The Occurence of Terminal Spined Eggs, other than those of Schistosoma Haematobium, in Human Beings in Rhodesia

BY

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Increasing interest is being shown in the probability that schistosomes laying terminal spined eggs, other than *Schistosoma haematobium,* may occur in human beings much more often than has been thought the case in the past. The other schistosomes are generally parasites of animals, especially domestic stock, such as cattle, sheep and goats. Man, it seems, is only accidentally parasitised by them. Nevertheless, since in Africa stock-rearing as an occupation increases in scope and man and his domestic stock often have to share the same water supplies, the future impact of the stock parasites on human beings must not be ignored. As the eradication of tsetse fly from large tracts of Africa is accomplished, areas ripe for development for stock rearing will become available and human beings will be subjected to greater opportunities of being infected with terminal-spined egg-laying schistosomes other than *S. haematobium.* The presence of these other infections may also have important repercussions on bilharziasis control and eradiction programmes employing molluscicides.

Interest in schistosomes normally found in domestic stock, but which also occur in human beings, has been greatest in the countries in Africa where domestic stock rearing is an important part of the life of the rural population —Egypt, South Africa and Rhodesia.

Pitchford (1965) has done a great service in surveying the past work and thrown light on the problems of identification and classification. He stresses the difficulties in differentiating species on adult worm characteristics, as there are no very definite anatomical features which can be relied upon to separate species, particularly on male worms. Even the study of the female worms and of the intra-uterine eggs is not easy and morphological differences are indeterminate. Amberson and Schwartz (1953), in the course of a United States Navy Africa Expedition, attempted to classify the human and animal schistosomes of Africa and arrange them in their appropriate groups. In general there is agreement on the matter, but Pitchford does not agree with their suggestion that *S. capense* warranted sub-specific recognition as distinct from *S. haematobium.* Alves (1949) refers to short, stout eggs (*S. capense*) from Southern Africa in distinction to the longer eggs he received and measured from elsewhere in Africa. In Rhodesia, since the beginning of epidemiological surveys requiring egg counting of urine specimens, in which thousands of eggs are seen and counted, the polymorphism of mature *S. haematobium* eggs is most striking, not only as between eggs passed by persons living in the same locality, but even as between eggs in urine from an individual. From the other end of Africa, Girges (1934), in page 43 of his monograph, states: "The fully mature ovum is much irregular, even in the same patient, both in regards size and shape. Some are larger, others a good deal smaller; some are long and narrow, while others still have more the shape of a pear or even a boy's kite." What is needed to help settle the question as to whether *S. capense* is distinct from *S. haematobium,* even on a sub-specific status, is an extensive series of surveys throughout the length and breadth of Africa for measuring terminal spined eggs in order to see whether there are, in fact, any regional differences in the size and shape of eggs. Table I gives some representative *S. haematobium* egg measurements which have been recorded. This shows that on the *average, S. haematobium* egg lengths in Southern Africa are less than those recorded elsewhere in the continent, but many more observations would need to be made to determine whether this is of real significance.

The animal schistosomes which infect man in Southern Africa belong to the *S. bovis* group. *S. bovis* eggs have been reported from man but rarely, particularly when the evidence is re-examined in the light of more recent knowledge of the differences between *S. bovis* and *S. mattheei* eggs. Cawston (1921) described the eggs seen by him in the urine from a boy aged eight years at Durban. He found in this case typical *S. haematobium* eggs (120-157 x 60 microns wide), and eggs which he called *S. bovis?* (201-236 x 60-70). From the microphotographs reproduced these eggs are undoubtedly those of *S. mattheei.* Blackie (1932), on the other hand, described *S. mattheei* infections in man, but in his micro-photograph he depicted an egg of typical *S. bovis* shape labelled as an egg of *S. mattheei* on Plate II of his monograph. The confusion is increased by MacHattie, Mills and Chadwick (1933), who say that the egg reproduced in Blackie's paper is a *S. bovis* egg. In order to demonstrate the variety of forms of *S. haematobium* eggs to be seen in Iraq, they show two micro-photographs Fellow of the London School of Hygiene and of eggs which look uncommonly like those of *S. mattheei.* It is difficult to be certain on this,

Table I

LENGTH AND BREADTH MEASUREMENTS OF S. HAEMATOBIUM EGGS IN URINE

Locality and Authors	Number of Eggs Measured	Average Length in Microns and Range	Average Breadth in Microns and Range
South Africa:			
Cawston (1921)	Not known	(120-157)	60
Porter (1938)	1,000 eggs from 10 patients	125 (80-166)	47 (30-67)
Pitchford (1953)	About 55 patients	127 (88-178)	51 (34-67)
East Africa:			
Dowdeswell (1938)	Not known	139 (114-164)	59 (53-68)
Sierra Leone:			
Gordon, Davey and Peaston (1934)	Not known	143 (125-159)	60 (52-73)
Egypt:			
Girges (1934)	1,000 eggs from 100 patients	146 (83-181)	58 (50-83)

however, as the micro-photographs give no scale on which the length of the eggs can be assessed. Although *S. intercalatum* does not occur in Rhodesia, but only in a limited zone near Stanleyville in the Congo (Leopoldville), it seems definite that *S. intercalatum* and *S. mattheei* are indistinguishable other than the first-named has never been reported in man except as an intestinal parasite, while *S. mattheei* eggs are found in either urine or stool.

Eggs of the *S. bovis* group are easily distinguished from those of *S. haematobium* on their length alone. The eggs of worms of this group are 200 microns and over in length and 40 to 70 microns in breadth. Table I shows that even the longest eggs of *S. haematobium* do not come near the range of the *S. bovis* group, so there is no overlap in egg size. Eggs of worms of the *S. bovis* group cannot easily be distinguished on length and breadth of the egg alone, and Alves (1949) suggested the employment of a third measurement of the egg at 50 microns from the non-spiked (anterior) end of the egg. Table II reproduces Alves's measurements of the eggs of the three species. This demonstrated that on length measurement alone, *S. haematobium* eggs should never be confused with those of *S. bovis* or *S. mattheei*. It also demonstrates clearly the difference between *S. mattheei* with no "pinching off" at the anterior end of the egg as compared with the spindling of *S. bovis* eggs.

S. mattheei (Veglia and le Roux, 1929) was first described in South Africa as a parasite of sheep in which the eggs were passed through the gut wall into the faeces. MacHattie and Chadwick (1932) strongly contested the validity of this species and maintained that the worms were *S. bovis* producing "abnormal" eggs. Blackie (1932), working in Rhodesia as a Research Tropical Medicine, found *S. mattheei* in 19/167 sheep and 8/26 cattle slaughtered in the Salisbury area. He went on to describe finding *S. mattheei* in man in two cases in which the adult worms were recovered at autopsy and in eight cases on the morphology of the eggs observed in urine. All cases were African males who also had infections with *S. haematobium*. In one case the eggs were found on only a single occasion, in the stool, and he was led to dismiss this finding as an accidental contaminant, as the patient was said to have eaten a piece of raw ox intestine previously. He noted in all cases that there were many more *S. haematobium* eggs than those of *S. mattheei*. He gives the dimensions of the eggs of *S. mattheei* as seen in human urine as (210-240 x 40-70) microns. Porter (1938) supported the view that *S. mattheei* was merely a Southern African strain of *S. bovis*. Pitchford (1965) has drawn attention to the shouldering of *S. mattheei* eggs just anterior to the spiked (posterior) end of the egg.

The points of difference of the three species of terminal-spined schistosome eggs seen in human beings can be summarised.

(a) *S. haematobium*: eggs about 150 microns long and 50 microns in maximum width, length/breadth ratio 3: 1. The egg envelope is rounded in shape with no "pinching in" towards either pole. The micracidium in the mature egg fills the egg shell or envelope snugly.

(b) *S. bovis*: eggs 200 or more microns long and 50 microns in breadth, length/breadth ratio 4: 1. Marked hipolar spindling of the egg shell and no marked "shouldering" at the spiked end. In relationship to the size of the shell the mature miracidium appears small and does not swell into or fill the spindled ends. This results in large clear bipolar areas.

(c) *S. mattheei*: overall length and breadth measurements similar to *S. bovis*. Alves's third measurement (50 microns from the non-spiked

Table II

MEASUREMENT OF MATURE SCHISTOSOME EGGS IN MICRONS, LENGTH, MAXIMUM BREADTH AND BREADTH MEASURED AT 50 MICRONS FROM THE NON-SPIKED END OF THE EGG, IN THAT ORDER (FROM ALVES, 1949)

Species	Longest Egg	Shortest Egg	Average Measurements
S. haematobium	170 x 75 x 65	115 x 35 x 54	142 x 59 x 54
S. mattheei	272 x 76 x 56	180 x 68 x 50	200 x 64 x 50
S. bovis	232 x 71 x 43	179 x 49 x 27	208 x 55 x 31

(anterior) end of the egg) shows clearly that the marked bipolar spindling of *S. bovis* is not present and this measurement generally varies little from the maximum breadth measurement. There may, however, be a slight degree of "pinching in" of the egg shell contour at this end. The spindling of *S. mattheei* at the spiked end of the egg is characterised by a "shouldering" just anterior to the spike. The miracidium does not fill the egg envelope as snugly as *S. haematobium,* but does so at the spiked end fairly closely. The egg is characterised by a large clear space between the miracidium and the shell at the non-spiked end.

It is perhaps appropriate at this point to recall that Alves (1948) stated that both *S. bovis* and *S. mattheei* were capable of infecting man in Rhodesia, but that many eggs may be seen which occupy an intermediate position between "typical" *S. haematobium* and "typical" *S. mattheei.* This statement was presumably made before he had introduced the third measurement. He at the same time postulated an interesting hypothesis that the intermediate forms seen might be the products of cross-breeding between male worms of *S. haematobium* and female *S. mattheei.* He seems to have been inferring that *S. mattheei* cercariae entering and developing in a human being might, in the absence or ready availability of male worms of the same species, be carried by *S. haematobium* males to the egg deposition site. Schistosome male worm material is notoriously difficult to classify and studies so far have not progressed to a stage that there are well-marked characteristics in male worms good enough for species differentiation.

S. BOVIS IN HUMAN BEINGS IN RHODESIA

There is little doubt that the egg illustrated by Blackie (1932) on Plate II, Figure 10, of his monograph has the appearance of an egg of *S. bovis.* Kissner, Stoffberg and de Meillon (1953) described a urinary infection in a European boy of 13 years who also had a *S. haematobium* infection. They pointed out that the egg output was low and *S. bovis* was found in only five out of 10 specimens examined. In one specimen only one *S. bovis* egg was seen. These indications of *S. bovis* being present in man in Southern Africa are supported by the finding of *S. bovis* type eggs in the urine of an African child in Rhodesia.

Paul Marume, aged four years, had spent his life in the Inyanga Tribal Trust Area, about eight miles north-west of Inyanga village, in the Eastern Districts of Rhodesia. He left home for the first time in March, 1965, to visit his father in Salisbury. Complaining of abdominal pain, poor appetite, frequency of micturition and dysuria, stool and urine specimens were examined. He was found to be passing about 12,000 *S. haematobium* eggs per hour in the urine, and a number of *S. bovis*-like eggs were also present. Examination of the stool showed eggs of *S. mansoni* and *S. haematobium.* The little lad then became the subject of a drug trial with a newly-developed schistosomocidal agent. After treatment his stool and urine were examined on 25 separate days over the next ten weeks, sometimes two specimens of urine being examined in a day. Five days after completion of treatment the last *S. haematobium* and *S. mansoni* eggs were observed in the stool. Despite repeated and careful searches of the whole of the centrifuged deposit of stool on many occasions, no eggs of the *S. bovis* type were ever seen. It is interesting to record that in a specimen of urine six weeks after treatment, blackened dead *S. mansoni* eggs were found in a urine specimen. The number of *S. haematobium* eggs seen in the urine fell from over 10,000 an hour prior to treatment to about 1,000 an hour, and hatching of miracidia ceased 15 days after treatment. Eventually the output fell to about 300 eggs per hour, all black and dead. Before treatment the number of *S. bovis*-like eggs observed was small, never more than six to ten in a drop of urine deposit in which 1,000 to 1,200 *S. haematobium* eggs were being counted. These *S. bovis* eggs continued to be observed for about 10 days after treatment; none was seen until a month later, and finally a single blackened egg was seen in the last specimen of urine examined. It is hoped to pay an early visit to the area where Paul lives and contracted the infection to establish by a stool and urine survey whether *S. bovis* infections in man are a frequent occurrence in the area. Fig. 1 illustrates a *S. bovis*-type egg in Paul's urine prior to the beginning of the treatment.

S. MATTHEEI IN HUMAN BEINGS IN RHODESIA

Blair (1965) has examined the portals of exit from the human body of *S. haematobium* and *S. mansoni* eggs from 7,007 subjects examined in epidemiological surveys in 1964-65. During the course of this study a small number of persons were found to be shedding eggs of *S. mattheei* in either the stool or urine. It should be stressed that the surveys required that egg counts on an hour's output of urine be done and the technique used required that 1/10 of the eggs in the centrifuged deposit of urine be examined and counted. This, of course, meant

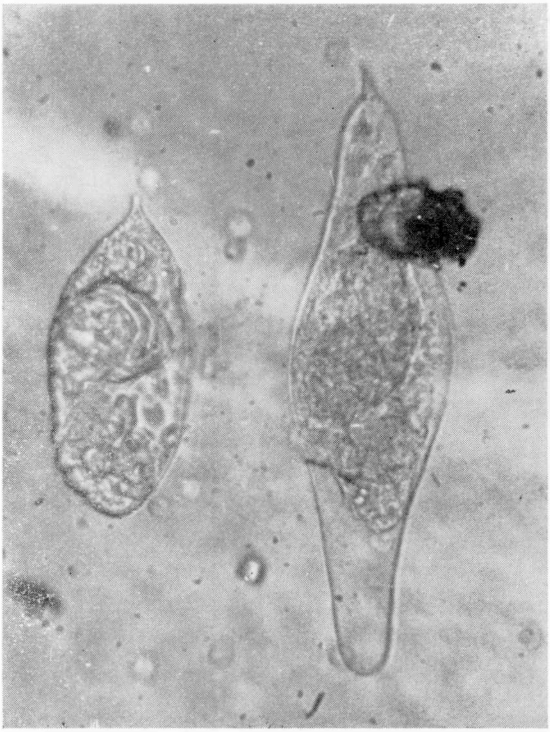

Fig. 1—Eggs of *S. bovis* and *S. haematobium* in urine.

that the examiners studied very many more eggs than would be seen by routine laboratories, which are generally only interested in establishing the presence or absence of eggs, and would on the probabilities be much less likely to observe and recognise *S. mattheei* eggs when large numbers of *S. haematobium* eggs are present in the preparation.

The table shows that 43 persons, 0.6 per cent. of all the subjects examined in the series of epidemiological surveys, were passing eggs of *S. mattheei* in urine or stool, including one case passing these eggs by both routes. In 32 instances the passage of *S. mattheei* eggs in urine or stool was associated with the presence of *S. haematobium* eggs in the urine. Nevertheless, 11 persons were passing only *S. mattheei* eggs: one in the urine, nine in the stool and one passing the eggs in both stool and urine, who had no *S. haematobium* eggs in stool or urine, which is one-quarter of the total cases observed. In view of the observations of Pitchford (1953), it is interesting to record that eight of the 11 persons passing *S. mattheei* eggs, unaccompanied by *S. haematobium* eggs, were passing *S. mansoni* eggs in the stool. This leaves only three cases who were passing *S. mattheei* eggs in the absence of *S. haematobium* or *S. mansoni* eggs. The three cases of pure *S. mattheei* infections were a female aged 17 years with a stool infection and males aged nine and over 40 years with eggs in the urine.

In the course of the surveys a further three urinary infections of *S. mattheei* in association with *S. haematobium* were seen in individuals who did not furnish stool specimens for examination.

More recently it was possible to survey over 1,800 European schoolboys aged 13 to 18 years attending high schools in the Salisbury area. Seven boys were found to be passing *S. mattheei* eggs, four in the stool and not associated with the eggs of any other schistosome in stool and urine, one in stool associated with *S. haematobium* eggs in the urine, one in the urine associated with *S. haematobium* and the last case with *S. mattheei* eggs in association with *S. haematobium* in the urine and *S. mansoni* eggs in the stool. Considering that in all only 163 boys were found to be infected with *S. haematobium*, *S. mansoni* or both, the number found to be passing *S. mattheei* eggs is surprisingly high. In the European survey *S. mattheei* eggs were found in seven out of 163 boys suffering from bilharziasis, 4.3 per cent., while in the African surveys there were 43 in 3,557 positive cases—1.2 per cent.

CONCLUSIONS

(1) A case of what is believed to be *S. bovis* infection in man in Rhodesia is described. Blackie (1932) undoubtedly saw and photographed an egg which appeared to be of this species of worm, although he named the egg as being that of *S. mattheei.*

(2) *S. mattheei* in man occurs in over 1 per cent. of persons infected with bilharziasis in Rhodesia, and the eggs are passed out in stool and urine with equal frequency.

(3) It is maintained that the eggs of *S. haematobium*, *S. mattheei* and *S. bovis* can be recognised on morphological signs: egg length, breadth, shape and relationship of the mature miracidium to the egg envelope.

(4) In view of the difficulties in separating adult schistosome material found in man or bred up in experimental animals from eggs from man, much more interest and attention should be given to further studies in the field, which could include species separation by the more sophisticated techniques such as immuno-diffusion.

(5) The stated differences in egg length of eggs of *S. haematobium* from Southern Africa

Table III

AGE AND SEX DISTRIBUTION OF S. MATTHEEI INFECTIONS BY PORTALS OF EXIT AND RELATIONSHIP WITH OTHER SCISTOSOME INFECTIONS

Age Group in Years	Sex			*S. mattheei* Infections									
				In Urine Associated with				In Stool Associated with				In both with	Total
	Male	Female	Total	No Sh.	Sh. in Urine	Sh. in Stool	Sh. in Urine and Stool	No Sh.	Sh. in Urine	Sh. in Stool	Sh. in Urine and Stool	No Sh.	
0- 3	—	—	—	—	—	—	—	—	—	—	—	—	—
4- 6	2	5	7	—	1	—	1	1	3	—	—	1	7
7- 9	6	3	9	1	6	—	—	—	1	1	—	—	9
10-12	2	6	8	—	4	—	1	2	1	—	—	—	8
13-15	4	1	5	—	2	—	1	—	—	—	2	—	5
16-20	2	4	6	—	1	—	2	1	2	—	—	—	6
21-40	3	4	7	—	2	—	—	4	1	—	—	—	7
41 and over	1	—	1	—	—	—	—	1	—	—	—	—	1
TOTAL	20	23	43	1	16	0	5	9	8	1	2	1	43

Sh. = *S. haematobium*.

as compared with the longer forms seen in Egypt and West and East Africa merit further regional studies of *S. haematobium* egg measurements, using standard conditions for collection, processing and measurements of eggs.

(6) It is suggested that as tsetse fly control and eradication schemes in Africa progress, the importance of animal schistosomes parasitising man will increase and become a matter for consideration in bilharziasis control programmes.

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After Note

Since the paper was submitted for publication a further case of apparent *Schistosoma bovis* infection has been discovered. An African girl, aged about 14 years, living at Norton, 22 miles south-west of Salisbury, was found to be passing *S. bovis*-like eggs in the urine and no other schistosome eggs have been found in either stool or urine. The infection is scanty and the most eggs found in a preparation has been six, and eggs have been found in only four out of six specimens obtained on different days. Unfortunately, despite all attempts, none of the eggs could be persuaded to hatch, otherwise the case would have provided a very good opportunity to take these eggs through a cycle of snails to experimental animals and recover adult worms for examination, free from schistosome worms of other species.