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THE PASTURE FLY (DIPTERA) FAUNA ASSOCIATED WITH CAMELS IN SOUTH TUVA

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The specific composition and biology of flies associated with camels is of great interest, since many of them are or may be of definite epidemiological or epizootiological importance. Nevertheless, the literature contains hardly any biological information, even on many of the prolific species. In 1955, for example, Ivashkin discovered that Lyperosia titillans, which is widespread in the south of the Soviet Union, is an intermediate host of the helminth Parabronema skrjabini Rassowsko, a parasite of domestic and wild ruminants; yet its biology had hardly been studied at all until then.

Flies associated with the camel are mainly pasture species. They do not fly into buildings and are associated with man only through the intermediary of animals, although the bloodsucking horn flies, gad flies, buffalo gnats and so forth, of course, attack man as well. There is no doubt that many of the facultative and obligate haematophagous species infesting camels are capable of transmitting various kinds of infections both to animals and to man.

The helminthological expedition of the Soviet Academy of Sciences, in which I took part in the summer of 1956, worked chiefly in the region of the Naryn-Gol River in the southernmost part of Tuva, bordering on Mongolia. The material was collected in June-August 1956 from camels belonging to a local livestock collective farm in the Tes-Khem district. In its physical geography South Tuva is a typical sandy semi-desert, dissected by low, treeless ridges. The area lies about 1,000 m above sea level. The Naryn-Gol starts in the N. Mongolian Desert, but the valley is in the Soviet Union for 30 km along the middle course of the river. Here the climate is sharply continental, with considerable fluctuations of diurnal and seasonal temperatures.

This paper sets out the results of a study on the composition and population dynamics of flies associated with camels. Species caught on the animals themselves are considered separately from those caught in camel dung.

I am deeply indebted to V. M. Ivashkin, who led the expedition, for the opportunity of performing the experimental part of the work, and also to L. S. Zimin, N. G. Olsuf'yev, B. B. Rodendorf, I. A. Rubtsov, Ye. S. Smirnov, and A. A. Shtakel'berg, all of whom gave me a great deal of help in determining the material.

METHOD OF WORK

An old female was taken for test purposes from a camel herd at pasture. Flies were removed from the animal with an aspirator for 40 minutes, twice a week (10 minutes each from the back, abdomen, legs and head).

Mechanical mesh traps (0.5 x 0.5 mm mesh) with wooden supports measuring 20 x 20 x 15 cm were used to determine the fly fauna in the camel dung. The height of the legs was 2.5 cm. Fresh dung was used as bait. The traps were usually left for two hours. In order to find out when the dung attracted different species of flies, the traps were removed consecutively at intervals of 15 minutes, 30 minutes,

one hour and two hours after the dung had been laid down. During periods of maximum activity, the dung was removed from under the traps and placed in boxes, in order to determine which species developed in camel dung. In order to learn which species of dung flies fed on fermenting matter, we used kvass (beer made of cereals) in a Petri dish as bait.

Work on the material collected was done at the Department of Entomology of the State University of Moscow and at the Institute of Zoology (USSR Academy of Sciences) in Leningrad.

FLIES PARASITIC ON CAMEL

Species composition. In summer 1956 I collected 3,767 specimens of flies from camels in the course of 14 inspections. It was found that the fly fauna consisted of 22 species belonging to 5 families and 15 genera (see list of species below).

More than 90% of all the flies captured belonged to the family Muscidae. Most numerous among these were Musca amica, Lyperosia titillans, Musca tempestiva. Next in numbers came the Simuliidae (7.5%) and third the Tabanidae (2%). Species of other families were represented by single specimens and constituted only fractions of one percent.

Ecology. Apart from the bot flies, all flies feed on camels only in the adult stage. They can be divided into two groups, according to diet.

In the first group I include the obligate haematophages. To these belong L. titillans, 6 species of Tabanidae and one, very numerous species of the family Simuliidae, Wilhelmia turgaica. The obligate bloodsuckers account for about 30% of the total number of species. An interesting point is that, apart from L. titillans, no horn flies were detected in this area, although 100 km further north I happened to catch several specimens of Haematobia simulans Mg. on sheep and horses.

The second group of flies is the more numerous (about 70%) and comprises 15 species of facultative haematophages. These lick the blood after the animal has been bitten by gad flies and horn flies, and will also lick secretions of the mucous membranes of the eyes, mouth and nose, and the sweat. In this group M. amica clearly predominates (35%); M. tempestiva comes second (21%). Members of the genera Fannia, Morellia, Dasymorellia, Hydrotaea and others are not numerous. In addition, two species of the family Sarcophagidae were found: Blaesoxipha lineata (one specimen) and Ravinia striata (2 specimens).

Two species of bot flies (Gastrophilus intestinalis De Geer and G. haemorrhoidalis L.), although caught on camels, evidently did not belong to their normal fauna. Pyrellia cadaverina was probably a chance visitant.

How long each species remains on the animal is closely dependent on the character and frequency of feeding. L.

titillans leaves the animal only for oviposition and is an almost permanent ectoparasite. How long the other flies remain on the camel is determined by the period (duration) of feeding.

We can thus arrange the species infesting camels according to the degree of haematophagy. *Musca amica* (♂♂) stands at the head of the list. On several occasions I happened to see males with the abdomen filled with blood, but haematophagy is probably of secondary importance in them, since females were found eleven times more frequently on the camels than males, which were usually licking the mucous membrane secretions.

Next comes a series of species which are typical facultative haematophages: *M. tempestiva*, *M. amica* (♀♀), *Fannia* sp., *Morellia hortorum*, *Dasymorellia simplicissima*, *Hydrotaea* and others. *Scatophaga stercoraria* can be regarded as an intermediate link between the facultative and obligate haematophages. According to Dremova (1949), the mouth parts of this species are adapted for independent bloodsucking by scratching the scabs formed on the animal's wounds. This species was captured from camel dung (see below), but the possibility that it feeds on the animal itself cannot be excluded.

The series is completed by a group of obligate bloodsuckers: *L. titillans* (fam. Muscidae), all species of Tabanidae and *W. turgaica* (fam. Simuliidae).

In certain species supplementary feeding is observed. Derbeneva-Ukhova (1942) mentions *M. tempestiva* and *Morellia* as feeding on dung. The only species we obtained from the kvas were *M. amica* and *M. tempestiva* (females).

In the majority of species the peak of diurnal activity coincides with the hottest part of the day. In *L. titillans* peak activity occurs in the early morning (toward the end of the first hour after sunrise) and in the evening (an hour and a half after sunset).

Population curves for the main species. The 22 species of flies feeding on camels include some very thermophilic forms, which develop their peak population during the hottest part of the summer, and also some cold-loving forms whose development is inhibited by high temperatures.

The most numerous were *M. amica*, *L. titillans*, *M. tempestiva*, *W. turgaica*, *T. muehlfeldi*, and *Fannia* species (see Fig. 1). *M. amica* must be placed first in terms of abundance. This is a highly thermophilic species; its population peak coincides with the hottest summer months, July. Next comes *L. titillans*, which is also decidedly a warmth loving species.

W. turgaica has a first population peak in the second half of July, but develops its maximum population in mid-August.

Among the gad flies *T. muehlfeldi* predominates. Its numbers are comparatively uniform throughout July and August.

M. tempestiva must be regarded as a less thermophilic species. Its maximum activity coincides with the cold periods of summer (end of June, beginning of August). Derbeneva-Ukhova (1940) reports similar findings in regard to the cold-loving nature of this species.

Species of *Fannia*, *Hydrotaea* and *Morellia* are relatively cold-loving. Their maximum numbers were observed with the onset of dull, cool weather.

FLY FAUNA ON CAMEL DUNG

Species composition. Camel dung serves as a substrate for the larval growth and imaginal feeding of a considerable number of species of flies.

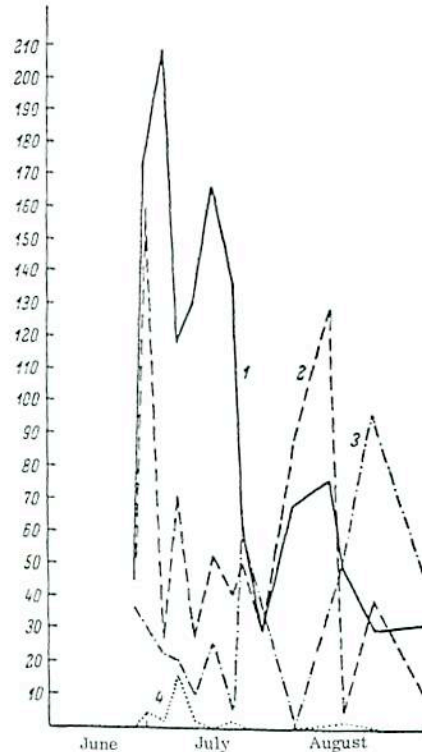


Fig. 1. Population curves for the main species of flies feeding on camels (40 minute catches twice a week from an old female camel).

1) *Musca amica* Zim.; 2) *Musca tempestiva* Fall.; 3) *Wilhelmia turgaica* Rubz.; 4) *Fannia* sp. n.

I made 43 collections from dung, using mechanical traps and a net. Determinations of 1,527 captured individuals comprised 45 species of 16 families and 35 genera (see list of species below). Of these, 26 species belonged to the family Muscidae, which accounted for 90.5% of the total number of flies. In this family members of the genus *Calythaea* predominated (about 65%). Of the genus *Musca*, the most numerous was *M. amica* (7.3%). Also worthy of mention were *Paregle cinerella* (5%), *Pyrellia cadaverina* (2.5%) and *Myiospila mediatubunda* (2%).

Of the family Sphaeroceridae *Borborillus costalis* was captured in considerable numbers (2.9%). *Meoneura* (fam. Milichiidae) accounted for 2.3%. Of the family Sepsidae only one species was caught, *Sepsis nigripes* Mg. (2.7%). Flies of other families were represented by single specimens.

I found two species of Milichiidae, *Meoneura lamellata* and another species of *Meoneura*.

Ecology. Taking into account the distinctive features both of the adult and of the larval habits of the various species of Diptera associated with camel dung, we can distinguish several ecological groups.

In the first group we can include species which are associated with dung in the larval stage, but are facultative or obligate haematophages in the imaginal stage; *L. titillans*, *M. amica*, *M. tempestiva*, *Mor. hortorum*, *R. striata*, and *Scatophaga stercoraria*. Adults of these species were captured on camels and reared on camel dung in cages. *S. stercoraria*, of which we obtained one specimen from dung, can also be included in this group, according to published data (Dremova, 1949; Shtakel'berg, 1956). For certain species of this group (*L. titillans*, *M. amica*,

M. tempestiva and *Morellia*) dung can be a supplementary food. This is confirmed by published data (Derbeneva-Ukhova, 1942) and by my own observation.

The second group consists of species in which the larvae develop in camel dung, but the adults do not feed on the animal. This group comprises the following species: *Myospila mediatubunda*, *Paregle cinerella*, *Calythea pratincola*, *C. albicincta*, *Pegomyia* sp., *Chortophila frontella*, *Muscina stabulans* and others. Other species of the family Muscidae, not mentioned here, can probably be assigned to the same group, together with members of the families Sphaeroceridae, Milichiidae and Sepsidae.

A third group can be tentatively distinguished. This would include species of which solitary specimens, belonging to various families (Trypetidae, Ortalididae, Agromyzidae, Musidoridae, Dolichopodidae, Chloropidae, Chamaemyiidae, Empididae etc.) were captured from dung. They were not reared in cages. The flies of these species probably fed on the dung only incidentally, or they may have fallen into the traps in search of refuge from the sun. Larvae of *Piophilus casei* must have developed in curds, which the Tuva people dry in the open air throughout summer.

Flies caught on kvas and dung yielded 12 species common to both baits: *M. amica*, *M. tempestiva*, *Muscina stabulans*, *Paregle cinerella*, *Calythea pratincola*, *Coenosia* sp., *Hydrotaea glabricula*, *Pegomyia* sp., *Chortophila frontella*, *Meoneura lamellata*, *Oscinella ventricosi* and *Dolichopus* sp. Feeding on plant juices and fermenting matter is obviously widespread among flies associated with camel dung.

On hot days camel dung rapidly acquires a crust and loses its attraction for flies after 3 or 4 hours. In dull weather the flies would visit the dung for a period of 10 hours. The number of flies on the dung was greatest toward the middle of the first hour after it had been dropped. During this time the flies almost completely covered the dung heap.

Comparison between cow dung fauna (Porchinskiy, 1892; Shtakel'berg, 1933; Vaynshteyn and Rozova, 1940; Romanov, 1940; Zimin, 1951; Derbeneva-Ukhova, 1952) and camel dung fauna (our data) shows that both are similar in regard to the composition of the main species.

SUMMARY

1. Study of the fly fauna associated with camels in South Tuva is of interest, since many species have or could have epidemiological and epizootiological importance.

2. During the summer of 1956, 5,294 specimens of flies were caught on a camel and in camel dung. It was found that the fly fauna associated in one way or another with camels numbered 60 pasture species, belonging to 18 families. Of these, 22 species are forms that feed on the animal itself and 45 species feed on the dung.

3. Numerically the most important of the flies associated with camel are those of the family Muscidae.

4. Next most numerous in the group of flies feeding on camels is *Wilhelmia turgaica* (Simuliidae), followed by species of the Tabanidae.

5. The most numerous flies on the animal itself were *Musca amica*, *M. tempestiva*, *Lyperosia titillans*, *W. turgaica*, *Fannia* sp., and *Tabanus muehlfeldi*.

6. Among the flies feeding on camels some are warmth-loving species, the maximum population of which coincides with the hottest summer period (*M. amica*, *L. titillans*, *T. muehlfeldi*), while others are cold-loving, whose development is inhibited by high temperatures (*M. tempestiva*, *Fannia* sp., *Hydrotaea* sp.).

7. Camel flies can be arranged in a series in order of increasing degree of haematophagy. The series is headed by the males of *M. amica*, followed by *M. tempestiva* Fall., females of *M. amica*, *Fannia* sp., *Hydrotaea* sp. and others; the series terminates with obligate bloodsuckers — *L. titillans*, all species of Tabanidae and *W. turgaica*.

8. Among the camel dung flies, the second most numerous after the Muscidae are the Sphaeroceridae, followed by the Sepsidae and the Milichiidae.

9. The most numerous on dung were *Calythea pratincola*, *C. albicincta*, *M. amica*, *Paregle cinerella*, *Myospila mediatubunda*, *Borborillus costalis* and *Sepsis nigripes*.

10. Among the camel dung flies two ecological groups can be distinguished. To the first belong facultative and obligate haematophages, the larvae of which develop in the dung; to the second belong species associated with dung both in the larval and adult stages.

11. In general there is a marked similarity between cow- and camel-dung fly faunas.

LIST OF SPECIES FEEDING ON CAMEL AND THEIR ABUNDANCE (AS PERCENTAGE OF TOTAL)

I. Muscidae (90.7%)	
1. <i>Musca amica</i> Zim. (♀)	32.5
2. <i>Lyperosia titillans</i> Bezzi (♀)	17.3
3. <i>Musca tempestiva</i> Fall. (♀)	17.4
4. <i>Fannia</i> sp. (♀)	4.2
5. <i>Fannia</i> sp. (♀)	1.1
6. <i>Fannia</i> sp. (♀)	
7. <i>Morellia herteram</i> Fall. (♀ & ♂)	
8. <i>Dasyorellia simplicissima</i> Zim. (♀ & ♂)	0.7
9. <i>Pyrellia cadaverina</i> F. (♀)	
10. <i>Pyrellia</i> sp. (♀)	
11. <i>Hydrotaea</i> sp. (♀ & ♂)	7.5
II. Simuliidae (♀)	
12. <i>Wilhelmia turgaica</i> Hubs.	
III. Tabanidae (♀)	
13. <i>Tabanus muehlfeldi</i> Br.	2.0
14. <i>T. montanus</i> Mg.	
15. <i>T. subbaletorum</i> N. Ols	
16. <i>Chrysosona tamerlani</i> Seil	
17. <i>Ch. turkestanica</i> Kröb.	
18. <i>Chrusops ricardae</i> Pl.	
IV. Sarcophagidae	
19. <i>Ravinia striata</i> F. (♂)	0.2
20. <i>Biorosiphia lineata</i> Fall. (♀)	

LIST OF SPECIES ASSOCIATED WITH CAMEL DUNG AND THEIR ABUNDANCE (AS PERCENTAGE OF TOTAL)

I. Muscidae (90.5%)	
1. <i>Calythea</i> sp. & sp. (♀)	50.1
2. <i>Calythea pratincola</i> Fz.	16.5
3. <i>Musca amica</i> Zim. (♀ & ♂)	7.4
4. <i>Paregle cinerella</i> Fall. (♀ & ♂)	3.0
5. <i>Pyrellia cadaverina</i> F. (♀ & ♂)	2.5
6. <i>Myospila mediatubunda</i> F. (♀ & ♂)	2.1
7. <i>Pegomyia</i> sp. (♀)	1.7
8. <i>Lyperosia titillans</i> Bezzi (♀)	1.4
9. <i>Ophra onthras</i> Mg. (♀)	0.7
10. <i>Calythea albicincta</i> Fall. (♂)	0.6
11. <i>Musca tempestiva</i> Fall. (♀ & ♂)	0.5
12. <i>Coenosia</i> sp. (♀)	0.6
13. <i>Coenosia</i> sp. (♀)	
14. <i>Coenosia</i> sp. (♀)	
15. <i>Morellia herteram</i> Fall. (♀)	1.4
16. <i>Hydrotaea glabricula</i> Fall. (♀ & ♂)	
17. <i>Pegomyia</i> sp. (♀)	
18. <i>Helina</i> sp. (♀)	0.7
19. <i>Helina</i> sp. (♀)	
20. <i>Orthella cornicina</i> Fall. (♂)	
21. <i>O. casarion</i> Mg. (♀)	2.9
22. <i>Muscina stabulans</i> Fall. (♀)	
23. <i>Hydrotaea euvripes</i> F. (♀)	
24. <i>H. armipes</i> Fall. (♂)	2.7
25. <i>Chortophila fastipes</i> Zett. (♀)	
26. <i>Chortophila frontella</i> Zett. (♀)	
27. <i>Anthomyia pluvialis</i> L. (♀ & ♂)	
II. Sphaeroceridae	
28. <i>Borborillus costalis</i> Zett. (♀ & ♂)	2.9
29. <i>Leptocera</i> sp.	
III. Sepsidae	
30. <i>Sepsis nigripes</i> Mg. (♀ & ♂)	2.7

	IV. <i>Milichiiidae</i>	
31. <i>Mesocera lamellata</i> Collin (♀ & ♂)		} 2.3
32. <i>Mesocera</i> (♂)		
	V. <i>Dolichopodidae</i>	
33. <i>Dolichopus</i> sp.		}
34. <i>Chrysotus</i> sp.		
	VI. <i>Musidoridae</i>	
35. <i>Musidora</i> sp.		}
	VII. <i>Ortaliidae</i>	
36. <i>Meliera cona</i> Loew		}
	VIII. <i>Tegopteridae</i>	
37. <i>Tephritis</i> sp.		1.6
	IX. <i>Empididae</i>	
38. <i>Leptopiza</i> sp.		}
	X. <i>Plaphilidae</i>	
39. <i>Plaphila casei</i> L.		}
	XI. <i>Chamaemyiidae</i>	
40. <i>Parachthiphila</i> sp.		}
	XII. <i>Chloropidae</i>	
41. <i>Oscinella ventricosa</i> Nart.		}
42. <i>Mesomyza sulfatata</i> L.		
	XIII. <i>Azomyzidae</i>	
43. <i>Disgomyza croceivitta</i> Nrt.		}
	XIV. <i>Scatophagidae</i>	
44. <i>Scatophaga stercoraria</i> L.		1.6
	XV. <i>Sarcophagidae</i>	
45. <i>Havinia strutsi</i> F.		}
	XVI. <i>Simuliidae</i>	
46. <i>Wittelmia turgeica</i> Rubz.		

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