SUMMARY

(1) General notes on sixty-nine species of mammals are given of which fifty-six are recorded as occurring within the Mkuzi Game Reserve.

(2) The continued survival of *Diceros bicornis*, *Nesotragus moschatus* and *Redunca fulvorufula* in the area is as yet by no means assured.

(3) There is a decided lack of surface water for game drinking purposes during the dry season. During periods of prolonged drought herds of game mammals move out of the park on to adjoining state owned land.

(4) There is an apparent lack of numbers amongst the smaller terrestrial mammal population, in particular the Shrews and Rodents. There is a corresponding over-population of various game species.

(5) Where known the local African names for mammals have been included.

(6) A list of named ecto/endo parasites is included.

(7) Numerical estimates of game species are given wherever possible.

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PARASITES OF THE WHITE AND THE BLACK RHINOCEROSES

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The two species of rhinoceros (*Ceratotherium simum* (Burchell) and *Diceros bicornis* (Linnaeus)) in the Natal game reserves are not only great attractions to the tourist because of their enormous size, their unpredictable behaviour, and their insecure fate in other parts of Africa, but are also of outstanding interest to the scientist in several respects.

The taxonomist places them into the family Rhinocerotidae, together with three other species in the Oriental region. Many more species, however, roamed in the Tertiary, and the few species of rhinoceroses which have succeeded to survive in the merciless struggle for existence in the recent world are actually only the poor remnant of a once large family.

The Rhinocerotidae are, according to the mammalogist,[1] related to the Equidae (horses, zebras, donkeys), and the Tapiridae (tapirs). A relationship between the Tapiridae and the Rhinocerotidae is not so surprising, but one between the latter family and the Equidae is less obvious. The mammalogist has anatomical reasons for his classification, but the parasitologist is also able to provide him with facts which allow the conclusion that he is correct in uniting the Rhinocerotidae with the Equidae in the order Perissodactyla. However, some groups of parasitic Nematoda seem to reveal a relationship between the Rhinocerotidae and the Elephantidae. This idea is not so unrealistic to the layman, but it poses some problems to the scientist who bases his conclusions on anatomical and palaeontological data.

Apart from these highly academic speculations, the study of the parasites of any animal or group of animals is of the greatest practical importance. The parasites may be harmful to their host, they may cause diseases and counteract our efforts to conserve and protect rare animals, or they may even be transmissible to man and domestic animals, and in this way may greatly influence the interests of public health and animal husbandry.

We shall now discuss three groups of parasites associated with rhinoceroses, namely flies (Diptera), ticks (Ixodoidea) and worms (Trematodes, Cestodes and Nematodes).

FLIES

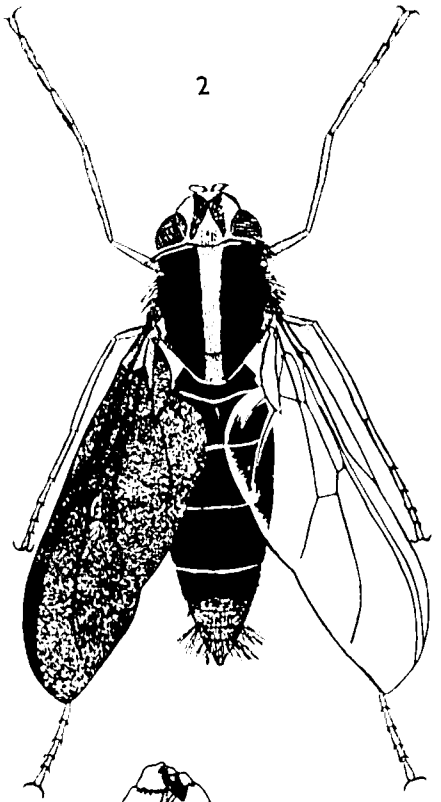
In Zululand when the stomach of a dead rhinoceros is opened, a great number of maggots up to 4 cm. long are regularly found attached to the wall. They are whitish to yellow; the biggest ones may show irregular dark spots, which indicate that these larvae are soon to be passed via the anus for pupation. The body is composed of 12 segments which are provided with bands of tooth-like

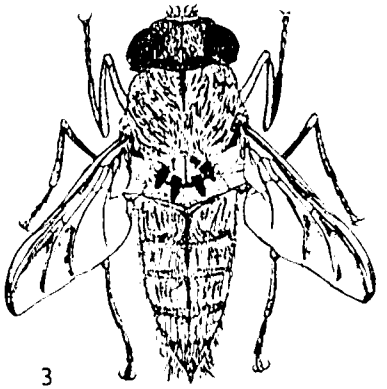
FIGURE 1
Larvae of Grostigma pavesii, *attached to the stomach wall of a White Rhinoceros from Zululand. The large pits produced by larvae already detached are clearly visible.*
(Photo: B. Stuckenberg)

spines. The one end of the larva is broadly truncated and shows two plates broadly fused in the midline, with tortuous slits. These are not eyes, as the layman often believes, but breathing organs. The head of the maggot is greatly reduced; only the oral opening with a pair of strong mouth-hooks and a pair of small, cone-like protuberances is left. These cones are each provided with a pair of so-called "pseudocelli", the function of which is not yet clearly understood. (Fig. 1).

These maggots are larvae of a fly which bears the scientific name *Gyrostigma pavesii*, and belongs to the family Gasterophilidae.[3] It is a very striking insect of 24 to 35 mm. body-length (Fig. 3), with an orange and reddish head, a predominantly deep black thorax on which only a median vitta of variable width is reddish, and a black abdomen with a reddish tip. The wings are deeply infuscated and the legs are very long and slender.

The adults are rarely seen in the field and represent great





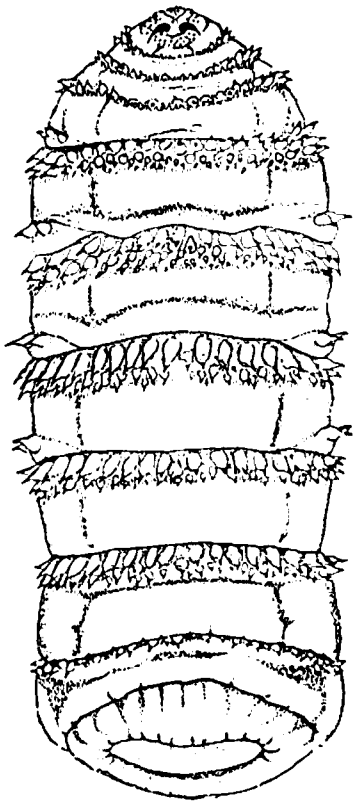


FIGURE 2—*Female fly of* Gyrostigma pavesii. *Right wing shading omitted in order to show wing venation (after Zumpt).*
FIGURE 3—*Female fly of* Gyrostigma conjungens. *The adults of this species were reared only recently in Kenya, but may also occur in Zululand (after Zumpt).*
FIGURE 4—*The first instar larva of* Gyrostigma pavesii, *freshly hatched from the egg. It is not known how it reaches the stomach of the rhinoceros. (After Rodhain and Bequaert.)*
FIGURE 5—*The third instar larva of* Gyrostigma pavesii *from the ventral side (after Zumpt).*

rarities for the insect collector. This is largely explained by the fact that they are very short-lived, with only a few days of life in which they mate and the females lay their eggs. No food is taken during this period, indeed the flies cannot feed, because their mouth-parts are reduced to tiny rudiments.

Another reason why the flies are so rarely seen in the field lies in their behaviour. They stay in the close vicinity of rhinoceroses, the only hosts in which their larvae can develop, and who would approach a rhinoceros so closely that he could catch the swarming flies?

With strong field glasses, however, one can watch the flies, and see how they deposit their eggs. The Warden of the Hluhluwe Game Reserve, Mr. N. N. Deane, has done this several times and has made very interesting observations. According to him, on hot and sunny days the female flies move around on the neck and head regions of the rhinoceroses, and attach the eggs firmly to the skin, mainly in front and below the anterior horn and between the anterior and posterior horns.

In captivity, the flies readily deposit eggs at random in the cage, and it is possible to extract the young larva from the egg-shell. It is about 2 mm. long and shows a distinct spinulation (Fig. 3). However, we do not yet know what this first instar larva does on the rhinoceros when it leaves the egg-shell.

The genus *Gyrostigma* is most closely related to the genus *Gasterophilus*, the larvae of which develop in the alimentary tract of equids. The life-history of these parasites is better known than that of *Gyrostigma*, and it was found that the first instar larvae migrate in the epidermal tissue of the cheeks and the mouth cavity, in order to reach the oesophagus. Possibly the *Gyrostigma* larvae follow a similar pattern of early development; this gap in the life-history of *Gyrostigma* has still to be filled by careful investigations.

The second and third larval stages of *Gyrostigma pavesii* are found in the stomach, and they are quite easily separable from one another. The third instar larvae (Fig. 4) are barrel-shaped and relatively short, provided with a strong spinulation; the second instar larvae are shorter, at most 2 cm. long, more slender, and show a more delicate spinulation. Another striking feature is that, in the second stage the posterior breathing plates (peritremes) have two slits each, whereas in the third stage three slits are developed.

The mature larvae, which find their way out of the host via the anus, pupate in the soil, and the flies hatch after approximately 6 weeks.

The maggots are often found in the stomach in enormous numbers; several hundred may be present, and the pits they produce in the stomach wall are quite impressive. However, we do not know whether the presence of larvae is connected with severe pathological reactions of the host. The rhinoceroses certainly tolerate a great number of them without showing any symptoms of illness. The maggots feed on blood and tissue exudate, but they grow very

FIGURE 6
Lateral view of a male fly of Rhinomusca dutoiti, *which develops in the dung of rhinoceroses, and sucks blood on these pachyderms. The rigid proboscis is clearly visible. (Original.)*

slowly and the loss of substance to the host is probably relatively small.

It must be stressed once more that *Gyrostigma pavesii* develops only in rhinoceroses, it is strictly host-specific to them, and therefore represents no danger either to any other animal or to man.

A second species of *Gyrostigma* is known from East Africa, which, together with *G. pavesii*, parasitizes the Black Rhinoceros there. The scientific name is *Gyrostigma conjungens*, and its description was based on a few larvae of the 3rd stage. Only quite recently did Mr. J. G. Tremlett of the East African Veterinary Research Organisation succeed in rediscovering this species, and in rearing two female adults.

These two females measure 20 and 24 mm. in body-length. In general appearance they are strikingly different from *G. pavesii*, and strongly reminiscent of a huge *Gasterophilus*. Several morphological features in the two species and also the general appearance of *G. conjungens* indicate that the genera *Gyrostigma* and *Gasterophilus* are closely related to one another, and support the view

of the mammalogist that rhinoceroses and equids have neighbouring places in the tree of evolution.

Gyrostigma conjungens is densely covered with long yellow and reddish hairs. The latter form two pairs of stiff brushes at the margin of the scutellum (Fig. 5). The wings are predominantly hyaline and shorter than in *G. pavesii*. It is quite possible that this species may also some day be found in Zululand.

In January, 1950, when I paid my first visit to the Umfolozi and Hluhluwe Game Reserves, I discovered a curious fly sucking blood on rhinoceroses. I named it *Rhinomusca dutoiti*, in honour of Professor R. du Toit, who freed Zululand from the menace of Nagana, and saved the game sanctuaries, which had nearly been given up, because the Nagana transmitting tsetse-flies were breeding there.

Rhinomusca dutoiti (Fig. 6) has a body-length of 7 to 10 mm. and is similar and also closely related to the well-known Stablefly (*Stomoxys calcitrans*). As far as we know it breeds only in rhinoceros dung, and normally sucks blood only on these animals. When a car is parked near a dung-heap of White Rhinoceroses, the flies will come into it and are easily caught on the windows, but from my own experience, they never try to bite man.

TICKS

The majority of ticks are not host-specific, but are found on a great variety of vertebrate hosts. It is therefore not surprising that our two species of rhinoceroses, wherever they still occur in Africa, have been found parasitized by no less than 24 different species of ticks:

Amblyomma gemma	Rhipicephalus appendiculatus*
,, hebraeum*	,, capensis*
,, lepidum	,, compositus
,, personatum	,, humeralis
,, rhinocerotis*	,, maculatus*
,, sparsum	,, muhlensi*
,, variegatum	,, pulchellus
Haemaphysalis leachi*	,, sanguineus*
Dermacentor rhinocerinus*	,, senegalensis
Hyalomma albiparmatum	,, simus*
,, rufipes*	,, supertritus
,, truncatum*	,, ziemanni

Those with an asterisk also occur in Zululand. Two of these show a pronounced preference for rhinoceroses and may be called typical rhinoceros parasites: *Amblyomma rhinocerotis* and *Dermacentor rhinocerinus* (Figs. 7 and 8).

Both species are large and beautifully coloured ticks. Unfed males and females of *A. rhinocerotis* are on an average 9 mm. long, and show a characteristic ornamentation consisting of dark reddish-brown spots and stripes on a dull ochre-yellow ground. The *Dermacentor* species is 6 to 8 mm. long and the male bears yellow-ochrous blotches on a chocolate brown background.

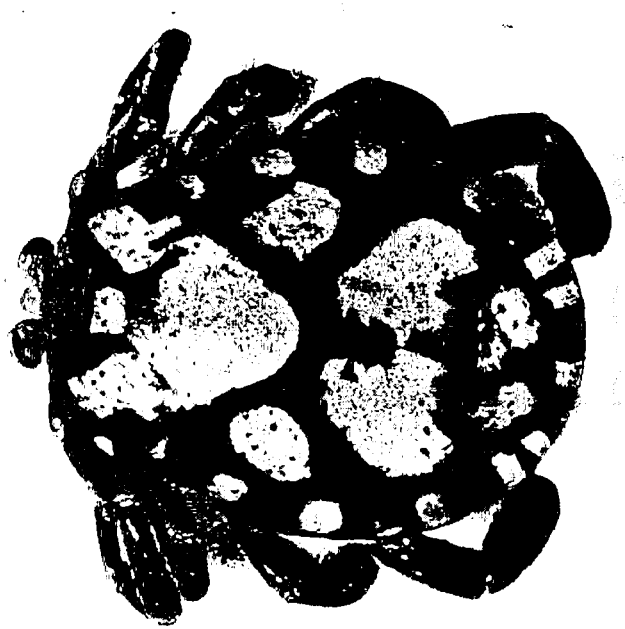


FIGURE 8—*A male specimen of* Dermacentor rhinocerinus, *another tick typically found on rhinoceroses (original).*

FIGURE 7—*A male specimen of* Amblyomma rhinocerotis, *a typical tick of rhinoceroses (original).*

It is not known whether any of the above-listed ticks transmit a disease to the rhinoceroses.

WORMS

The common name "worms" does not designate a homogeneous group of animals. Three phyla are included in this vernacular term, namely the Platyhelminthes, the Nemathelminthes and the Annelida. All three phyla contain free-living and parasitic groups, but with respect to the rhinoceroses, only the Trematoda (flukes) and the Cestoda (tape-worms), which belong to the Platyhelminthes, and the Nematoda (round-worms) which belong to the Nemathelminthes, are of importance.

As in the ticks, we shall first list all worms which have been found in rhinoceroses in Africa. These occurring in Zululand are marked with an asterisk:

Trematoda
Brumptia bicaudata.

Cestoda.
Anoplocephala vulgaris*.

Nematoda.

Kikuluma africana*
„ brevicauda
„ brevivaginata
„ cylindrica
„ goodeyi*
„ longispiculata
„ macdonaldi
„ magna*
„ pachyderma*
„ rhinocerotis*
„ solitaria*
„ stylosa

Quilonia africana
„ parva
„ rhinocerotis
Paraquilonia brumpti
Murshidia bozasi
„ didieri
„ omoensis
„ raillieti
Buissonia africana
„ longibursa
„ rhinocerotis
Khalilia buta
„ rhinocerotis
„ sameera
Grammocephalus intermedius
Oxyuris karamoja*
Habronema khalili
Parabronema rhinocerotis

It is surprising how little is known about the occurrence, distribution and especially the biology of worms parasitic in vertebrates, or in other words, how much is still to be done.

The species of trematode—*Brumptia bicaudata*—has been found a few times only in elephants and rhinoceroses in Central Africa. It lives in the alimentary tract and is evidently restricted to these pachyderms, like many species of nematodes. But this is actually all we know.

Anoplocephala vulgaris is a tape-worm living in the small intestine. There are three more species recorded from Oriental

rhinoceroses and two others are well-known parasites of equids. *A. vulgaris* occurs in both African species and is very variable in shape (Fig. 9). Its greatest length probably does not surpass

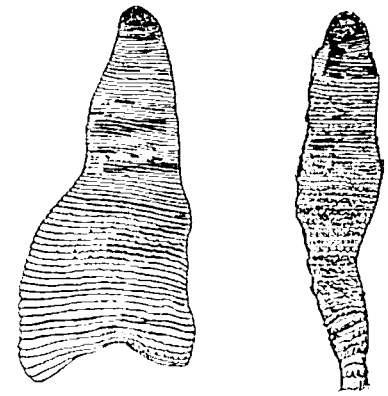


FIGURE 9
Two specimens of Anoplocephala vulgaris, *the rhinoceros tape-worm.*

12 cm. but most specimens collected from the intestine are shorter. The number of segments depends on the body-length; a tape-worm measuring 75 mm. was found to be composed of 150 segments, another specimen measuring 48 mm. had only 114 segments. Of those *Anoplocephala* species living in horses it is known that their larval forms develop in free-living mites of the family Oribatidae, and the final vertebrate host gets infected by swallowing the mites with food. *A. vulgaris* will have a similar life-history, and it is accepted that any oribatid mite which is large enough to ingest the tape-worm egg may act as intermediate host of the various *Anoplocephalidae.*

The *Kiluluma* species are nematodes living in the stomach, averaging 2 cm. in length. Twelve different species have been described from the African rhinoceroses, and one from the Lesser One-horned Rhinoceros (*Rhinoceros sondaicus*) in the Orient. This last species of *Kiluluma* will probably be distinct, but it is questionable whether all 12 African species are really so-called "good species" or whether they are only variations of a few or perhaps even one or two species. In the genus, everything is still open for research. Only adult worms are known, and we can assume that they occur exclusively in rhinoceroses. No other biological data are available.

Closely related to *Kiluluma* is the genus *Quilonia* (Fig. 10). Three species have been recorded from rhinoceroses, but others are found in the African and Indian elephants. All *Quilonia* species are strictly host-specific to rhinoceroses or elephants, and they do not infest any other animals.

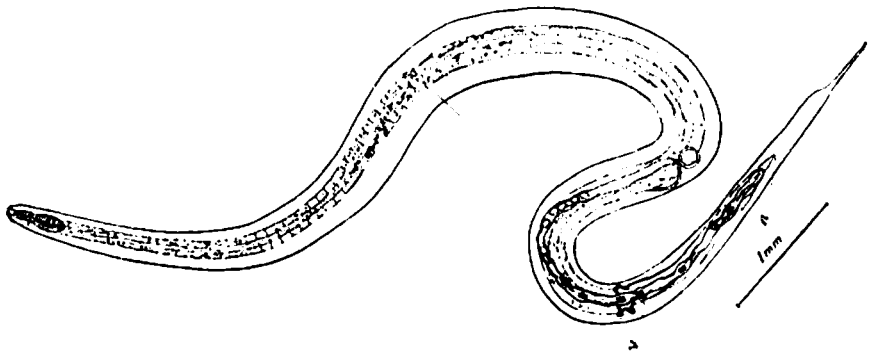


FIGURE 10
A female of Quilonia parva *from the intestine of a Black Rhinoceros. a-anus, v-vulva. (After Neveu-Lemaire.)*

FIGURE 11
A female of Khalilia rhinocerotis, *another typical intestinal worm of rhinoceroses. (after Neveu-Lemaire).*

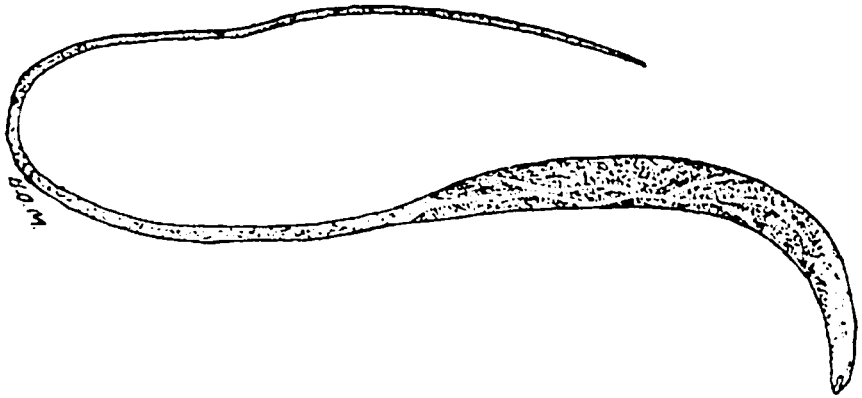


FIGURE 12
Oxyuris equi, *the pin-worm of horses, which is, in general appearance, almost indistinguishable from* Oxyuris karamoja, *the pin-worm of rhinoceroses. (after Lapage).*

Paraquilonia brumpti is quite similar to the *Quilonia* species, and the only fact so far known is its exclusive occurrence in the Black Rhinoceros.

The genus *Murshidia* comprises a number of round-worms which live in rhinoceroses, elephants and wart-hogs. They are all host-specific; those developing in wart-hogs are not able to live in elephants or rhinoceroses, and vice versa. No further details are known about the life-histories of these parasites.

The genus *Buissonia* again is known only from African rhinoceroses, and *Khalilia* from these hosts and from elephants. (Fig. 11).

Grammocephalus intermedius belongs to a different family from all the foregoing round-worms. It is a hook-worm (Ancylostomidae), whereas *Kiluluma* a.o. are thread-worms (Strongylidae). We can conclude from related genera that the young larvae of *G. intermedius* are found in mud, and that they actively penetrate the skin, reach the blood-stream, and finally migrate to the intestine, where they grow into adult worms. This outline of the life-history remains to be proved. *Grammocephalus* species are recorded only from rhinoceroses and elephants. *G. intermedius* occurs in the large intestine of the rhinos, while *G. clathratus* is found in the bile-ducts of elephants.

Oxyuris karamoja is so similar to *Oxyuris equi* (Fig. 12) the pin-worm of horses and other equids, that it has been confused with it and recorded as "*O. equi*" from the rhinoceroses in Zululand, but the two are distinct, and restricted to their specific hosts. However, from their great morphological similarity, it may be deduced that the life-history of *O. karamoja* will also be more or less the same as in *O. equi*. The males and young female worms inhabit the caecum and large colon. After fertilisation the females, having reached a length of 4 to 15 cm., migrate to the anus and crawl out, in order to lay the egg clusters on the skin of the perineal region. After a few days the eggs fall off and are ingested by other rhinoceroses with food or water.

The genus *Habronema* (Fam: Spiruridae) contains a great number of species living mainly in the stomach of various and quite unrelated mammals and birds. Three species are well-known parasites of horses, and cause pathological conditions which are termed "habronemiasis". They consist of tumours in the stomach and also of a granular dermatitis, the "summer sores" of horses. Arthropods act as intermediate hosts of these worms, in the case of horses these are House- and Stableflies. The worms in the stomach give birth to small larvae, which are passed in the faeces and ingested by the fly-maggots living in the dung. The worms grow up in the maggots and are passed through the pupal stage to the adult flies, which as they feed, transmit them to the horses. The Stablefly (*Stomoxys calcitrans*) is blood-sucking, the Housefly feeds on wounds or licks the mouth secretions.

We do not yet know the life-history of *Habronema khalili*, but

it is quite possible that the transmitter is *Rhinomusca dutoiti*, the blood-sucking fly discussed above, which develops exclusively in the dung of rhinoceroses.

The last species of worm parasite to be mentioned is *Parabronema rhinocerotis*. It is related to Habronema and also found in the stomach. Other species of *Parabronema* are recorded from elephants and camels. That is all we know.

Nothing is known of any diseases caused by these parasites in the rhinoceroses, but a pathological skin condition has been reported from the Black Rhinoceros in Hluhluwe [2], and a so-called "microfilaria" was extracted from the lesions. Microfilaria are larval forms, and those extracted from the rhinoceros cannot be correlated with any species of round-worm listed above.

This summary of the worm parasites of rhinoceroses is certainly not a satisfactory one. All we know about them is their names, and that they are all host-specific, which means that they do not infect any other animals except rhinoceroses. They therefore are no danger to domestic animals and man. From the aspect of wild life protection, this fact is quite important.

In the introductory paragraphs I mentioned that among the worm parasites several genera have members parasitizing rhinoceroses and elephants, but not equids. This puzzling finding may perhaps be explained by ecological factors. Rhinoceroses and elephants have the habit of wallowing in mud, and the worms concerned may spend a certain period of their life-history in mud.

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