

**SOME OBSERVATIONS ON
BITING FLIES (DIPTERA, MUSCIDAE, sub-fam. STOMOXYDINAE)
ASSOCIATED WITH THE
BLACK RHINOCEROS (*DICEROS BICORNIS* (L.))**

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INTRODUCTION

During the latter part of 1962 many rhinos in Tsavo Park (East) were noticed to be of a tarry-black colour or to have black patches and this coloration was often associated with general debility of the animal. Further study showed that at least two species of biting flies were feeding on the rhinoceros. They were a small 'buffalo fly' (*Lyperosia* sp. indet.) and a much larger fly presumed to be a species of *Rhinomusca*. Both are related to the more familiar 'stable fly' — genus *Stomoxys*. Field and laboratory studies were undertaken on both these flies during 1962 and 1963, and this paper details the observations made so far.

LYPEROSIA SP.

This fly, which has a sexual difference in coloration which is rather unusual for the genus, was first collected from a shot rhino by Dr. S. F. Barnett, late of the Veterinary Research Laboratory, Kabete. By placing a small jar over the flies which were resting on the recently killed animal, 40 flies (10 males, 30 females) were captured, and from the area of the mouth of the jar an estimate was made of the density of the flies — some 2,800 per square foot.

The flies were provisionally identified as a species of *Lyperosia*, and this identification was confirmed by Dr. H. E. Paterson of the South African Institute for Medical Research, Johannesburg.*

Species of *Lyperosia* are widespread in the warmer parts of the world, and in most cases inhabit humid regions, so

that it was surprising to find them in Tsavo Park. The species best known from the Ethiopian Region is *L. minuta* (Bezzi) while *L. exigua*, the 'buffalo fly', was introduced into N. W. Australia and has now spread across most of the north of that continent. Bezzi (1913) gives a key to the principal species, but in no case is there a record of the males and females being of a different colour. The adult flies spend their life closely associated with their host, and the females fly down and lay their eggs on freshly-dropped dung and then return to their feeding-place on the beast.

Field observations were made on this fly in November, 1962, July and October, 1963, and attempts were also made to rear and study it in the laboratory at Kabete. Flies from Tsavo Park were also compared with specimens collected from a captive White Rhino (*Ceratotherium simum* (Burchell)) which had been sent by Mr. D. J. Wheeler, Warden of Murchison Falls National Park.

(i) Flies on Rhino

In November, 1962 several rhinos were observed in the area to the north of the Yatta plateau where deaths had been occurring. Four different animals were watched through $\times 8$ binoculars at distances of 50-100 yards. In each case they were accompanied by a cloud of flies. The best view was had of a female rhino asleep under a Baobab tree at mid-day. This animal was black from forward of the shoulder to behind the hips, and appeared as though tarred. Each time it flapped its ears a cloud of flies, looking like dust-particles, rose

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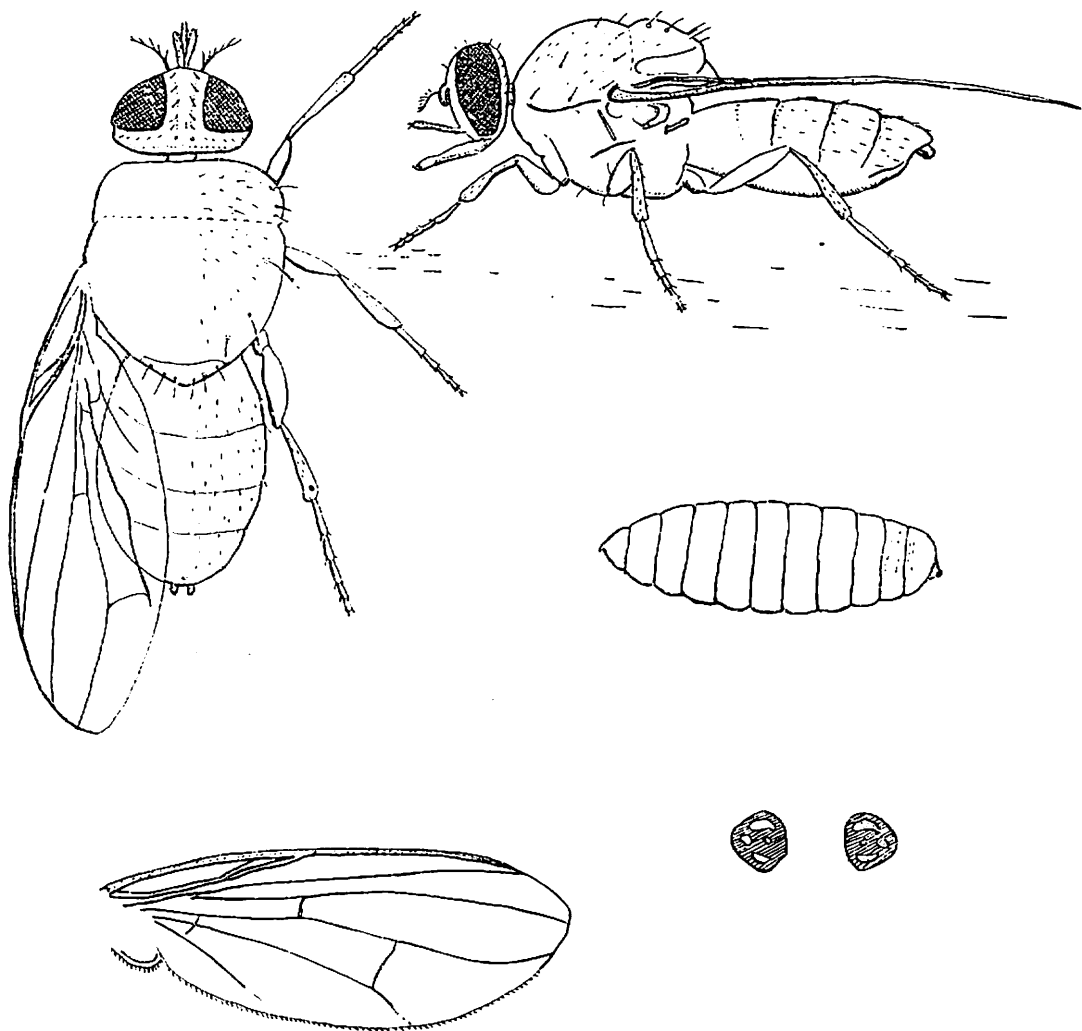


Fig. 1: *Lyperosia* sp., showing lateral and dorsal view of female (actual length c. 3 mm.); wing; puparium (actual length c. 2.2 mm.); spiracles.

from the shoulder region and settled again. A few large flies, of which some were 'horse flies' (*Tabanus* sp.) and some probably *Rhinomusca*, also disturbed the small flies by walking about on the surface of the rhino. The other rhinos seen also had many flies which rose in a cloud and settled again. When the animals moved the flies went with them. *Lyperosia* were far less in evidence in July and October 1963, but some were seen in July on a rhino

which had a black patch behind its shoulder. In October two rhinos were seen in the same area as that examined in 1962, but they had no trace of these flies as far as could be ascertained.

(ii) **Flies attracted to Man**

Isolated flies were attracted to man, and they usually attempted to bite on the legs, especially where there were scratches. It was striking, however,

how few flies remained behind when the rhino and its attendant cloud of flies had moved off. Both males and females were captured with a sucker while biting man.

(iii) Flies attracted to Fresh Droppings

During November, 1962 the attempt was made to find fresh droppings of the principal large game animals, and to see whether *Lyperosia* was attracted to them. Freshly dropped dung of elephant, buffalo and rhino was examined.

(a) Elephant. A small herd of cow and calf elephant was found near the road about ten miles south of the Lugard's Falls crossing. A ball of fresh dung was carried to the road, and several *Lyperosia* appeared, settling on the dung and biting people on their legs.

(b) Buffalo. A small herd of 14 buffalo was disturbed from under some trees. Fresh droppings were examined but no *Lyperosia* were seen. Many small black or brown flies (Family *Sepsidae*) were present.

(c) Rhino. A female rhino was watched in open ground near the pass in the Yatta plateau. When it dropped some dung we drove up and again collected several *Lyperosia* from the dung and from our legs — in all 15 males and 15 females. A few Muscid flies (including *Rhinomusca* sp.) and a *Wohlfartia* sp. were also attracted to the dung.

In October, 1963 one or two flies were collected from fresh dung voided by the tame elephant at Voi, and another fly was seen sitting on pellets of the Dikdik (*Rhynchotragus kirkii* Günther).

Eggs and Larvae in Dung

Small white eggs about 1 mm. long were found in rhino dung collected near the lower Athi river, and they corresponded in size to eggs deposited in tubes by captured *Lyperosia*. Various lots of dung of elephant, buffalo and rhino were examined for larvae, but the former type was too porous and so dried out too quickly for any larvae to be able to develop. Owing to the

rhino's habit of returning to the same place to defecate and urinate, the deeper layers of its manure piles (or 'middens') were found to be moist even in the very dry conditions prevailing in Nov. 1962, and plenty of small larvae could be found; these were very active in the hot dung. One lot of buffalo dung examined had dried to a hard crust on the outside, but the centre was still moist and contained fly larvae.

Laboratory observations consisted of breeding out the fly from rhino dung, attempting to feed males and females, and later, comparative study of Tsavo and Murchison Falls specimens.

Biology: Some small yellowish larvae and some light brown pupae c. 3 mm. in length were isolated from rhino dung collected near the lower Athi river in July, 1963; but it was not possible to rear the larvae or to hatch out the pupae. However, from a sample of rhino dung collected near the Galana river in Nov. 1962 many flies were hatched out, and later search showed many empty puparia of similar size and shape. The flies hatched within 2-7 days after collection of the dung, which was kept in a warm room at approximately 80°F (26°C). The main hatch occurred 5-6 days after collection. 20 'black' and 48 'grey' flies were obtained. Some of these were treated with caustic potash to clear them and it was easy to confirm that the 'black' individuals were all males and the 'grey' were all females. Some adult flies were kept alive in 3in. × lin. glass tubes, and mating of a black male with a grey female was observed on five separate occasions. Mating lasted about five minutes, and one male mated twice within 15 minutes. It is probable that mating occurs soon after hatching.

Attempts were made to keep flies alive by feeding them on the human arm, but they seemed unable to pierce the skin unaided. They were attracted to drops of blood caused by pricking with a needle. The bite could sometimes be felt while the fly was inserting the proboscis, but there was no later reaction. The greatest number of feeds taken (by a female) was four on four successive days.

TABLE OF *LYPEROSIA* SPECIES

	Tsavo-principal sp.		Tsavo 2nd sp.		Murchison-principal sp.		Murchison 2nd sp.	
	male	female	male	female	male	female	male	female
Number of specimens examined	5	11	1	not seen	21	22	not seen	1
Body colour	black	grey with indistinct black marks	dark slaty grey	—	grey with paired black spots on abdomen, less distinct in male		—	dark grey
Eyes, inter-ocular width	equal to width of one eye	greater than width of one eye	about 1/5 width of one eye	—	holoptic eyes touch	equal to width of one eye	—	less than eye width
Frons	black	grey with central dark stripe	dark grey	—	—	grey with central dark stripe	—	grey with central dark stripe
Wing length (mm.) mean	1.9	2.25	3.1	—	2.5	2.9	—	3.0
range	nil	1.9-2.5	—	—	1.9-2.8	2.6-3.2	—	—
Hind tarsus joints	normal, cylindrical not serrate		serrate with bristles on dorsal side segs. 1-3	—	not serrate		—	not serrate

Comparison of species from Tsavo and Murchison Falls Parks

The principal species from these places appear to be quite different, and there were single specimens in each collection which appeared to belong to a second species of *Lyperosia*. Wing measurements, using a binocular microscope and measuring eyepiece, were made on as many specimens as possible.

RHINOMUSCA SP.

A few large Muscid flies were collected in October and November, 1962 from the shot rhino, from fresh droppings and by breeding out larvae. These flies are somewhat larger than a house fly, and have a stout horn-coloured proboscis. Enquiries about the presence of *Rhinomusca* in Kenya were received from Dr. Paterson and specimens were sent to him. Comparison of adult flies and third-stage larvae with the description of *Rhinomusca dutoiti* sp. nov. Zumpt (Zumpt, 1950) from white rhino in Zululand indicates that this is a very closely related if not identical species of fly and it has now been identified as *R. brucei* Malloch. Pictures of black rhinos often show these flies sitting on their sides.

In contrast to *Lyperosia* these large flies were more in evidence in 1963 than in 1962. The Warden of Tsavo Park (E) collected many from fresh rhino dung in June, 1963 and he also noted the brown colour of the eggs. The flies were studied in the field and in laboratories at Voi and Kabete. In general they are somewhat like a house-fly in appearance, about 8 mm. in length. The colour of the thorax is light grey with three well-defined dark stripes. On the abdominal segments there are dark grey and brown, roughly square markings on a light grey background. The proboscis has a dark tip and is stouter and shorter in proportion than that of a *Stomoxys*. The male has a much narrower frons than the female, and the frons of the latter has a dark central stripe on a grey ground. The wing has a venation similar to that of *Musca*, with a distinct bend in the 4th radial vein which approaches very closely to vein R 2+3 at its tip.

Field observations: A few of these flies were collected from the rhino shot in October, 1962 and they were also seen on various rhinos observed in November of that year, while some were bred from large (c. 12 mm. long) *Stomoxys*-like larvae found in rhino dung. In July, 1963 a rhino observed near the lower Athi river bore plenty of these flies and a Red-billed Oxpecker (*Buphagus erythrorhynchus* (Stanley)) was seen to snap at some of them while it was clinging to the animal's side. On another occasion Drongos (*Dicrurus* sp.) had been noted accompanying rhinos and catching flies from their sides. In the same area female flies were collected while laying eggs on fresh rhino dung, and the rather unusual orange-brown colour of the newly-laid eggs was noted. Occasional flies were encountered while searching other heaps of rhino dung for puparia. Zumpt stated that the female flies swarmed around white rhino droppings, but our experience is that relatively few flies are encountered away from the black rhino, and they seem strongly attracted to their hosts. Closer study of these flies was possible by watching their behaviour on the tame three-year-old male rhino, 'Rufus', kept at the Warden's H.Q. at Voi. The animal was followed for most of the morning of Oct. 23rd, 1963 and several points of the flies' behaviour were noted. By 0930 hours about 50 flies had landed on the rhino. They did not remain on it at night, and it is presumed that they 'roost' in the bush — this may be because the animal is housed in a stable at night. The flies remained on the rhino in the 'head-down' position, with many clustering round a small sore behind the right elbow. They ran quite actively over the skin and made short flights when disturbed.

As the rhino passed one of its habitual places for defecation ('middens') near the park gate, it stopped to deposit some fresh dung. About ten flies flew down on to the dung where they stayed for about ten minutes and then went away. As the rhino was feeding about 50 yards away they could easily have rejoined it. Flies were watched closely,

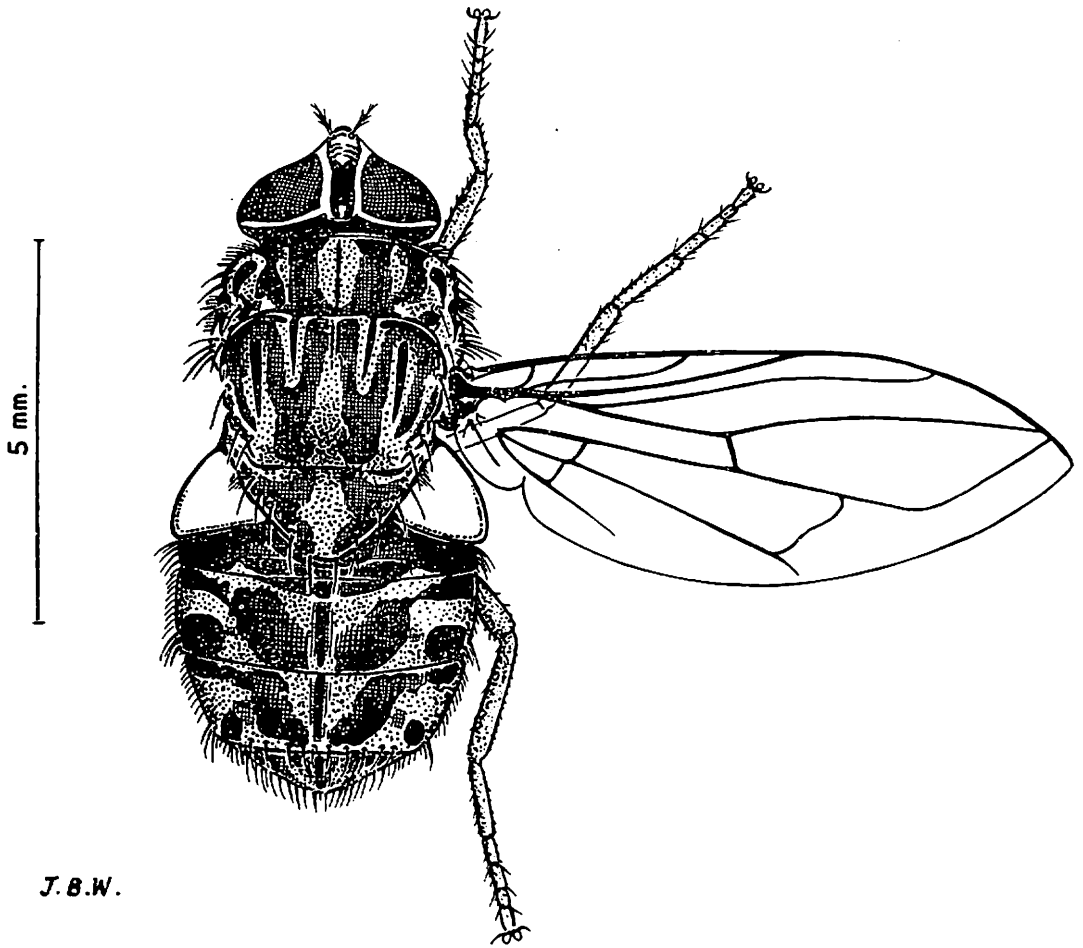


Figure 2: *Rhinomusca brucei*, female.

but were not seen to oviposit, and no eggs were found in the dung after they had left, but both eggs and larvae were common in similar 'middens' in the pass through the Yatta plateau.

Later the rhino lay down on his side in the shade of a small *Cordia* bush near the Voi river, and most of the flies congregated on his lower side. During some half an hour that he was resting he was being bitten by tsetse flies (*Glossina pallidipes* Austen) and by one horse fly (*Tabanus* sp.). These chose almost any part of the skin to puncture, and sometimes a small drop of blood

oozed out where they had been feeding. However, these punctures did not appear attractive to *Rhinomusca*. When the rhino was seen shortly before entering its stable at approximately 1830 hrs. the flies had left it.

Dissection of Wild-caught Flies

Over 40 flies were caught from the tame rhino with one sweep of a fly-net, and they were dissected in the laboratory at Voi on the same afternoon. All the flies had some blood in their fore-

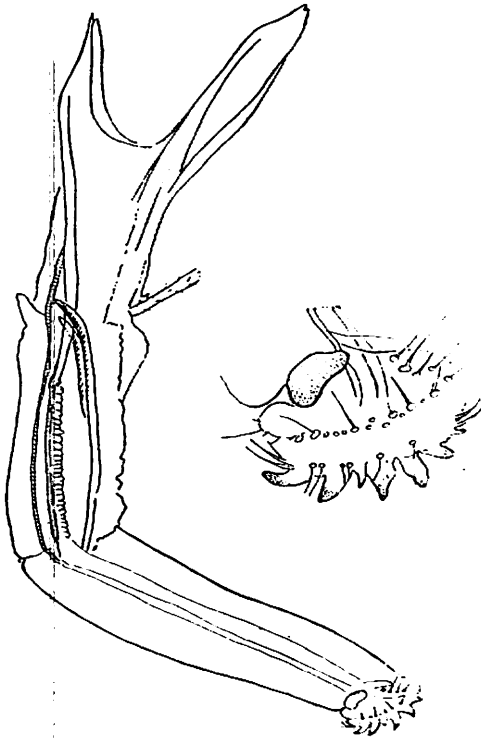


Figure 3: *Rhinomusca brucei*; proboscis.

gut, and this was usually divisible into fresh red blood and older black (altered) blood. One newly emerged male (with expressible ptilinum) had taken a full blood meal.

	TABLE OF BLOOD MEALS			Total
	Full	Partially fed	Unfed	
Male	8*	4	0	12
Females	26	4	0	30
Total	34	8	0	42

* 1 newly emerged male.

The condition of the females' ovaries was also studied, with the following results.

Mature ovary with full-size coloured eggs	...	...	6
Ovary with visible but mainly white eggs	...	...	10*
Small ovary	...	...	14
Total	...	...	30

* in one case the eggs were already turning brown at one end.

There seemed to be little correlation between stage of ovary and size of blood meal. Five females with fully ripe eggs also had a full blood meal, the remaining one had a very small meal. All those with white eggs had a full blood meal. The development of brown pigment in the ovarioles of a Muscid fly before oviposition is an unusual feature, and most closely related flies lay creamy white eggs. In a fly with mature ovaries some 80 eggs are present on each side so that a batch of about 160 eggs will be laid and there are other undeveloped follicles in each ovariole, giving the possibility of a second batch.

Other Laboratory Observations

(a) Rearing larvae and pupae:— Flies were bred out from larvae and pupae, both at Voi and Kabete. In the former case a fresh supply of rhino dung was at hand, whereas at Kabete horse manure was used as a substitute. At Voi with a high air temperature (90-95°F = 33°C) the life-cycle from egg to emergence of the fly could take 17-20 days (egg 12-24 hours, 3 larval stages 8 days, pupa 8+ days). At Kabete with unsuitable food the life stages took much longer even when some larvae were kept in the warm room at 99°F (37°C). Other batches of larvae were also kept in 3 in. × lin. glass tubes or in small glass capsules 2½ ins. (5.5 cm.) in diameter, at room temperature (70°F = 21°C) and in an incubator at 77°F (25°C). Up to 30 3rd stage larvae were kept in such capsules, but there were sometimes sudden deaths of many larvae.

After pupation pupae were put in 3 in. × lin. glass tubes and kept in an incubator at 77°F (25°C). Hatching time for 11 pupae ranged from 8-9 days. It was noted on several occasions that newly hatched flies had great strength and could push through mosquito gauze or between the glass tube and its cottonwool plug. This resulted in flattening of the soft newly hatched fly. It is probable that this marked strength in pushing upwards is an adaptation to emerging from pupae lying below a mass of rhino dung which may be more than a foot thick. Only some 20% of

pupae hatched from larvae reared at Kabete, as many larvae transformed into abnormal pupae and these died.

(b) Feeding adult flies:— Two methods were tried for feeding these flies. (i) Cotton-wool soaked in citrated ox-blood was placed on the gauze covering the tubes in which the flies were kept. One or two meals were taken in this way and in one case a fly was imbibing blood for 2-3 minutes.

(ii) Other flies were given the opportunity to feed on a human arm, generally where there was a small scab. They fed quite readily on the sore, but it is doubtful whether they can pierce the unbroken skin. Engorgement of the fly took about one minute, but several flies fed incompletely so they were recorded as having taken 'half a meal'. During feeding considerable pain was felt, and the proboscis appeared to make quite a large puncture out of which blood welled freely. A male fly took 14½ meals between day of hatching and death 17 days later, but did not feed on the last two days. Another male took 13½ meals in 18 days, again feeding on the day of hatching but not on the last 2 days of its life. Unmated females fed less readily, and took 2 meals in 3 days and 3 meals in 4 days respectively. They were harder to keep alive than males. Flies were usually given one chance daily to bite, but this did not seem sufficient for their maintenance, and it may be that they take several small blood meals daily while sitting on the rhino.

Copious black excreta, similar to the tarry black material found on the sides of sick rhinos, were produced even after a single blood meal.

Attempts to mate flies by placing male and female in small jars or 3 in. × lin. tubes were unsuccessful.

(A description of the life-history stages of *Rhinomusca* will be published later).

DISCUSSION

Both *Lyperosia* and *Rhinomusca* seem to be closely associated with the rhino, and they must cause it much discomfort in the height of the dry season, when wallowing is impossible. Also the use of the same places by the rhino for defecation ensures a continuous moist breeding place for the flies.

It is quite possible that when there is a drought and shortage of food and cover (due in part to elephant damage), the swarms of these flies may help to contribute to 'stress' and death of the rhino. Possibly they could be reduced at such times by (a) provision of artificial wallows, (b) scattering of dung heaps so that these dry out more rapidly.

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REFERENCES

- Bezzi, M. in Patton and Cragg (1913). Text-book of Medical Entomology.
- Zumpt, F. (1950). Key to the Stomoxydinae of the Ethiopian Region, with description of a new *Haematobia* and a new *Rhinomusca* sp. from Zululand. *An. Inst. Med. Tropical*, VII: 397-426.

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