscope of the worm; and the mistake has even been made by such of confounding it with Bright's Disease of the kidneys. A patient of mine, a young German, son of a missionary near Rustenburg, who went to Germany when suffering from Bilharzia in its earlier stages, was told by three different medical men there that he had Bright's Disease, and was treated by them for that complaint.

Prognosis
VIII. Prognosis

The ravages of the Bilharziasis in Egypt have been compared to those of the more rapidly fatal trichina disease in Germany. In South Africa the bad effects seem to be much less severe, yet they are nevertheless of such a nature that the prognosis must always be guarded, the more so that up to the present little or nothing has been effected by treatment in the way of a radical cure of the disease. The immediate danger to life is small but the exhaustion caused by the constant loss of blood, the ever recurring attacks of pain, or the continued discharge of pus, is in many cases so great that life must no doubt thereby be shortened. A complete cure may sometimes be established.
established, but in most cases though all symptoms may have disappeared there will always remain the fear, too often realized, that subsequent trouble in the shape of urinary or other disorders may, perhaps ten or twenty years later, make their appearance. I am frequently consulted by adults of all ages in the Rustenburg district in reference to ailments where the history points clearly to Bilharzia as the original cause. The most common of these is renal calculi produced as already mentioned by the deposition of uric acid or salt of lime upon a nucleus of Bilharzia eggs. The accompanying specimen was passed by a man of 34 years of age who had a history of severe haematuria lasting from his 8th to his 24th year and had suffered from renal pain.
from since his 18th year. On examining the contents of the small cavity seen in its section, after heating them gently in a little dilute hydrochloric acid, I had little difficulty in discovering numerous fragments of the Bilharzia egg cases, one of which, from the end of a shell, still bore the characteristic projecting spine. (Fig. 11 e.) In this case no worm were discoverable in the urine; there was also no blood, but a good deal of pus was present.

Patients with Bilharzia are not looked upon by the life assurance offices as eligible for life assurance.
IX. Treatment

The indications for the treatment of the Bilharzias disease are the following:

1. The removal of the Cause
2. The alleviation of symptoms
3. The prevention of sequelae

1. Removal of the Cause, implying as it does removal from the blood of the adult worm, and removal from the organs and tissues of its eggs, will manifestly be difficult of achievement. In regard to the adult worm this result could only be brought about by means of some agent capable of killing the animal in the blood, whose absorption of it could ultimately take place. Nothing has up to the present been found to have any such power, for the reason that the animal taking
If its abode in the interior of the veins, cannot be reached except through the blood, and it is thus impossible to act upon it efficiently by means of the ordinary anthelmintics. In spite of this apparently insurmountable difficulty, all these agents have been tried, and success been claimed by various authorities for one or other of them. In my own part I have never observed any such result attending their use. Variations in the quantity of blood passed are noticed as for instance after large doses of turpentine by which it may be diminished, but we continue to pass much as before and the disease does not appear to be shortened in its course or influenced in any very important respect. Harley recommends a mixture with oil of turpentine and
and male fem. for bringing away
the era. But probably only in one
way, namely, by prophylactic measures,
can we at all limit the duration
of the helminthicosis. By taking care
that no fresh parasites find their way
into the blood it is probable that
a definite although uncertain limit is placed to its duration.

It is scarcely necessary to do more
than mention the attempts which
have been made to attack the parasite
directly by means of vesical injection.
It is not credible, knowing what
we do of the pathology, that any
success should seriously be anticipated
from such a mode of treatment, except
what might accrue from the effect
of the injections upon any secondary
lesion in the urinary tract. And
that their use is not free from danger
is proved by the occurrence of acute cystitis in consequence of such attempts.

2. With regard to the alleviation of symptoms, fortunately much more success can be looked for from treatment. Haematuria is the commonest and most serious of these symptoms, as well as that generally first noticed; although it is by no means the symptom for which the medical man is most frequently called upon to give relief. Indeed it is generally neglected until the exhaustion and anaemia produced by its long continuance induce the patient to seek advice. The administration of iron, especially in the form of the perchloride, is of the greatest benefit, not so much by diminishing the amount of blood passed, (although it probably also acts in that direction), as by en-

braced
abling the patient to bear the drain upon the system, and by combating the tendency to anaemia. The addition of arsenic (e.g., Arsenic acid hydr. chlor.) to the perchloride, prescribed with a bitter infusion as quassia, I have found very efficacious for the latter purpose. Violent exercise or severe exertion of any kind, and particularly riding on horseback, must be forbidden, the quantity of blood in the urine being always increased thereby. Complete rest should be enjoined whenever the amount of blood is excessive.

The occurrence of pain is in the earliest stages of the disease clearly connected with the haematuria, being principally due to passage of blood cells through the ureters. The same remedies are therefore indicated, and
in addition aromatic diuretics as buchu and demulcent and diluent drinks should be given; or in severe cases the exhibition of opiates may be required. In later stages where the pain arises from the passage of uric acid or oxalate of lime calculi, the usual antilithic remedies will be called for, hypodermic injections of morphine being employed for the more acute paroxysms.

Irritability of the bladder is relieved by injections once or twice a week of saturated boracic acid or weak carbolic acid solutions.

Other symptoms such as epistaxis, diarrhoea, and digestive disorders, frequently call for treatment appropriate to their nature. The practice of masturbation must be especially guarded against as,
doubtless from irritation of the genital organs, the habit is exceedingly common amongst the victims of Bilharzia. Whenever practicable, the patient should leave the infected district where this is not possible he must carefully avoid using, either for drinking or bathing purposes, any water that might be the means of conveying fresh parasites into the system. Attention must be paid to diet and other general hygienic measures, and exposure to cold or wet and any over exertion or violent exercise carefully avoided.

3. The prevention of complications and sequelae will be best effected by carefully carrying out the foregoing treatment in every case from the commencement. The daily use of bicarbonate or citrate of potash
in weak solution is especially to be recommended with the object of combating the tendency to stone. Soothing and astringent injections into the bladder may be employed for the same purpose.

In regard to the treatment of such complications and sequelae when once established, nothing further need be said, since it differs in no respect from what is necessary in these same complaints under ordinary circumstances. Surgical interference is sometimes though rarely required for the removal of calculi from the bladder or urethra, or of papillomatous and often very growing from the bladder or rectum.

(a) Stanley "On the Edemic Urethralis of the Cystitis," (loc. cit.)
(b) Guillemand, quoted by Hilton Fagge, (loc. cit.)

Prophylaxis
X. Prophylaxis

The uncertainty surrounding the question as to how the Bilharzia gains access to the body, renders it a difficult matter to say precisely and positively by what means we can make sure of preventing the disease. But many observations warrant us in believing that the greatest if not the only danger lies in the use for bathing or drinking purposes of the water of certain streams. It has been noticed in Cairo that while the natives who drink Nile water without any precaution are extremely liable to infection, Europeans, who mostly use well water, are very little affected. I have frequently had opportunities in Rustenburg of observing the same fact with regard to the use of the water there. Indeed it would
would scarcely be exaggerating to say that it is only the children who neither drink of nor bathe in the streams in that neighbourhood who escape the infection. So much care cannot therefore be taken to ensure that all water used for domestic purposes be first freed from the parasite by boiling or by filtration. Rain water and water from properly closed wells might perhaps be used without this precaution but it is safer always to adopt it. Bathing in the streams or stagnant pools must especially be avoided, since it is in this way that the disease is most easily contracted. Dr. Allen of Petermannzurg, who holds very strongly the view that infection takes place during bathing, even suggests that circumcision should be performed to prevent the parasite lodging beneath the
the prepucce and thence passing into the urethra, as he considers it is in this way that the animal is enabled to gain access to the body.

I have had no occasion to think that, as Griesinger suggested, the disease is ever contracted through the eating of salads or fruit.

There are all the precautions necessary to its prevention only known and strictly carried out, not only would much suffering and ill-health be spared to those communities affected by the Bilharzia disease, but there is a possibility that the parasite itself might ultimately disappear from amongst them, since so far as is known it can only reach its sexually mature condition in one other host than man, namely, the species of monkey already mentioned. But until the development of the parasite from its embryonic to its mature condition has been fully traced the danger...
of infection from some unsuspected source must always remain. It is therefore a matter of great importance that every fact which may in any way help towards this end be observed and recorded, especially by those of us, who like myself, have exceptional opportunities of studying the subject.

In this thesis I have tried to present in a connected form a résumé of the knowledge which has so far been gained, both in regard to the parasite itself, and the helminthiasis it originates, on the one hand, lifting the various facts in the light of my own clinical experience of them which has been considerable, and on the other endeavouring, as I trust—actively without success—to add some fresh facts which may aid, however little, in the prosecution to a successful issue of this most important inquiry.

(a) Sonders, Op. Cit.

Explanation of Drawings

Sheet I.

Fig 1. Blood clot containing embedded B. ova x 90
2. a. Immature ova, showing partial embryo mass x 200
   b. D, more advanced x 200
3. Various forms of ova x 200
4. Mature ovum showing the various parts of the embryo and the shell x 350
   a. Outer shell, a shell
   b. Spire
   c. Inner shell or vitelline membrane
   d, d'. Chitinous extruded from lateral aperture, into space between the body of the embryo and the vitelline membrane.

e. Integument of body of embryo, ciliated
f. Oral papilla, showing oral aperture and projecting rud of stalk of pyriform body

q. Acrophorus
h. Knoch

i. Commence treatment
i. Commencement of intestine

K. K. Anterior intestinal coelom

l. Caudal depression

m. Pyriform body (right)

n. Stalk-like prolongation forwards of right pyriform body

Fig 5. Ovary showing mural matter extruded from lateral apertures into space surrounding body. (Germ layers shown thymus movement) x300

6. a. Dehiscence of ovum; subyos (e) occupying by lateral rupture of shell (c) Vitelline membrane left in shell. x250

b. Appearance presented by a ruptured shell from which the subyos has escaped.

Vitelline membrane (m) seen protruding. x250

Sheet II.

Fig 7. Free subyos, showing markings of:

a. Anterior series of lateral apertures

b. Posterior do. do. x320

Fig 8.
Fig. 8. Embryo forms assumed by embryos after escaping from their egg shells. X300
9. usual form assumed by vigorous free swimming embryo. X 600
10. Embryo in the act of freeing itself from its attachments previous to rupture of shell. X 500
11. Specimen of ovum in which the branches of the vitelline run backward nearly to the caudal extremity. X 450
11 a. Fragment of shell with spine attached found in the nucleus of a renal calculus. X 600
12. Copy of drawing (from Cousins) of shell with laterally placed spine.
13. Shred of tissue (from a case of Bilharzia, supposed by the patient to have been cured, of 16 years standing) showing embedded cora. X 100

Sheet III.

Fig. 14. Highly magnified view of mature ovum (dorsal aspect) showing cora clearly
clearly the various parts.

Sheet IV.

Fig 15, 16 and 17. Branch Nature ova X 750
Fig 15. Dorsal Aspect. Stalked masses uppermost.


17. Lateral Aspect (from left)
Alimentary canal coloured blue -
Stalked masses coloured yellow -
Contractile organs and water vascular system coloured dark red -
Globules seen lying between alic, opposite lateral apertures, space outside body full of pannels.

Note. All of the above have been drawn carefully so as to represent accurately the form of the ova and its parts; the colours being added for the sake of distinction.

Copies of Harvey's plates illustrating his original paper "On the Epidemic Haematuria of the Cape Horse" are inserted for comparison.
Key to the Plate

1. An egg of Bilharzia of man with polar spine: the embryo may be seen therein, already formed.
2. An egg with lateral spine of the Bilharzia of man a form which is frequently met with especially in the large intestine.
3. Egg of Bilharzia haematobia (a species found in the ox).
4. Its embryo B. Haematobia
5. A section of the rectal mucous membrane of man, crowded with eggs of B. Haematobia.
   a. An ordinary egg
   b. Section of follicle
   c. An egg with lateral spine
   d. An egg with lateral spine in transverse section at the level of the spine.
6. Intestinal mucous membrane
   e. An ox with eggs of B. Crassa.
Fig. 1. Fragments and lumps of mucus containing ova (a) from one specimen of worm. (b) from another.
2. A portion of 1. Fig. 1. x 50 diam.
3. Impregnated ova; a, c, as they appear in the paste urine, b after maceration in carbolic acid water or glycerine; d, Spherical mass, probably the scooped embryo mass. x 100
4. Embryo mass escaped from the longitudinally déhiscence egg case. x 100
5. Ovum embedded in mucus. x 10 x 5
6. Ovum in a more advanced stage
7. Ovum, common appearance, showing sphaerules of the embryo mass
8 & 9. Ova after maceration in water, oxidated with HCl. Fig. 8 shows longitudinal déhiscence of the egg case. Liberation of fatty sphaerules. x 2 granules

(Copied from drawings in B. Hanley's paper read before the Med. Club. Ser. 5 Jan 20th. 1861.)
Fig 10. Ciliated embryo.
Fig 11. Ciliated integument, probably belonging to an adult Bilharzia.
Fig 12. Elongated and wound form of ovum.
Fig 13. Another form of ovum with abrupt shine.
Fig 14. Compound sacculated tube probably the intestinal canal of the parasite.
Fig 15. Ciliated embryo escaping from the egg case.
Fig 16. Another form of ciliated embryo.

(Copied from drawings in Dr. Henley's paper read before the Med. Chir. Soc. Jan 26th 1864.)
Ova of Bilharzia Haematobia.

To show the relative position in the body of the various organs from different aspects. X780

Fig. 15.

Dorsal Aspect.

Fig. 16.

Ventral Aspect.

Fig. 17.

Lateral Aspect.