

A Request.

Finally, I wish to appeal to my colleagues for the collection of snails for identification and the presentation of identified specimens to the various African Veterinary Research Institutions and Colleges. The various institutions would undoubtedly not hesitate to exchange specimens.

Veterinary malacology is a subject to which the veterinary colleges should pay more attention in the immediate future than has been the case in the past.

Paper No. 11

ONCHOCERCIASIS OF CATTLE, WITH SPECIAL REFERENCE TO ITS POSSIBLE LIFE-CYCLE AND CONTROL.

By P. L. LE ROUX, B.Sc. (Edin.), M.R.C.V.S., Veterinary Research Officer, Department of Agriculture, Union of South Africa.

ONCHOCERCIASIS of cattle has been known in Australia for almost fifty years, and is there due to the nematode *Onchocerca gibsoni* (Cleland and Johnston, 1910). York and Maplestone list fourteen species of *Onchocerca* Diesing, 1841, as parasitizing ligaments, vessels, subcutaneous or intramuscular connective tissue of mammals. Four of the fourteen species are imperfectly known, and eight of the remaining ten have been recorded from domestic stock. Man harbour the remaining two.

The *Onchocerca* recorded from domestic stock are:—

- (1) *Onchocerca reticulata*, Diesing, 1841, parasitizes the horse, and is chiefly met with in the tendons of the forelegs. It may occur in subcutaneous nodules and elsewhere.
- (2) *O. cervicalis*, Railliet and Henry, 1910, is a parasite of the *ligamentum nuchae* of horses.
- (3) *O. armillata*, Railliet and Henry, 1909, is recorded from the wall of the *aorta* of the zebra and cattle in the East Indies.
- (4) *O. bovis*, Piettre, 1912, was collected in France from the ligaments and tendons off the knees of cattle.
Cretien, 1920, observed a species of *Onchocerca* in the subcutaneous tissues in the neighbourhood of the *ligamentum nuchae* of bovines in France.
- (5) *O. gutturose*, Neumann, 1910, is recorded as the causal agent of subcutaneous and muscular Onchocerciasis of North-African cattle.
- (6) *O. indica*, Sweet, 1915, is named as the worm responsible for Onchocerciasis of *Bos indicus* in the Peninsula of India.
- (7) *O. fasciata*, Railliet and Henry, 1910, from subcutaneous nodules in camels from India and Australia.
- (8) *O. gibsoni* parasitizes cattle and occasionally sheep in Australia and cattle in the Malay Archipelago, and infests *Bos indicus* in the Malay Peninsula.

Cameron (1928) describes a species of *Onchocerca* from the ox in West Africa, and concludes with the lines: "It is impossible, however, to say to which—if either—of these two species the present forms should be referred until a more detailed morphological and biological study of *O. volvulus* and *O. gibsoni* has been undertaken."

De Kock and Snyman (1928) in their communication: "Occurrence of *Onchocerca* in South Africa," record their observation of *Onchocerca* nodules in cattle from Southern Rhodesia, Bechuanaland, Mooi River, in Natal, and from the sale yards at Bloemfontein, Orange Free State. No proof is offered that in any of the cases observed in the Union of South Africa the infection took place within that territory.

Monnig (1928) mentions *O. gibsoni* as not very frequent in South African cattle.

In 1880, Dr. William Morris, of Sydney, reported to the Royal Society of New South Wales on "a filaria found encysted in the flesh of a bullock." He mentioned that more than one worm may occur in a nodule, and that the capsules of the nodules were composed of dense white fibrous tissue. Twelve years later, Mr. Stanley, New South Wales Government Veterinarian, sent Dr. John Gibson specimens labelled "Tumours from the brisket of a fat bullock, containing filaria-ova viviparous." Gibson, after whom the worm was later named, reported to the Inter-Colonial Congress of Australia (1892) on "worm nests" from the subcutaneous tissues of the briskets of cattle. A full survey of the earlier references to onchocerciasis is given by Cleland and Johnstone, 1910.

Leiper (1911) deals with the morphology and the life-history of the parasite as well as with the pathological effects of the parasite on the host and its possible transmission to man. His summary and conclusions were:—

- "(1) The parasitic nodules in Australian beef are, without exception, due to the presence of long, thread-like worms of the genus *Onchocerca*.
- (2) The diseased condition, Onchocerciasis, is not peculiar to Australian cattle, but occurs also in other animals and in various parts of the world including the United States of America.
- (3) The parasites belong to a group of worms that require to be taken up by a biting insect and to undergo a certain degree of development therein before they can be transmitted to another warm-blooded animal.
- (4) The worms and their young do not appear to be capable of surviving for more than a few hours the death of the cattle. No evidence of vitality of the worm or its embryo has been met with in the case of Australian beef reaching this country.
- (5) From (3) and (4) above, it follows that the direct development of the parasite in men, as a result of eating the affected meat, is impossible.
- (6) The nodules are the product of changes taking place in the tissues as a result of some acrid toxin excreted by the worms. In my opinion, their presence in meat intended for human consumption is for this reason undesirable.

The geographical distribution of *O. gutturosa*, *O. gibsoni*, and *O. indica* is recorded by Sweet (1914) as follows:—

"*O. gutturosa* is characteristic of Northern Africa, presumably in *Bos taurus*; *O. indica* is found in *Bos indicus* in the Peninsula of India; and *O. gibsoni* and *Bos indicus* in the Malay Peninsula; and, as a very variable form, in *Bos taurus* in Australia, and most probably in the Malay Archipelago."

Sweet finally concludes that this evidence supports the theory that *Onchocerca* was introduced probably from the Malay Archipelago and not from India. The worm would, therefore, have arrived in the cattle from Coepang, in Timor, in 1924 or 1840, and not in the buffaloes from Timor as suspected by Cleland and Johnston (1910).

Sweet (1914) records that onchocerciasis of cattle has never been observed in either North or South America.

De Kock and Snyman (1928) discuss the possible introduction of "the disease" into South Africa from New South Wales in 1901, and the reader is thus led to deduct that the specimens examined by them were members of *O. gibsoni*. The identification of the parasites as *O. gibsoni* would, however, not have proved their suspicions as well founded. Surely there was importation of cattle from the Malay Archipelago and adjoining territories into East Africa prior to 1901? Dr. De Kock has personally informed me that they have never recovered specimens from nodules, and the species remained undetermined.

PROBABLE LIFE-CYCLE OF *O. gibsoni*.

The observations of Blacklock (1926) on the development of *O. volvulus* in *Simulium damnosum* suggest that some species of *Simulium* should be responsible for the transmission of *O. gibsoni* and others.

A blood-sucking insect has always been considered the transmitter. Some of the insects which have been suggested or experimented with to trace the life-cycle of *O. gibsoni* are: *Tabanus gregarius*, *T. nigrotarsis*, *T. lineatus*, *T. cinerescens*, *T. sp* near *circumdatus*, *Haematopinus vituli*, *H. eurysternus*, *H. tuberculatus*, *Trichodectes scalaris*, *Culiselsa vigilax*, *Culicoides submitidus*, *Stomoxys calcitrans*, *Lyperosia exigua*, *Musca domestica*, *Silvius sordidus*, *Silvius, sp.*, *Pycnosoma dur*.

In the case of *O. caecutiens*, Brumpt, 1919, of man, *Simulium samobni*, and *S. dinelli*, were suspected by Robles. Brumpt found the embryos of *O. volvulus* in the peripheral parts of the nodules, and concludes that they can reach the lymphatics and, finally, the general circulation, and that the transmitting agent may be a biting insect (*Tabanus*, *Glossina*, or *Simulium*). He also believes that *O. reticulata* is similarly transmitted. Blacklock (1927) observed apparently dead larvae of *O. volvulus* in the gut of two specimens of *Glossina*, but never in any *Tabanus*.

Fulleborn and Rodenwaldt state that the embryos of *C. volvulus* have not yet been observed in the general circulation.

Cleland and Johnston (1-10) observe that they have failed to find the embryos of *O. gibsoni* in the blood. Sweet (1914), dealing with the nodules caused by *O. indica*, writes: "The whole tissue of the nodule is often permeated with larvae even in cases where mature worms show no larvae in the genital tubes; also larvae (.12-.16 mm. long) are to be found on the periphery of the nodule and sometimes thickly in the loose connective tissue on the surface of the nodule."

Blacklock found the larvae of *O. volvulus* just under the skin, and ascertained experimentally that *Simulium damnosum* became infected by allowing it to settle on and attempt to draw blood for a nodule.

By capturing and dissecting flies which had settled and sucked blood from nodules, Blacklock recovered developmental forms of the worm from the thoraces of these flies on the 7th 8th and 10th day after feeding. From this and the fact that *O. volvulus* infection coincides with the prevalence of *O. damnosum*, Blacklock concludes that it is the transmitter of the causal agent of West-African human onchocerciasis.

The situation of the *O. gibsoni* nodules and the site usually selected by simuliidae to draw blood coincide, and one wonders why this fly should have been overlooked in Australia, from which country there have been reported no less than five species of *Simulium*. Another genus of the family simuliidae to be considered is *Austrosimulium*, Tonnoir. Of this genus, Tonnoir describes nine species of *Simulium* in New Zealand, where he collected six species of *Austrosimulium*.

Cleland (1927), in reply to Blacklock's (1927) suggestion that *O. gibsoni* might be transmitted by a species of *Simulium*, writes:—

"I can state authoritatively that transmission occurs in districts entirely free, so far as careful investigation showed, from any species of *Simulium*." This author suspects a tabanid or a mosquito.

De Kock and Snyman (1928), by their statement: "It is interesting to note that the nodules under description only occur on those parts of the animal in contact with the ground when lying down, i.e. the V formation on the brisket," suggest that they may be inclined to believe in the soil and direct contamination theories. Surely the infected portions of the body would not only be confined to the brisket if the animal were to contract the infection only when lying down?

The presence of the nodules on the brisket strongly suggests transmission by a *Simulium*, and it may be desirable to consider briefly the habits and bionomics of this genus to appreciate why onchocerciasis is not very prevalent in South Africa.

DISTRIBUTION AND HABITS OF SIMULIIDAE.

The Simuliidae have a world-wide distribution, and in some parts of the world are a source of great annoyance to man, beast, and bird. In parts of North America and Central Europe, they are claimed as the cause of serious losses to stockowners through worrying the animals and preventing grazing in peace, or causing them to stampede and be injured, even drowned, in their endeavours to escape from the flies, which are most active in the early morning and late afternoon, and invariably settle on the abdomen of stock. To escape the animal's tail, they settle on and in the vicinity of the brisket.

In North America these flies are often referred to as "turkey gnats" because they commonly attack turkeys and other birds. It is remarkable that the same species may behave differently in different localities. As an example may be mentioned *Simulium damnosum* that attack man and goats in West Africa (Blacklock, 1928), but at Onderstepoort, according to Mr. Bedford, it confines itself mainly to parasitizing birds. Another species observed at Onderstepoort has hitherto never been found on cattle or sheep. In Zululand, Mr. Bedford has seen a species that would occasionally attack cattle and horses.

Lounsbury (1905), writing from the Cape, states that the flies of this genus "do not appear to be known as a stock pest, but one or more species affect poultry to a slight extent."

The fact that the South African members of the genus prefer avian to mammalian blood, may account for the relative absence of Onchocerciasis from our herds. Let us hope that they may never change in their habits, and that the birds will be preserved for them to feed on. It would be interesting to have details as to the prevalence of birds in these areas of Australia badly affected with Onchocerciasis. The public should therefore be taught to protect the birds that indirectly protect the trek ox against this dreaded parasite, and that his whole carcass may still be passed for human consumption after he has pulled the plough for many years.

Simuliidae are invariably found most abundant in bushy country near shallow, swiftly-running streams. The eggs, commonly ovoid and yellowish in colour, are laid on an object just under the surface of the water. The eggs hatch in three to four days, and the larvae attach themselves by their posterior suckers to a support in a rather swiftly-running portion of the stream. When it is about to pupate, it spins a characteristic heart-shaped cocoon, which is scooped out, anteriorly, and pointed, posteriorly. At Onderstepoort, *S. damnosum* attaches itself mostly to stones, and may be found on all surfaces.

BREEDING SIMULIUM.

The essentials for the normal development of the larvae are (1) swiftly-running water and (2) supports on which to attach themselves. Attempts to obtain flies by keeping pupae in stagnant water in an aquarium are never very satisfactory. To obtain strong healthy flies, they should be collected where the larvae feed and pupate in the stream. All that is necessary for their collection is a four-gallon paraffin tin with the top, bottom, and three-quarters of the one side removed, the first two being replaced by wire gauze and the third left open. The tin, with the opened side uppermost and containing several stones, etc., with larvae and pupae attached, is now placed in the stream so that the current flows directly through it. A square frame covered with mosquito-netting is fixed over the opening, and the flies on emerging from the water congregate in it and can be transferred to wherever desired.

KEEPING THE ADULT FLY ALIVE.

Blacklock, and others before him, found it most difficult to keep adult flies alive for any length of time. They often die within a few hours. They require moisture and shade, and cannot be induced to feed when kept in close captivity.

To demonstrate the transmission of *O. gibsoni* or other species parasitizing stock by *Simulium*, it may be desirable to construct fairly large (to hold one or more animals) fly-proof cages, and to transfer all newly-caught flies here to feed on a heavily *onchocerca*-infected animal. The infected animal can then be replaced by a known non-infected one. The experimental animals should perhaps be confined only to one portion of the enclosure so that long grass and a moist patch will be available for the flies. Direct sunlight would, according to Blacklock, be detrimental to a fully-engorged fly. The flies, as a rule, only feed during the early morning and late afternoon.

AFRICAN SIMULIIDAE.

Of the various species of *Simulium* recorded from Africa, *S. damnosum* would appear to be the most widely distributed.

According to Austin (1909) the species recorded from Africa are: *Simulium latipes* in Natal; *S. damnosum* from Uganda, French Guinea, French Congo, Anglo-Egyptian Sudan, Congo Free State; *S. griseicollis* in Egypt, Anglo-Egyptian Sudan; *S. nigratarsis* in Cape Colony; *S. reptans* from French Congo, *S. wellmanni* from Angola.

Mr. Bedford informs me that he has collected *S. damnosum* and *S. nigratarsis* at Onderstepoort, and in Zululand a species which may be a new one.

New species have undoubtedly been added since 1909. The simuliidae have probably not received too much attention as yet, and it is for those in a position to collect specimens to do so and have them identified.

CONTROL.

All infected animals discovered in a not badly affected area should be destroyed and the importation of infected stock should be guarded against. Cases of onchocerciasis have been reported in sheep, but would appear to be extremely rare, and the possibility of its importation into South Africa by this animal would seem very remote.

In endemic areas it may be possible to limit its devastations by an attack on the intermediate host. The use of chemicals for the destruction of the larvae of the intermediate host should be investigated.

Paper No. 12.

A BRIEF REVIEW OF THE LITERATURE DEALING WITH THE KIDNEY-WORM (*STEPHANURUS DENTATUS* DIESING, 1839) OF SWINE, TOGETHER WITH SUGGESTIONS FOR ITS CONTROL AND ULTIMATE ERADICATION.*

By P. L. LE ROUX, B.Sc. (Edin.), M.R.C.V.S., Veterinary Research Officer, Department of Agriculture, Union of South Africa.

It would not be out of place to allude briefly to the earlier contributions, for, from the references consulted, it is evident that there has, within recent years, been little real progress towards elucidating the life-cycle of this parasite, and, as Butler (1928) remarked:—"By losing sight of facts and principles discovered long ago, we repeat work that is entirely unnecessary."

It is lamentable that practically all the textbooks treating with Veterinary Parasitology contain rather inaccurate statements about *Stephanurus dentatus*. These inaccuracies have proved to be most virulent and resistant, for they have not only successfully crept into the more recent literature, but have continued their vicious career in many "carefully revised" editions.

The research worker who depends solely on textbooks for the latest information is often badly misled.

* It has been requested that the more recent contribution on the life-history and the control of the kidney-worm of swine should be discussed at this Conference.