to the under eyelids and the tissues below them, and varied greatly from day to day, presenting the striking peculiarity that at periods it was to be noticed only on one side of the face, a fact not noticed by previous observers. This I thought due to local conditions, possibly to a greater accumulation of the parasite in the capillaries of the part acting either chemically or mechanically for the time being.

The attack of pneumonia which the patient had on the steamer, and for which I attended him along with the ship's doctor, was, as Dr. Dutton remarks, atypical. It was rather a limited consolidation of the base of the left lung accompanied with a scant expectoration, which for two days inclined to be rather arterial in colour than rusty. When it ceased, no further expectoration of any kind whatever occurred. Might not this attack be due to a stasis of the parasite in the capillaries of the lung; has the time come to speak of a new form of pneumonia?

Now, as to the cause of the disease in man, I would venture to put forward a theory supported by a new fact not previously mentioned. The patient spent most of his time as master on board the Government river steamer, where, he informed me, he had been twice bitten by rats. Now, it is well known that trypanosomiasis is a common disease among such animals, and might it not be that a direct transference resulted in this instance? The rarity of it would support this, because it is seldom that one is so bitten. It was conveyed by tics or mosquitos one would expect greater frequency. The original seat of the parasite, I would suggest, might be some insect (*pulex*) peculiar to, and living only on, the juices of the rat, which in its turn is capable of conveying it to man, acting as an intermediary. Mosquito curtains are decidedly a protection against ratbites, but as it is difficult to arrange them to satisfaction in a small steamer bunk, the patient probably was exposed when bitten.

At first sight one would expect the natives to be more exposed to the disease than Europeans from their surroundings, but the use of the curtain is fairly common among the natives of the Gambia, at least by the Mandingoes and Jollofs. The disease might perhaps be more frequent among the Pagan Jollas or Phoullas.

I would submit that the disease is conveyed by direct inoculation, and hence it is that the trypanosomiasis of horse and cattle has not yet been observed in man. Although I see no reason why it could not occur if direct inoculation took place. The rat harbouring such a parasite, with its propensity of biting sleepers, seems to me a probable cause. Points worthy of elucidation are as follows:

1. The nature of the rat trypanosoma of the Gambia, and its resemblance to or difference from that observed in man.
2. Is its origin to be found in any animal constantly parasitic on the rat; and, incidentally, is the rat on board the local steamers an imported English rat or a native species?
3. Is the parasite to be found in the salivary secretion of the rat or man?
4. Has the trypanosome any relation to sleeping sickness?

It may be objected that sleeping sickness has not been observed in Europeans, but I submit that the case given in Henny's *Principles of Military Surgery*, third edition, 1829, case lxxvii, p. 469 (a white soldier returned from the West Coast) was in all probability a case of sleeping sickness. Though the symptoms of the two diseases are different might they not be different stages of the same process—in the first stage the parasite circulating freely in the blood, in the second stage accumulating in the brain tissue, and so causing somnolency through local anaemia?

Cases of sleeping sickness are not uncommon on the Gambia but are not often seen by European doctors, as the natives believe that the white surgeon, however well informed concerning other diseases, does not understand this complaint. They go to some native who undertakes the cure, which is entirely surgical. The method consists in the excision of the enlargements at the angle of the jaw, which are to be found almost universally in the earlier stages. It is said, when the operation is done in time, to be a certain cure.

It will be noticed that I have hinted that the rat is the intermediate host of the parasite. If the parasite has several metamorphoses, the origin is probably in some insect infecting the rat—the stages in man and the rat being identical.

If the above surmise be correct, the rat is necessary to the continuance of the life-history of the trypanosoma, its occurrence in man being accidental.

FILARIA PERSTANS.

By GEORGE C. LOW, M.A., M.B., C.M.,
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THE embryonic or larval forms of *filaria perstans* were first discovered by Manson in 1891 in the blood of a West African negro suffering from sleeping sickness, who was under the care of Dr. Stephen Mackenzie in the London Hospital. Later, in films of blood sent from Old Calabar and the Congo, he found the same parasite, and in 1897 described small sharp and blunt-tailed filarial embryos in specimens of blood sent by Dr. Ozzard from British Guiana, which he provisionally named *filaria Ozzardi*.

Daniels in 1897 confirmed the latter observations by finding that those embryos were very common in the blood of the aboriginal Indians of the interior of British Guiana, and in the following year he discovered the parental forms of the blunt variety.

Adult forms of the African blunt-tailed embryo were next found at the necropsy of one of the negroes who died from sleeping sickness in Charing Cross Hospital, and Manson, after a comparison of those with the British Guiana forms, came to the conclusion that they were identical, and so cleared up the life-history of his original embryos which he had named *filaria perstans*.

GEOGRAPHICAL DISTRIBUTION AND PREVALENCE.

South America.—*Filaria perstans*, as Daniels and Ozzard first pointed out, is very common amongst the aboriginal Indians in the interior of British Guiana, though not being found in Georgetown and the coast adjoining.

While studying filarial diseases in the West Indies in 1901 I did not once meet with it in the blood of large numbers of individuals examined in St. Kitts, Dominica, St. Lucia, Barbadoes, St. Vincent, Grenada, or Trinidad, but, as already mentioned, it was exceedingly common in British Guiana. Out of a total of 163 Indians seen in different parts of the dense tropical forests no fewer than 94, or 57.6 per cent., exhibited the parasite in their blood, 56 of those being pure infections, while in the other 38 it was associated with sharp-tailed embryos. Although it is not found in Georgetown and in New Amsterdam, nor the cultivated strip of the coast lying between those two towns, it is common on the coast to the north near the Venezuelan boundary where the forests come down to the sea, Warau Indians living at the mouth of the Waini river being found to be infected.

There is little doubt that the same parasite, if looked for, would be found in Dutch and French Guiana, Brazil, and in parts of Venezuela where the tropical forests are dense, and its distribution therefore is probably a much more extensive one in South America than we at present know of.

Africa.—Manson has shown that the parasite is common on the Congo, Old Calabar, and other parts of the West Coast of Africa, 30 out of 54 individuals showing it in blood slides sent to him by Professor Firket from the Congo, and 35 out of 61 in slides sent from Banza Mankeka. Further, Dr. Rice has lately informed me that he found *filaria perstans* in 50 per cent. of the people of Ibadan in the hinterland of Lagos, and the members of the Liverpool School of Tropical Medicine expeditions have also found it in other parts of the West Coast of Africa.

On the East Coast of Africa it is not found in the towns of Zanzibar or Mombasa; nor amongst the Masai, a large tribe inhabiting the highlands beyond Nairobi; nor amongst the Kavirondo, who dwell along the north-east shores of the Victoria Nyanza lake.

In Uganda, on the other hand, as Moffat, Hodges, and Cook have shown, it is extremely prevalent in many areas of that large province.

I found it in 86 out of 100 people from the Sese Islands to the south of Entebbe; in 62 out of 100 in Bulemezi and Mugema respectively, districts some distance north of the lake; and Moffat and myself got it in 76 per cent. of the people of Unyoro, the province lying to the east of the Albert Nyanza. In the Alur tribe, from near Wadelai on the Nile, Bagshawe and myself found that it was not so common, only 4 out of 48 having it. To the south Daniels found one case in a native of British Central Africa on Lake Nyassa.

PHYSICAL FEATURES OF THE COUNTRY WHERE FILARIA PERSTANS IS FOUND.

So far *filaria perstans* has only been found in or near the

equatorial belt, where the temperature is high and the atmosphere saturated with moisture, examples of those places being the tropical forests of South America, the steamy forests of the Congo, and Uganda, where tropical forests alternate with enormous swamps and open ground. In Kavirondo, as already mentioned, where the forest disappears and the land is covered with scrub and short grass, it is not found, nor on the grassy plains of the highlands of British East Africa. Towns, and areas where the forest has been cut down and cultivation taken its place, as on the coast line of British Guiana, are also exempt from it.

THE EMBRYONIC OR LARVAL FORM.

The anatomy and measurements (0.203 to 0.205 mm. by 0.0042 mm. broad) of the embryos of *Filaria perstans* correspond closely to those of *Filaria demarquaii*, but it can readily be distinguished from those by its blunt or rounded tail.

TABLE I.

Date and Hour.	CASE I. Number of F. Perstans in 5 c.mm. of Blood.	CASE II. Number of F. Perstans in 5 c.mm. of Blood.	CASE III. Number of F. Perstans in 5 c.mm. of Blood.	CASE IV. Number of F. Perstans in 5 c.mm. of Blood.
Sept. 8th, 1902, 10 a.m. ...	16	12	10	15
" " 2 p.m. ...	8	17	10	17
" " 6 p.m. ...	19	8	13	19
" " 10 p.m. ...	10	6	10	10
Sept. 9th, 1902, 6 a.m. ...	10	4	18	10
" " 10 a.m. ...	14	15	8	14
" " 2 p.m. ...	10	10	10	10
" " 6 p.m. ...	7	8	11	7
" " 10 p.m. ...	5	10	11	9
Sept. 10th, 1902, 6 a.m. ...	11	10	9	15
" " 10 a.m. ...	10	10	10	10

TABLE II.

CASE I. Died 6 p.m., September 30th, 1902. Number of F. perstans in 5 c.mm. of blood on that day—8 a.m., 0; 4 p.m., 4. Necropsy, 6 a.m. Sept. 31st, 1902.	CASE II. Died 3 p.m. September 16th, 1902. Number of F. perstans in 5 c.mm. of blood on that day—2 p.m., 7. Ne- cropsy, 4 p.m., September 16th, 1902.
Enumeration of <i>F. Perstans</i> in 5 c.mm. of Blood from the Dif- ferent Internal Organs and in Lymph.	Enumeration of <i>F. Perstans</i> in 5 c.mm. of Blood from the Dif- ferent Internal Organs and in Lymph.

Organ.	No. of Slides. No. of F. Perstans in 5 c.mm. of Blood.	Organ.	No. of Slides. No. of F. Perstans in 5 c.mm. of Blood.
Heart, L. vent. ...	1 19	Heart, L. vent. ...	1 11
" R. vent. ...	1 14	" R. vent. ...	1 24
Lung, R. ...	1 14	Lung, R. ...	1 10
" L. ...	1 17	" L. ...	1 15
Liver ...	1 1	Liver ...	1 0
Spleen ...	1 0	Spleen ...	1 0
Pancreas ...	1 2	Pancreas ...	1 1
Kidney, R. ...	1 0	Kidney, R. ...	1 8
" L. ...	1 0	" L. ...	1 2
Aorta ...	1 30	Aorta ...	1 10
Superior vena cava ...	1 16	Superior vena cava ...	1 10
R. common carotid ...	1 4	R. common carotid ...	1 24
R. internal jugular vein ...	1 10	R. internal jugular vein ...	1 7
L. saphenous vein ...	1 7	L. saphenous vein ...	1 10
Sup. longitudinal sinus ...	1 7	Sup. longitudinal sinus ...	1 4
Subdural vein ...	1 8	Subdural vein ...	1 2
Brain, capillary motor area ...	1 1	Brain, capillary motor area ...	1 8
R. middle cerebral ...	1 0	Capillary at base of brain ...	1 1
Smears not measured	—	Smears not measured	—
Lateral ventricle fluid	1 0	R. lateral ventricle fluid	1 0
Mesenteric gland, A.	2 0	Femoral gland	1 0
" B.	2 0	Neck gland	1 0
" C.	2 0	Mesenteric gland	1 0
Cervical gland	1 0		
Femoral gland	1 0		

The cephalic armature as seen in fresh specimens consists of a non-serrated prepuce, difficult to make out, and the little fang first described by Manson. A V-spot with the angle more obtuse than that seen in *Filaria nocturna* is present, but it is difficult to say if a tail spot is or not. In stained specimens a break in the continuity of the central column of cells

anterior to the position of the V-spot is seen. They have no sheath, and locomote freely over the slide on which one examines them. Their numbers in the peripheral blood vary, being equally numerous, however, by day as well as by night. That is, they observe no periodicity. The four cases in Table I demonstrate this.

In determining the number of filarial embryos in the blood at any given time, it is of the utmost importance that the same quantity of blood should be used each time, and it may not be out of place here to give the technique employed. A pipette graduated to 5 c.mm. may be used, and this quantity of blood, after being sucked up, is blown out on to a slide, spread out, and allowed to dry. The haemoglobin is washed out by placing the slide for a minute or so in water, and after this the film is fixed in alcohol and ether, stained with fuchsin or haematoxylin, and the number of filariae present accurately counted.

By this method an examination of the blood from the viscera and large vessels of the thorax in cases that have died reveals the fact that the special seat of selection of the parasites is apparently not in the peripheral blood but in that of the heart, lungs, aorta, and other large vessels. They are never found in the spleen, and only rarely in the liver and pancreas (see Table II).

THE PARENTAL OR ADULT FORMS.

The parental forms of the embryonic *Filaria perstans*, first discovered by Daniels in British Guiana, resemble fine coiled threads, the males being shorter and finer than the females. In both sexes the head is club shaped; the neck, narrower than the head, joins the body, which tapers somewhat as it approaches the tail, the latter organ having the cuticle thickened over it, forming two triangular appendages.

A well marked, musculo-cutaneous, non-striated layer encloses the body cavity, in which the viscera and generative organs are placed. The alimentary canal begins with a simple circular mouth, and extends almost throughout the entire length of the worm, ending on the concavity of the curve formed by the tail.

In the female the anus opens at the apex of a slight bulge or papilla on the cuticle; in the male it opens at the general level of the outside of the body, but has four pairs of papillae placed in front of it (preanal papillae) and one pair behind it (postanal papillae), and two unequal spicules may sometimes be seen protruding from the orifice. The two uterine tubes almost completely fill up the body cavity of the female, these being packed with eggs posteriorly and with embryos anteriorly, the latter escaping into the vagina, which unite and open externally some distance behind the head.

Fig. 1.—Tail of *Filaria perstans* ♂ (slightly diagrammatic) $\times 525$. a.p., anal papilla; c.t., cuticular thickening at tip of tail, one of the triangular appendages only seen.

The adults inhabit the connective tissues at the base of the mesentery and may be found readily if some time is expended

Fig. 2.—Tail of *Filaria perstans* ♂ (slightly diagrammatic) $\times 525$.
a, p, anal papillae; tip of tail not seen.

on the research. The best method to adopt is to remove the whole of the mesentery from the intestines and the tissues at its base *en bloc*, and then to place them in 2 per cent. formalin. This is then dissected piecemeal at one's leisure, and with good eyes a lens is unnecessary. The worms when found may be placed in 2 per cent. formalin, and after measuring them, they should be mounted for permanent preparation with or without staining in glycerine jelly.

TABLE III.—Measurements of an Adult Female and Male *Filaria Perstans* from Uganda.

	♀	♂
Length...	50 mm.	34 mm.
Greatest thickness...	0.160 mm.	0.104 mm.
Diameter of head...	0.080 mm.	0.064 mm.
Diameter of neck...	0.072 mm.	0.054 mm.
Distance from head of vaginal orifice...	1.22 mm.	
Distance of commencement of uterus from head...	1.60 mm.	
Distance of end of uterus from tail...	0.600 mm.	0.120 mm.
Distance of anus from tail...	0.160 mm.	
Anal papillae...	None	Four pairs of pre-anal papillae, one pair of posterior
Termination of tail...	Cuticle thickened to form two triangular appendages	Cuticle thickened to form two triangular appendages

THE INTERMEDIATE HOST.

Analogy leads one to suppose that the embryo filariae must be sucked out of the blood by some insect in which they may undergo the metamorphosis necessary to enable them to become once more adult worms, and the peculiar distribution of the parasite and its association with dense tropical forests suggests some insect with a similar distribution. To determine the point a series of experiments were conducted with many different mosquitos and other insects, the procedure adopted being to catch the insects in infected huts or to rear them from larvae and then allow them to bite infected persons.

Subsequent dissections were then made, but with one exception all the results were entirely negative. In one isolated instance two forms, showing what has been described as a sausage shape, were seen in the thoracic muscle of *Taenio-rhynchus fuscopennatus* (Theobald), and this is interesting, because Vincent and myself when working in Trinidad at the intermediate host of *Filaria Demarquaii* found in several instances sausage-stage forms in the thoracic muscles of *Stegomyia fasciata* reared from larvae and fed on infected cases. Those, however, never developed further, and in dissections at later dates entirely disappeared.

The fact, however, of finding forms of perstans and Demarquaii in the thoracic muscles showing this stage of development suggests at once that if one could find the proper efficient host the embryos would migrate to that same region, and undergo a similar development to that of *Filaria nocturna* in *Culex fatigans*.

Some of the other insects experimented on, all of which,

however, gave negative results, were *Stethomyia nimbus*, of the subfamily of the *Anophelinae*, *Anopheles argyrotarsis*, *Culex fatigans*, *Culex atratus*, *Janthinomsoma musica*, *Culex viridis*, *Culex luteolateralis*, *Culex quasigildus*, *Anopheles costalis*, *Anopheles funestus*, *Panophites africanus vel uniformis*, *Uranotaenia caeruleocephala*, *Pulex irritans*, *Pulex penetrans* (chigger), *Pediculus capitis*, and *Pediculus vestimentorum*.

PATHOLOGY.

Filaria perstans, like *Filaria Demarquaii*, gives rise to no pathological symptoms, the position of the worms in the connective tissues of the mesentery apparently causing no harm. A differential leucocyte count in a series of 8 cases showed that 5 had no eosinophilia, even though one of those had also bilharzial disease—a very common complaint in Uganda. The other 3—two children, one a young adult—showed an eosinophil percentage of 15, 16, and 19 respectively; but as their faeces exhibited the ova of ankylostomata, trichocephalus, and ascaris lumbricoides, it is difficult to decide to which of those the condition was due.

The idea that sleeping sickness was associated with *Filaria perstans* is disproved by the fact that in British Guiana, where this parasite is common, there is no sleeping sickness, and vice versa in Kavirondo, where the latter disease is rife, there are no filariae.

SCREW-WORMS IN ST. LUCIA.

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THE screw-worm, which is the larval form of a small fly—*Chrysomya (comptosia) macellaria*, Fabr.—is one of the most important of all the insects that affect domestic animals in the New World. It does not confine its attentions, however, to the lower animals, for not infrequently it attacks man, and sometimes fatally. Its area of distribution is very wide, the species having been found in nearly all parts of America, from Patagonia to Canada, but it does the most damage within the tropical and subtropical belt.

I have seen numerous instances of its ravages in cattle, etc., chiefly in the navels of young calves and in barbed wire injuries. Not long ago I saw a goat with a cavity in its thigh caused by these worms into which I could have put my hand. Within the last few months I have seen several cases of screw-worm in man. These I shall briefly describe:

CASE I occurred in a young woman who was admitted to the Victoria Hospital, St. Lucia, with a sloughing ulcer on her upper lip. This spread rapidly, but was finally controlled by the application of pure formalin. Before the ulcer had healed, however, a large number of screw-worms were discovered in the nose. These were removed by injections of a dilute solution of izar, and the patient recovered with the loss of the greater part of the upper lip and of the septum nasi.

CASE II.—A man had his left hand and forearm amputated for malignant disease, which reappeared later in the axillary lymphatics. The affected glands broke down, leaving a large abscess cavity which was soon found to be swarming with screw-worms. As in the first case, these were removed by the dilute izar injections. But the patient succumbed to his original disease, dying of exhaustion several weeks later.

CASE III.—A young woman suffering from phthisis with diarrhoea. This patient used to throw off the bed clothes when sleeping, and one morning she found a worm in her bed. I examined her, and removed forty-six screw worms from her vagina and rectum. There was no wound and the patient seemed none the worse for her experience, but she is now more careful to keep herself covered while sleeping. This patient has since died of phthisis.

CASE IV was a woman with advanced phthisis. There was an offensive discharge from the nose, which afterwards became bloody, and then numerous screw-worms crawled out of the nostrils and mouth. I put five of these into a bottle with some earth, and twelve days later bred out five large flies similar to the flies which I had found attacking cattle, but many times larger. Dilute creolin injections soon removed the worms, and the patient improved somewhat, but her case was hopeless from the beginning, and she died just ten days after the last worm had been removed.

CASE V.—A man, about 50 years of age, received some slight injury to his left great toe. This was treated with *remède Crôle*, which probably consisted of a mixture of various herbs, leaves, etc., boiled down with tallow, whale oil, and perhaps a little cow dung, and other ingredients. The result was a fetid ulcer, which soon became infested with screw-worms. On my first visit to him I removed twenty-two of the worms. I did not see him again for five days—he lived several miles in the country—and then found that my directions had not been carried out. The creolin lotion had simply been applied on a piece of rag without any attempt at cleaning the sore, which had now become a large suppurating cavity, in which I could still see a few worms moving. The end of the toe was gangrenous, and when I cut through a small bridge of skin in order to get at the worms at the bottom of the cavity, the ungual phalanx almost dropped