

Tabanid and muscoid haematophagous flies, vectors of trypanosomiasis or surra disease in wild animals and livestock in Nandankanan Biological Park, Bhubaneswar (Orissa, India)

During May 2000, 13 tigers (*Panthera tigris* Linn.) including 12 white tigers died in Nandankanan Biological Park, Bhubaneswar¹, due to an epidemic of trypanosomiasis. These deaths have attracted global attention.

Trypanosomiasis is one of the important diseases of livestock and wild animals which is mechanically transmitted to them by several blood feeding species of flies of the families Tabanidae and Muscidae (Diptera). Hematophagous species of these families are pestiferous and vectors of several viral, bacterial, protozoan and filarial diseases of man and livestock^{2,3}.

Trypanosomiasis is quite common during rainy season, when these flies are in abundance, and causes high mortality in acute form to the animals. It affects horses, cattle, buffaloes, mules, ponies, camels, Indian elephants throughout the tropical and subtropical parts of the world and also carnivores like tigers, dogs, hyaenas, etc., and is common in equines, cattle and camels. Tiger was found more susceptible to surra disease among wild animals of zoos⁴. Trypanosomiasis is commonly known as *Surra* (Hindi, meaning *rotten*) in India and elsewhere, and is caused by the flagellate protozoan, *Trypanosoma evansi* (Steel).

Clinically, the disease is characterized by remittent fever leading to emaciation, anaemia, oedema, debility and uncoordinated movements (gait), enlargement of lymph nodes and spleen and weight loss in a short period among animals. This disease occurs throughout India but has very high incidence in Haryana, Punjab, western Uttar Pradesh and Assam.

Tabanid and muscoid biting flies are the mechanical vectors of surra disease. At the same time, having piercing and sucking mouthparts and being persistent feeders, they may cause annoyance and loss in milk production and in body weight to the animals. Female adults of tabanids are blood feeders, whereas in muscoid flies both males and females do so. About 13 species of tabanid flies are incriminated in the transmission of animal trypanosomiasis in Indian sub-region². Tabanid flies are commonly

known as horse-flies or deer-flies and 241 species are known so far from India (Vijay Veer, unpublished). Muscoid flies are of two types, stable flies and buffalo flies.

These flies represent extremes of host dependence and host specificity, ranging from being completely host dependent in case of buffalo fly to the free-living tabanids, with stable fly being intermediate since it can live independent of the host for a major period of adult life and feeds on them in day time. Although the preferred hosts of stable flies are livestock, they can also use alternate vertebrate hosts. They require at least one blood meal for egg development and the larvae develop in fermenting vegetation or in dung. Buffalo flies are dependent on their vertebrate hosts since they live day and night on the host, and leave it only to lay their eggs in intact fresh host droppings. Buffalo flies require multiple blood meals for egg production.

Nandankanan Biological Park is located amidst natural moist deciduous forest in Chandka range along the banks of Kanjia lake, covering an area of 426 hectares between Bhubaneswar and Cuttack (Orissa) (Figure 1). No information is available so far on the composition of these haematophagous flies of the park and

of their wild animal hosts in India. We therefore undertook a survey of these flies occurring in and around the park area so that suitable control measures can be designed. Flies were collected by using canopy traps (Figure 2) and by hand picking them while feeding on the body of sambar (*Cervus unicolor*) and livestock during 21–25 August 2000 and 9–15 June 2001. Eight species of tabanids and four species of muscid flies were collected (Table 1). Out of these, five species of tabanids and two species of muscids are known vectors of surra.

Family Tabanidae

1. *Chrysops dispar* (Fabricius) (Figure 3 a). The adult fly is 7–10 mm long, slender, yellow and black in colour with long, slender antennae. It can be easily recognized by a characteristic v-shaped marking on the abdominal tergites II to III which may extend to tergum IV.

It is a widely distributed and common deer-fly of the Oriental region. However, it was collected only once from the park on canopy trap during the study period. It is also known from several southeast Asian countries, like Brunei, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Taiwan, Thailand and Vietnam.

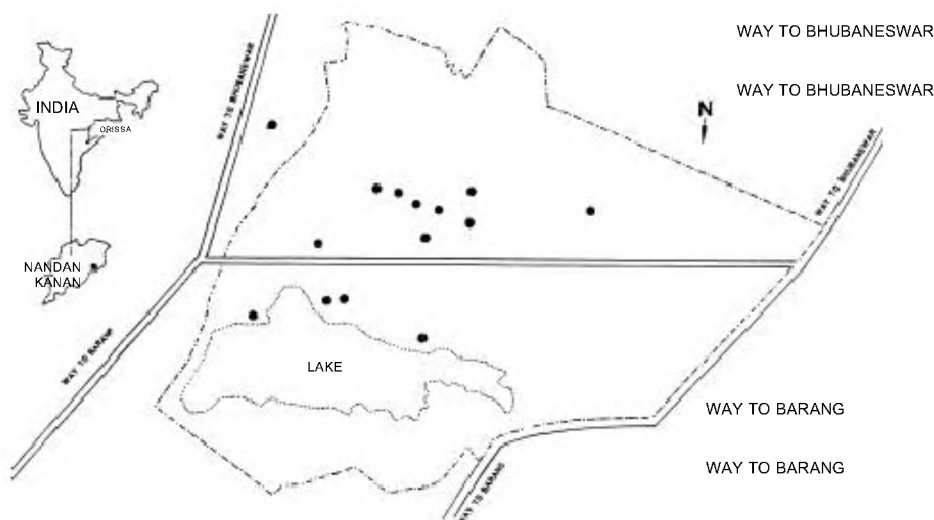


Figure 1. Map of the Nandankanan Biological Park, Bhubaneswar (Orissa) showing sites (●) of flies collection by canopy trap.

Table 1. Species composition and density of various haematophagous flies collected from Nandankanan Biological Park, Bhubaneswar

Family	Species	Collected in canopy trap or from animal body	No. of specimens
Tabanidae	<i>Atylotus agrestis</i>	Tiger area	1
	<i>Atylotus cryptotaxis</i>	Raghunathpur village, School Camp, Tiger and zebra enclosures	8
	<i>Chrysops dispar</i>	Tiger enclosure	1
	<i>Tabanus optatus</i>	Tiger and zebra enclosures	6
	<i>Tabanus partitus</i>	Tiger enclosure	7
	<i>Tabanus rubidus</i>	Tiger, mithan enclosures; on sambar and cattles	7
	<i>Tabanus striatus</i>	Tiger, mithan enclosures, on sambar	2
	<i>Tabanus triceps</i>	Tiger area; on cattles	2
	<i>Stomoxys calcitrans</i>	Tiger, deer and mithan enclosures; on sambar and cattles	62
Muscidae	<i>Stomoxys dubitalis</i>	Tiger enclosure	10
	<i>Haematobia irritans exigua</i>	Tiger, deer enclosures; on sambar and livestock	42
	<i>Musca (Philaetomyia) crassirostris</i>	Tiger, deer enclosures; on sambar	32

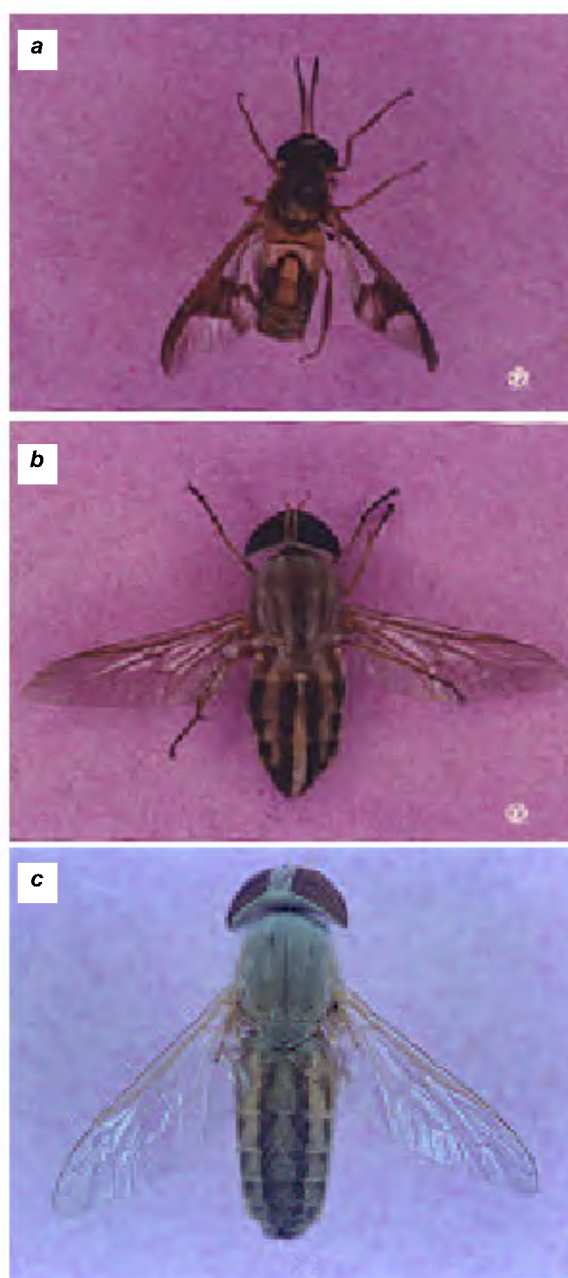
**Figure 2.** Canopy trap for fly collection.

C. dispar has been implicated in the mechanical transmission of surra, and buffalo sickness disease².

2. *Atylotus agrestis* (Wiedemann) (Figure 3 c). Adult fly 13–15 mm long, with two distinct circular light brown callosities on frons. Frons (frontal space between eyes) parallel-sided. Eyes bare, rusty brown in dried specimens, but a single purple band visible in relaxed specimens. Eye colour in life pale apple-green with shining dark spots. Basicosta on wings with yellow setae. Abdomen blackish with two sublateral stripes on orange or reddish yellow ground colour; median stripe indicated by yellowish setae on blackish ground colour.

This fly was collected only once from the park but it is widely distributed in the Palaearctic and Afrotropical regions and in some Oriental countries (India, Sri Lanka, Pakistan) and China. It is common in northern and central India and has been incriminated in surra disease transmission in India⁵.

3. *Atylotus cryptotaxis* Burton. Medium-sized fly, 8–10 mm long and orange brown in colour. In life its eyes are merchant green in colour which disappear after death. Frons with a small basal callosity with a short median, streak-like extension. It was found to be common in the park area during the present study. Earlier

**Figure 3.** Habitus of (a) *Chrysops dispar*, dorsal; (b) *Tabanus triceps*, dorsal; (c) *Atylotus agrestis*, dorsal.

it was known from Assam in India and in Thailand.

4. *Tabanus optatus* Walker. Adult fly is 15–18 mm long and reddish in colour. Frons parallel-sided and five times as long as broad, basal callosity well separated from eyes with a median extension reaching up to middle of frons. The wings are brownish at base and with a median brownish band. *T. optatus* is common in and around park area. This is the second report of this species from India, earlier it was recorded from Bihar⁶. It is widely distributed in Indonesia, Java and Sumatra. This species has been implicated in the transmission of surra disease among animals in Indonesia².

5. *Tabanus partitus* Walker. Medium size fly (10–13 mm in length), brown to grey in colour with trivittate abdomen. This fly is very similar to two other trivittate flies of the park, *striatus* and *triceps* and is difficult to separate from them. The adult fly has a complete pale median abdominal stripe, which is incomplete on tergum II in *striatus* and the fore tibia is bicoloured with blackish apical one-third and paler basal two-thirds.

It is one of the common flies of the park and is being recorded for the second time from India. Earlier it was reported from Assam and Sikkim⁷. It is common in south-east Asian countries. The adult fly is an important mechanical vector of surra disease and is also implicated in the transmission of anthrax⁸.

6. *Tabanus rubidus* Wiedemann. A large and robust fly, 13–20 mm long. Frons parallel-sided but divergent above, basal callosity triangular with a median extension. Eyes dark green and unpatterned in life. Abdomen with brown to black areas, median stripe nearly parallel-sided, and with two sublateral stripes present appearing step-like.

T. rubidus is common in the park area and was collected many times from the body of wild sambar and mithan and also from the cattle of adjoining villages. It is the most widely distributed and abundant fly in the plains of our country and is known to occur from Pakistan to the Philippines and China to Indonesia. This species has been incriminated as the most notorious carrier of surra disease in India⁵.

7. *Tabanus striatus* Fabricius. This fly is similar to *partitus* in size (10–14 mm long) and appearance. Frons parallel-sided and slightly divergent above. Eyes in life dull brown and without bands. Abdomen trivittate with a dorsal median pale stripe

evanescent or absent on tergum II. Abdomen with blackish ground colour. Fore tibia sharply bicoloured with pale basal two-thirds and blackish apical one-third. Male with clear costal cell. *T. striatus* is not common in the park. It is found throughout India and is common in north India. It has also been recorded from Pakistan, Sri Lanka, northern and eastern Thailand, Laos, Cambodia, Vietnam and China. It is one of the important vectors of surra disease in India^{5,8}.

8. *Tabanus triceps* Thunberg (Figure 3 b). Adult fly is usually larger (14–16 mm in length) than the other two trivittate flies, *striatus* and *partitus* of the park. Frons slightly divergent above, frontal callosity narrowly separated from eye margins and median callosity spindle-shaped and narrowly joined to dorsal extension of basal callosity. Abdomen trivittate, mid-dorsal stripe complete and broad on tergum II, sublateral pale stripes noticeably step-like; venter uniformly grey tomentose and pale pilose. Fore femur and fore tibia are uniformly orange to orange brown in colour but are apically darkened. Thoracic stripes are distinct. The male has a yellow tinted costal cell on the wing.

T. triceps is not common in the park but is distributed throughout the country, and is common in northern India. It is also found in Pakistan and Sri Lanka.

Family Muscidae

1. *Stomoxys calcitrans* (Linn.) (Figure 4). Adults 4–7 mm in length and grey in colour with four black stripes on thorax and black-checked board markings on abdomen. Frons twice as long as wide at vertex in male, one-and-a-half times in female, proboscis projecting sword-like from beneath the head and more than

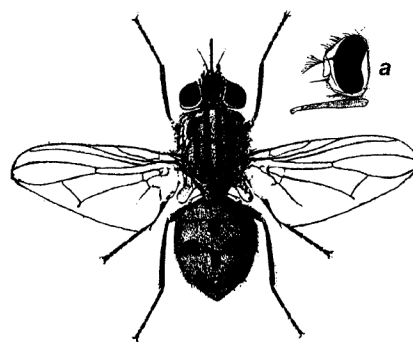


Figure 4. Habitus of *Stomoxys calcitrans*, dorsal. a, lateral view of head and mouth parts.

twice as long as the thread-like maxillary palps. Antennal arista with rays on upper side only. *S. calcitrans* is commonly known as stable fly, and to the untrained eye looks like the common house fly, *Musca domestica*.

It is found abundantly common on the park animals like sambar, spotted deer, mithan (a hybrid cattle between Indian bison and domesticated cattle), blackbuck (*Antelope cervicapra*), and on carnivores like tiger, leopard and lion. The fly usually prefers to feed below the knees and hocks of the host. It is the most widely distributed and cosmopolitan pest of livestock.

S. calcitrans causes debility in the host animals by blood-feeding and annoyance, resulting in weight loss and reduction in milk production. It can transmit a number of disease organisms among the host animals. It is an important mechanical vector of surra disease, in the absence of tabanid flies and also of equine infectious anaemia (EIA) virus³.

2. *Stomoxys dubitalis* Malloch. Adult fly 4.8–6.6 mm in length and fuscous-black with pale grey and brown dust. It is very similar to *calcitrans* and can be separated by the narrower frons and by markings on the abdomen. This fly is as common as *calcitrans* in the park and is found on the livestock, sambar, mithan, tiger and lion. It is also known from Sri Lanka, Myanmar, Bangladesh, China and Malaysia, and nothing is known about its disease transmission ability.

3. *Haematobia irritans exigua* de Meijere. Also known as *Lyperosia exigua*. This fly is smaller than the stable fly. Adult *H. irritans exigua* are 2.8–4.2 mm in length and grey in colour with darker marking on some parts of thorax. Palps as long as proboscis. It is commonly known as buffalo fly, and is very similar to another subspecies, *H. irritans irritans*, commonly known as horn fly, found throughout the world. The buffalo fly is found in Indonesia, Malaysia, Papua New Guinea, China, and northern Australia.

H. irritans exigua is a common fly in the park and was observed on the body of mithan, sambar and tiger. This fly is not important as a mechanical vector of surra³.

4. *Musca (Philaematomyia) crassirostris* Stein. Adult fly 4.5–6.5 mm long, with ash-grey body colour, and stout proboscis with prestomal teeth which are used for scratching the sore skin so that blood flows more freely. It is a common

blood feeding species which is collected in large numbers from the park in canopy trap and from livestock in the surrounding area.

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Advertisement call, courtship and mating behaviour of the frog, *Limnonectes syhadrensis* from Western Ghats, India

Amphibian fauna of India comprises as many as 228 species, of which 121 inhabit the Western Ghats¹. Many aspects of biology of these species remain unknown. Studies on bioacoustics of Indian anurans are restricted to a few species², whereas those on their breeding biology are even more scarce. *Limnonectes syhadrensis* is widely distributed in the Western Ghats and peninsular India³. It is also found in Pakistan and Nepal^{4,6}. Despite its relatively broad range and high abundance in some regions, very few studies have been made on this species. In this paper we describe the advertisement call, courtship and mating behaviour of the frog in the Western Ghats.

During the monsoon season, fieldwork was undertaken to study the breeding biology and bioacoustics of *L. syhadrensis*. Tape recordings of the calls were made in several parts of the Western Ghats between 1995 and 1999. The study areas included places around Sirsi (14°34'N, 74°32'E), Sagar (16°37'N, 76°51'E), Jog Falls (14°45'N, 74°53'E), Shimoga (13°56'N, 75°38'E), Sringeri (13°25'N, 75°15'E), Kollur (13°53'N, 74°53'E), Londa (15°60'N, 74°53'E) and Karwar (14°48'N, 74°11'E). Calls were recorded on Sony cassette tape using AKAI AJ 490 FS tape recorder and AKG, D 707C/190C, D-1000 I directional microphones. Microphones were held within a distance of 10 cm from the calling frogs. Air and water temperatures were measured at the time of recording

using a digital thermometer. LUTRON SPL meter was used to measure the sound pressure level. Calls of 20 frogs were analysed at Zoological Institute, University of Bonn, Germany, by using the computer program MOSIP (R) Spectro analysis V6 8, 41/89, MEDAV GmbH. The statistical analysis was carried out with Statagraphics Program, STSC Inc., Knoxville, USA. Observations on courtship and mating behaviour were made around Jog Falls between June and August 2000-01.

L. syhadrensis is a small-sized frog, male snout to vent length (SVL): 17.5-19.1 mm (18.3 ± 0.82 , $n = 10$), female SVL: 20.7-22.8 mm (21.3 ± 0.63 , $n = 10$), distributed in a large portion of the Western Ghats. Males, using a single subgular external vocal sac (Figure 1), emit advertisement call during the breeding season along with the sympatric species *Limnonectes limnocharis*. Calling activity begins after one or two heavy pre-monsoon (April/May) or monsoon (June) rains and continues up to the end

of the rainy season (September/October). The males call mainly during night beginning at 18.00 to 20.00 h and continue until the morning of the following day (6.00 h). Occasionally, calls were heard during daytime. They prefer to call from temporary shallow water pools. Calling is in chorus, rarely individual calling males are observed. Calls are emitted from the surface of the ground as the males sit under partly submerged grass or paddy. The calling position is upright, the head held upwards with the help of stretched forelegs and the hind legs are folded and totally immersed in water. Though there is chorus-calling, a regular distance ranging between 0.5 and 1.0 m (0.82 ± 0.33 , $n = 10$) is maintained between any two calling individuals. Calls are antiphonal between the two nearest calling males.

The advertisement call of *L. syhadrensis* consists of a series of pulse groups and the number of pulse groups per call varies between 7 and 28. The first pulse group is the largest, consisting of 9-11 pulses and the remaining pulse groups

Table 1. Acoustic features of advertisement call of *Rana syhadrensis*. Calls of 20 randomly selected individuals were used for statistical calculation

Parameter	Sample size	Mean \pm SE	Range
Call duration (ms)	25	903.6 \pm 48.4	447-1547
Call interval (ms)	22	2457.0 \pm 177.0	1243-4169
Call period (ms)	21	3224.5 \pm 211.2	1485-5227
Pulse groups/call (<i>N</i>)	32	13.2 \pm 0.9	7-28
Pulse group duration (ms)	140	32.1 \pm 0.8	19-74
Pulse group interval (ms)	140	51.4 \pm 1.7	19-125
Pulse group period (ms)	140	84.3 \pm 2.2	43-176