SCHISTOSOMIASIS MANSONI IN SWAZILAND

SURVEY BY RECTAL BIOPSY

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In 1952 a snail survey of the waterways of Swaziland showed that *Physopsis africana and Biomphalaria pfeifferi*, vectors respectively of *Schistosoma haematobium and S. mansoni*, were both present in all areas except the mountainous High-veld.

The marked incidence of haematuria combined with the passage of schistosoma eggs in patients at the several hospitals and clinics showed that the disease was widespread, but no precise figure was available, nor was anything known of the prevalence of the intestinal form.

In 1952 a report of the examination of the urine of schoolchildren showed that 34% were affected with bilharziasis, but no specific mention was made of the particular schistosoma involved. In 1954 a further study of the urine was made by the author; comparative figures are given in Table I. The finding of *S. mansoni* eggs, even in so small a number, confirmed the suspicion of the presence of that variety, but their very paucity pointed to the need for a more reliable method of search; to obtain figures upon which to base a judgment,

TABLE I. OVA OF SCHISTOSOMATA IN URINE

Year	*Number Examined*	*Positive S. haem.*	%	*Positive S. mansoni*	%
1952 ..	2,428	827	34	—	—
1954 ..	2,149	885	42	2	0·1

further study was deemed essential. Faecal specimens were therefore obtained from the first 40 of the last group of children, and examined by the acetic-acid-ether method; not one egg was found, though 26 passed eggs of *S. haematobium* in the urine. Lack of time, proper equipment and personnel prevented further examination of stools that year.

As all these children attended schools within 10 miles of the laboratory at Bremersdorp, over passable dirt roads, it was found possible to drive to each school, collect as many as a hundred bottles of urine, and carry them back to examine the deposit after centrifugation. To have examined in like manner specimens from all over the Territory, some schools lying over 100 miles away over indifferent dirt tracks, would manifestly have been impossible, there being no facilities for an over-night stop on the road. Thus a need for a change in the *modus operandi* became even more evident.

METHOD, MATERIALS AND TECHNIQUE

Following a modification of the methods of Hernandez and Morales (1946) and of Ottolina (1947), as demonstrated to the author by Dr. J. Schneider (1954*a*) at the Coronation Hospital, Johannesburg, specimens of mucous membrane were taken from the distal aspect of the last rectal valve, about 5 cm. above the anal sphincter, at about '12 o'clock', the 'snip' being 4 mm. in diameter. Beginning with home-made apparatus, by courtesy of the Superintendents of the local mission hospitals, a start was made in the wards, and then in the out-patient departments, changing over to instruments of commercial manufacture as soon as these became available. Examination in the hospital, even with the willing cooperation of the nursing staff, often took up a great deal of time. With experience, a technique was evolved which eventually permitted over 40 schoolchildren to be dealt with in 1 hour, once reaching a maximum of 100 in less than 2½ hours.

The choice of schoolchildren as subjects for this investigation was made because (1) sufficient numbers are assembled at a fixed spot; (2) the children are a part of the fixed population living near by; (3) adequate supervision is available; (4) schools are usually accessible by road; (5) a school building makes a suitable examination-room; (6) no child demurred when told by the teacher to submit to examination.

At other sites of assembly, such as markets, smallpox vaccination stations, etc., none came forward voluntarily, though harangued by a number of Swazi helpers.

The necessary equipment was carried in the back of the car, securely packed in a wooden box, 45×30×30 cm. The contents were:

(*a*) Protoscopes, child's, 2; (*b*) Forceps, biopsy, Berger's, 2; (*c*) Headlamp, focusing, 1; (*d*) Lubricant, instrument, pots, 1; (*e*) Dettol, bottle, 250 c.c., 1; (*f*) Soap, tablet, in box, 1; (*g*) Towels, hand, Turkish, 2; (*h*) Toilet-paper, soft, rolls, 2; (*i*) Wire, copper, 3 mm.× 25 cm., 1; (*j*) Stick, round, wood, 1×30 cm., 1; (*k*) Tubes, Wassermann-test, 100; (*l*) Boxes, 50 ampul NAB size, 2; (*m*) Trays, aluminium, refrigerator ice-cube type, 28×12×4 cm., 2. A microscope, with mounted specimens of rectal snips showing the eggs of *S. haematobium* and *S. mansoni* was also carried in the car for purposes of demonstration.

A school often having to be visited without previous warning (owing to the difficulties of communication), the principal was first interviewed and the purpose of the visit explained; this usually included a demonstration of a microscope-slide to the teacher(s) and also to the pupils to stimulate their interest. A class-room or separate hut having been chosen, it was furnished with a table, and chairs or boxes to serve as instrument-tables or steps. A numbered list was compiled by a teacher, giving for each child the sex, age-group, name and home and the river (stream) whence came the family water-supply or in which the child played. The instruments were laid out, a protoscope and biopsy forceps to each tray, immersed in a 10% solution of Dettol; the pot of instrument-lubricant was also placed conveniently at hand on one of the 'tables'.

As each child was summoned according to the prepared list, the previously-trained assistant gave instructions in the vernacular to remove the nether garment, to climb onto the table, to kneel down on it with the knees apart, to place the hands, palms down, flat on the table, one on top of the other, and to turn the head and rest the left ear on the back of the hand; strict adherence to this detailed procedure was found essential to ensure proper positioning for examination, irrespective of the sex, age or size of the examinee.

Swazi children having been long accustomed to have the tip of a cow's horn pushed into the rectum to be given an enema, no complaint was made at the insertion of a lubricated proctoscope. After rotation of the instrument, the assistant held the handle upright in the posterior natal cleft, retaining the barrel in position when the obturator was withdrawn. Often the rectum was full of faeces; to obtain a clear view of the mucosa, a piece of toilet-paper which had been loosely rolled into a ball and held ready in the hand by the assistant was pushed through the barrel of the proctoscope with the 'stick' and on into the rectum, carrying with it the stercus and exposing the mucosa. With the biopsy forceps a portion of the membrane was speedily snipped off, causing no pain and very little bleeding. The 'snip' was transferred at once by means of the copper wire to a correspondigly numbered Wassermann tube, which was corked and replaced in its compartment in the box; where some time might elapse before examination a drop of water was placed in the bottom of the tube to prevent desiccation of the specimen, which adhered to the side. Although a few cases were examined on the spot, it was found to be more convenient to carry the tubes back to the laboratory for study that same evening or the next morning, before putrefaction.

MICROSCOPY

For microscopic examination, 10 glass slides were laid in a row on the table, and each numbered with a grease-pencil to correspond with the specimen tubes. No. 1 tube having been uncorked, the contained snip was extracted with the copper wire (the distal tip having been hammered into spatulate form) and deposited in the middle of slide No. 1. A cover-glass, 1/100 inch

thick, was put on top of the snip, and on that another glass slide; turned on edge, the two slides were pressed together with the fingers, care being taken not to displace the specimen while squeezing it out flat. A wooden spring-type clothes-peg clipped on held the slides in apposition when laid to one side. This process was repeated for each snip until the 10 had been similarly mounted, by which time the first was ready for examination.

It was not found possible to obtain the necessary degree of magnification through the thickness of the super-imposed slide, hence the use of the cover-slip; after removal of the clothes-peg, the top slide came away, leaving only a thin yet sufficiently robust flake of transparent material between specimen and objective. Study under the low-power showed the absence or presence of an egg, but the detail of any contained miracidium was often too obscured by detritus to warrant a conclusion; the high-power permitted the viability of the egg to be assessed by observation of the degree of anatomical perfection of the contained

Fig. 1. Eggs of *Schistosoma haematobium* in a rectal snip. Viewed by transmitted light, the calcified eggs show black. Other eggs show varying degrees of degeneration, absorption of the spine, deformity, vacuolation, etc.

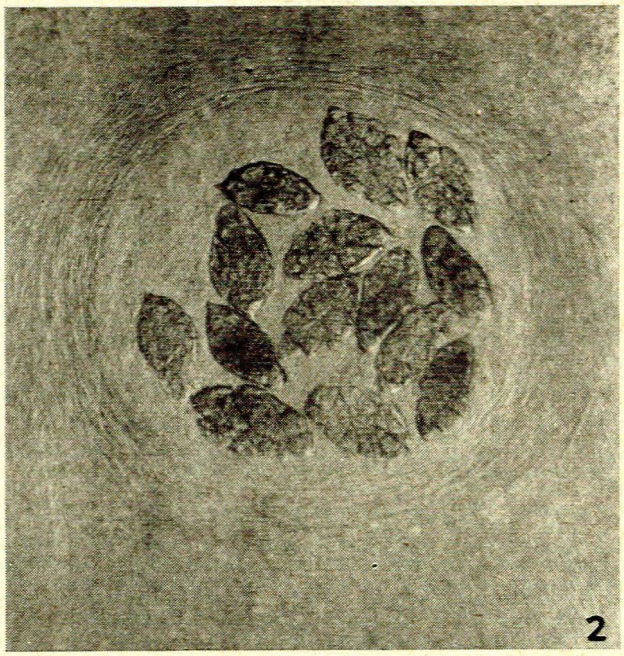

Fig. 2. A 'pseudo-tubercle' in a rectal snip, showing a nest of eggs of *Schistosoma haematobium* enclosed in a ring of fibrous tissue. The egg-shells are all cracked, probably by pressure when the preparation was mounted.

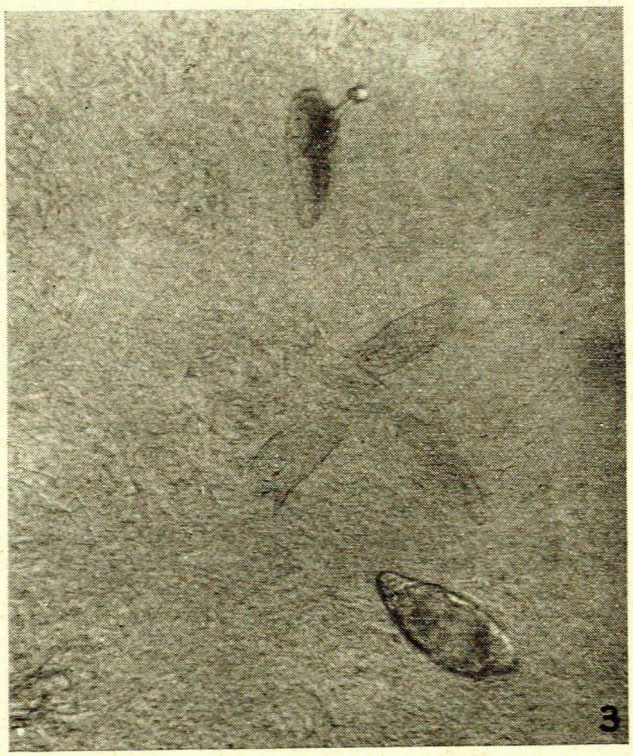

Fig. 3. Eggs of *Schistosoma mansoni* in a rectal snip; none is viable. That at 5 o'clock shows deformity of the shell and some calcification of the contained miracidium; those in the centre of the field are empty shells; that at 12 o'clock shows typical 'cystic' degeneration of the spine, deformity of the shell, and calcification of the miracidium.

miracidium and the motility of the flame-cells. No 'colour' was seen by transmitted light (the type customarily in use) though the dead calcified eggs appeared black; by incident light however, they changed to chalky-white. No 'washing' having taken place of the snip, this may account for the non-visibility of any 'colour', and the failure of any miracidium to emerge no matter how long the preparation may have been left undisturbed on the microscope stage (Ahmed Badran *et al.*, 1955). When called for, the cover-slip made possible also the use of the oil-immersion objective.

Of *S. haematobium*, all the ova seen in the snips were adjudged non-viable, this conclusion being based upon one or more of the following observations (Fig. 1):

1. Egg-shell empty, either from non-development, or after hatching.
2. Degeneration of the shell, showing either malformation, or blunting or absorption of the spine.
3. Vacuolation or fragmentation of the egg-content.
4. Calcification.

Of *S. mansoni*, though many ova were in little better state than were those of *S. haematobium* (Fig. 3), it was not unusual to find at least one egg that might be considered viable.

In one specimen, obtained before a micrometer became available, the eggs appeared very much larger than is usual in *S. haematobium*, especially in the long diameter, and with a terminal spine; a tentative diagnosis of *S. bovis* was advanced, but in a second snip taken 2 months later from the same schoolboy none but normal-sized eggs of *S. haematobium* were found. A further examination is planned at a later date.

The assessment of age in Table II is necessarily very rough; with rural people, age can rarely be determined with any degree of certainty. Therefore it was decided to use 3 age-groups only, the particular group to be at the discretion of the teacher. It may be noted that the percentage of persons with eggs of *S. haematobium* in the rectal mucosa appears to increase with the years in both sexes, which also seems to be true for *S. mansoni*, though the numbers are too small to be dogmatic about. Perhaps this follows from the increased duration of exposure to infection.

How long it takes for an 'ectopic' egg to be absorbed completely from the rectum (if ever it is) is unknown. Even in their presumably designated area, the urinary tract, some eggs of *S. haematobium* become degenerate and calcify, but nothing is known of the proportion that survive, nor for how long, nor why. Nor is definite evidence yet forthcoming on the effect of these 'foreign bodies' in the rectum, such as the fibrosis and dilatation that occurs in an infested ureter. In the 'nests' of eggs (the so-called 'pseudo-tubercles') often seen in the snips of rectal mucosa, whorls of fibrous tissue are to be seen formed around the periphery of the structure (Fig. 2).

DISCUSSION

One disadvantage of the 'snip' is that the presence of an egg is not evidence of infectivity, only that an infection has been contracted at some time in the past. With active egg-passers all around, it is utterly impossible to deduce from the rectal snip alone how long ago the last infection was contracted, especially in the absence of water-borne sanitation, when re-infection is an ever-present danger. That the eggs may be retained in the rectum for a considerable period, perhaps without overt illness, may be reasonably inferred from the figures shown in Table III. This was compiled from those pupils whom it was found practicable to examine by both urine specimen and rectal snip, i.e. a small number of the seniors, the so-called 'Adults'.

TABLE III. CONCURRENT EXAMINATION OF URINE AND RECTAL SNIP

Sex	*No. Examined*	*S. hm Eggs in Urine*	%	*S. hm Eggs in Rectal Snip*	%
M ..	61	4	7	32	52
F ..	53	3	6	26	49
Total ..	114	7	6	58	51

TABLE II. VARIATION OF INFECTION WITH SEX AND AGE

Sex	*Age*	*No. Exmd.*	*No. Infec.*	%	*Only S. hm.*	%	*Only S. mn.*	%	*Both S. h & m*	%	*Total S. hm.*	%	*Total S. mn.*	%
M	C	209	65	31	50	24	7	3	8	4	58	28	15	8
	Y	310	121	39	102	33	7	2	12	4	114	37	19	6
	A	147	65	44	51	35	5	3	9	6	60	41	14	10
F	C	286	88	31	79	28	2	1	7	2	86	30	9	3
	Y	177	61	34	46	26	4	2	11	6	57	32	15	8
	A	127	57	45	41	33	9	7	7	6	48	39	16	13
Total		1,256	457	36	369	29	34	3	54	4	423	33	88	7

C=child, 12 years or less. Y=youth, 17 years or less. A=adult, 18 years or more. S. hm=*Schistosoma haematobium*. S. mn=*S. mansoni*. S. h & m=*S. haematobium and S. mansoni*.

The average ratio of infections by *S. mansoni* to those of *S. haematobium* is in all ages about 1 to 5 (as shown in Table II), though this rises to 1 to 4 in older boys, and 1 to 3 in older girls. No reason for this difference in the degree of infestation by the two varieties of schistosoma has yet been established. In Swazi waters there are many Biomphalaria, more than enough to act as vector for *S. mansoni*, but for this variety of

blood-fluke the figure is consistently low, except in the extreme north of the Territory, in the valleys of the Lomati and nKomati rivers. Bush sanitation is the rule, and young children of both sexes often befoul the banks of streams whence domestic supplies are drawn, or where personal or other washing is done. Lavage is rare, there being no religion demanding this practice.

Geographical Factors. The incidence of *S. haematobium* and of *S. mansoni* in the schoolchildren examined at the 18 different centres in Swaziland is shown in Table IV and on the map in Fig. 4.

TABLE IV. RESULTS OF RECTAL BIOPSY AT 18 CENTRES IN SWAZILAND

Place	*Situation*	*Number Examined*	*Positive* S. haem.		S. mansoni	
			No.	%	*No.*	%
Maqudulweni	Highveld	30	1	3	0	0
Gollel ..	Lowveld 1	65	2	3	0	0
Nkambeni	Lowveld 3	71	5	7	1	1
St. Phillip's..	Lowveld 1	53	5	9	0	0
Dwaleni ..	Midveld	30	4	13	0	0
Hlatikulu ..	Highveld	79	11	14	0	0
Mhlotsheni	Midveld	36	5	14	0	0
Mbabane ..	Highveld	49	7	14	0	0
Mahamba ..	Midveld	57	13	23	0	0
Lubuli ..	Lowveld 1	21	5	24	0	0
Nomahasha	Lowveld 3	94	32	34	2	2
Eranchi ..	Lowveld 3	37	15	41	17	46
Mantembo	Lowveld 1	12	5	42	0	0
Big Bend ..	Lowveld 2	18	8	44	4	22
Bremersdorp	Midveld	280	139	49	7	2
Shongwe ..	Lowveld 3	51	30	59	25	50
Ndlalambi	Lowveld 3	23	15	65	6	26
Edwaleni ..	Midveld	60	42	70	0	0

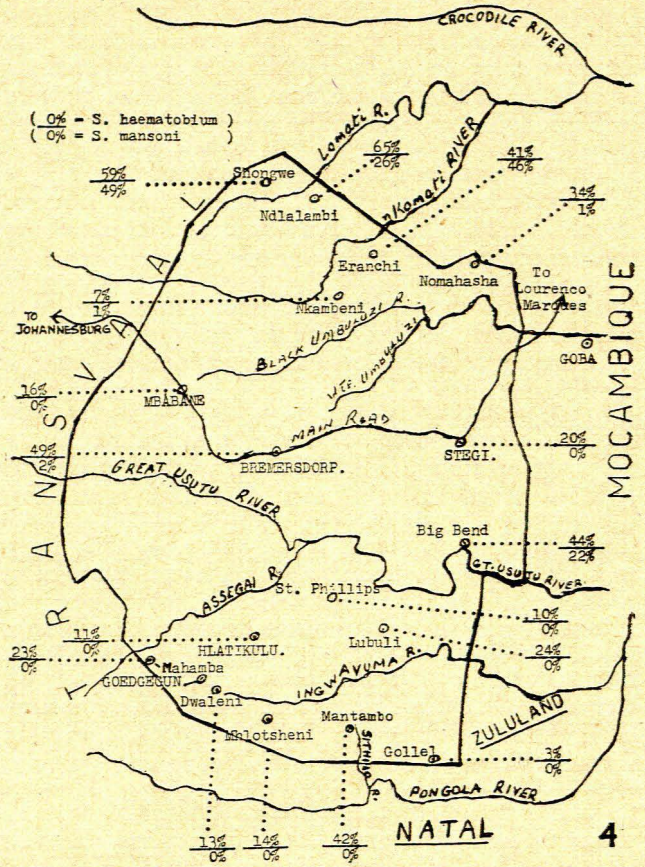

Fig. 4. Schistosomiasis in Swaziland. Percentage incidence in school children as shown by rectal biopsy (1955).

Altitude is a factor that must be considered in assessing the prevalence of infection. For this purpose, Swaziland may be divided into 3 regions by lines running roughly from north to south, thus: (*a*) High-veld, in the west above 4,000 feet, (*b*) Mid-veld, in the middle portion, around 2,000 feet, (*c*) Low-veld, in the east, 1,000 feet or less above sea-level.

Referring to Table V, although in the High-veld the percentage infection with S. haematobium is still notable, it is very questionable how much could have been acquired in that region. Owing to the scattered population in the mountanous terrain, the swiftness of the streams, which are frequently scoured by storms, and the possible absence of snail-vectors, sought in vain during several snail surveys, the probability of infection is considered low. It is thought more likely that many of the children attending the large schools situated in this more temperate region come from, or have visited relatives in, the other regions of the Territory, particularly during the holidays; swimming or playing in the streams forming a large part of their recreation, an infection may well have been acquired there.

In the Mid-veld, the percentage of *S. haematobium* is higher than elsewhere, as there are many watercourses with plentiful vegetation, numerous snail-vectors, a multitude of small African farms, and labourers and their families on the many European farms. Yet the figure for *S. mansoni*, though higher than the zero of the High-veld, is so low that it gives food for thought; this is discussed below.

In the Low-veld, while the percentage of *S. haemotobium* appears to have fallen slightly, the over-all infection rate of *S. mansoni* is very much (6 times) higher than in the Mid-veld; not only this, but there appears to be a great difference in the rate according to the section of the Low-veld, South, Central, or North. This is shown in Table VI, and in the sketch-map of Swaziland (Fig. 4).

For convenience of description, arbitrary division

TABLE V. ALTITUDE AFFECTING PREVALENCE

Veld	*No. Exmd.*	*No. Infec.*	%	*Only S. hm.*	%	*Only S. mn.*	%	*Both S. h&m*	%	*Total S. hm.*	%	*Total S. mn.*	%
High	116	17	15	17	15	0	0	0	0	17	15	0	0
Mid	537	215	40	206	38	2	4	7	1·3	213	40	9	2
Low	603	225	39	146	29	32	5	47	8	193	32	79	13

TABLE VI. VARIATION OF PREVALENCE OF SECTIONS OF THE LOWVELD

Section	No. Exmd.	No. Infec.	%	Only S. hm.	%	Only S. mn.	%	Both S. h&m	%	Total S. hm.	%	Total S. mn.	%
South	140	14	10	14	10	0	0	0	0	14	10	0	0
Central	102	29	29	25	25	3	3	1	1	26	26	4	4
North	361	182	50	107	30	29	8	46	13	153	42	75	21

of the Low-veld is made into 3 sections by lines running east and west:

1. South, from the southern border north to the Great Usutu River.
2. Central, from this river to the Bremersdorp-Stegi main road.
3. North, from this road to the Northern border.

The elimination of animal trypanosomiasis, and the more recent virtual eradication of malaria, have made the settlement of the Low-veld a practical possibility. Beginning in those parts adjacent to lands already farmed by Europeans in the Crocodile and nKomati river valleys in neighbouring territories, with the advent of suitable motor transport better roads have been cut, and the whole Low-veld is being opened up, bringing in workers, and at the same time the carriers of schistosomiasis.

In the South, the low percentage of *S. haematobium*, and the complete absence of *S. mansoni*, may perhaps be ascribed to the paucity of perennial streams and to the drying up of the majority of the other watercourses in the winter, with consequent death of the vector molluscs and their eggs.

In the Central section, the recent advent of large irrigation projects in the Big Bend area may be bringing infected workers and their families from elsewhere. That the vectors of both varieties have already moved in was verified by a pilot snail-survey by the author and the Swaziland health inspector in October 1955, when numbers of these molluscs were gathered with every dip of the scoop into the vegetation already lining the banks of the irrigation canal.

In the Northern section, to account for the doubling of the rate of *S. haematobium* and the quintuple increase of *S. mansoni* over the neighbouring section, note must be taken of the greater density of population, the large irrigation scheme at Eranchi, the presence of perennial streams, the valleys of the Lomati and nKomati Rivers, the proximity of the valley of the Crocodile River, which is known already to be heavily infected (Schneider, 1954), and the free movement of the people across the border in both directions.

The increase in the percentage of *S. haematobium* infection *pari passu* with the water-supply is easily understood, but the disparity between the rates of the two varieties of schistosome in the several sections despite the presence of the vectors of both cannot as yet be comprehended.

Whether the given factors are the only ones concerned in the described difference of *S. mansoni* rates in the Territory is not at all certain; further investigation is considered necessary.

SUMMARY

1. For the assessment of the need for remedial measures, precise figures were sought of the incidence of schistosomiasis in Swaziland.
2. Urine specimens in Bremersdorp (2,149) showed *S. haematobium* in 42%.
3. Urine or stool examination of the whole Territory was found impracticable.
4. Rectal biopsy was selected as the best method available.
5. The technique of taking and examining the rectal snip is described.
6. The results of the 1,256 snips are tabulated.
7. The results are discussed in the light of tables and a sketch-map of Swaziland.
8. Further investigation is considered necessary to determine the reason for the anomalous distribution of *S. mansoni*.

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REFERENCES

Ahmed Badran *et al.* (1955): J. Trop. Med. Hyg., **6**, 1068.
Hernandez, F. and Morales, J. F. (1946): Amer. J. Trop. Med., **26**, 811.
Ottolina, C. (1947): *Ibid.*, **27**, 607.
Schneider, J. (1954a): Personal communication.
Idem. (1954b): J. Trop. Med. Hyg., **5**, 112.