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Survey of Tsetse and Biting Flies in Gobu Sayo District, East Wollega, Oromia Region, Western Ethiopia

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Abstract: The study was conducted from December to April 2020 in Gobu Sayo district to avail information on apparent densities of tsetse and biting flies. Materials: Traps were used for the collection of flies. Forty-seven traps were deployed for 48 h. Entomological survey: a total of 8 tsetse flies, 13 Stomoxys and 29 Tabanus were caught from the two selected peasant associations (PAs). The *Glossina* species captured was *G.* tachinoides (100 %). The overall apparent density of tsetse flies trapped was 0.085 flies/trap/day and female tsetse flies were foremost in number. Different apparent densities of tsetse flies were recorded in two villages or PAs (0.1 in Adere and 0.0682 in Sayo). Biting flies caught were Stomoxys 13 (27.6 %) and Tabanus 29 (61.7 %). However, a low density of tsetse flies was recorded and these flies are very important in transmitting trypanosomosis in Gobu Sayo district either biologically or mechanically. In conclusion, tsetse and biting flies are the major vectors threatening production and productivity of the livestock subsector in the study area. Thus, it requires due attention in tsetse fly and other biting vector control. So, appropriate tsetse control methods should be warranted to alleviate the problem in the area.

Key words: Apparent Density · Glossina · Trypanosomosis and Vector

INTRODUCTION

Livestock contribute a large proportion of the continent's gross domestic product (GDP) and constitute a major source of foreign currency earning for a number of countries. Livestock production, indeed, contributes to improving food security and poverty alleviation in the developing world. However, animal diseases, lack of improved stock, poor food resources and other multifaceted problems limit the potential of livestock [1].

Domestic livestock in Africa are important as a source of protein (milk & meat) to humans, as a source of animal traction, as a source of income (e.g., hides) and investment (social security) and as a source of manure for enhancing agricultural (crop) production. Tsetse-transmitted trypanosomosis affects 37 sub-Saharan countries; an estimate of 160 million cattle and 260 million sheep and goats are kept in this area of risk extending over 10 million km^2 of land [2].

Sub-Saharan Africa faces multiple ecological, economic and social constraints that limit development [3]. Ethiopia is chiefly an agricultural country whose economy is largely dependent on crop and livestock production. Besides its direct contribution in terms of gross domestic product and foreign earnings, livestock provides virtually all the draught power for cultivation and transportation of agricultural crops and people in rural areas of the country [4].

A major constraint for the development of many East African agro-pastoral communities is African animal trypanosomosis, or nagana, caused by *Trypanosoma* spp. and vectored by species of tsetse flies (*Glossina* spp.) and key questions are how should this constraint be removed or managed and what are the eco-social consequences? The traditional view of humans managing ecosystems from the outside has been revised to include humans as integral parts of so-called eco-social systems, with the management objective seen as the enhancement of sustainability [5].

Tsetse (US /'si?tsi/, /'tsi?tsi/ or UK /'ts?tsi/), sometimes spelled tzetze and also known as tik-tik flies) are large biting flies that inhabit much of midcontinental Africa between the Sahara and the Kalahari Deserts [6]. Tsetse flies in Ethiopia are confined to the Southern and

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Western regions between longitude 33° and 38°E and latitude 5° and 12°N. They infest areas that together amount to 220,000 km^2. Tsetse-infested areas lie in the lowlands and also in the river valleys of Abay (Blue Nile), an infestation that is currently considered as one of Baro, Akobo, Didessa, Ghibe and Omo [7]. About 15-20 % of the land believed to be suitable for livestock production is affected by one or two species of the tsetse fly [8]. Consequently, new areas are being invaded and settled communities are being continually evicted by the advancing tsetse. These areas include the areas in the Upper Didessa Valley, the northern and northeastern edges of Lake Abaya in the rift valley and the upper reaches of the Omo-Ghibe and its tributaries.

According to whom in this account of his journey through southern Ethiopia is the ‘Gendi-fly’ (tsetse) attacking his transport animals and causing a disease locally called ‘Gendi/Kosa’ (rypanosomosis) from which many animals died [9]. So, the earliest history of trypanosomosis in Ethiopia is in accounts given by explorers and travelers telling of the losses of their transport animals when they had encountered tsetse fly belts. Five species of Glossina (*G. m. submoristans*, *G. pallidipes*, *G. tachinoides*, *G. f. fuscipes* and *G. longipennis*) have been recorded in Ethiopia and except for G. longipennis, all of them are widespread and of significant economic importance [10]. It is prevalent in two main regions of Ethiopia, i.e., the Northwest and the Southwest regions. In most low-lying areas, especially in the southwest, they are infested with trypanosomosis, which deters animal production [11].

Tsetse can fly at about twenty kilometers per hour and they are active for something like 30 minutes each day [12]. So they could travel up to 10 km every day. However, they tend to make many short flights every day and these are not all in the same direction. Hence, in practice, savannah species such as Glossina morsitans and *G. pallidipes* move about one kilometer a day and a fly front can advance about 25 kilometers in a year [13]. This movement means that areas cleared of tsetse rapidly become re-invaded from adjacent infested areas. Indeed, in experiments carried out in Zimbabwe in the 1980s, virtually every fly in a 4-square kilometer block was killed by aerial spraying in one night within a day; the catches in the block were back to normal because flies had swarmed back into the block from neighboring areas [14]. Tsetse fly can be differ from other biting flies by their feathery arista of antennae that have further hairs branching off them and presence of the discal medial cell of the wing having a shape like a butcher’s cleaver referred to as a “hatchet cell” [15].

Trypanosomosis, a debilitating and fatal disease of various domestic animals, is caused by the protozoan parasite of *Trypanosome species* [16]. With the exception of *T. equiperdum*, which is a venereal disease, all have arthropod vectors in which transmission is either cyclical or noncyclical. In cyclical transmission, the tsetse fly is necessary as an intermediate in which the trypanosomes multiply, undergoing a series of morphological transformations before the infective stage for the next mammalian host is produced [17]. Tsetse-borne trypanosomosis occurs only in Africa south of the Sahara, where there are tsetse flies. Animals become sick with trypanosomosis after they are bitten by infected tsetse flies [18]. Six species of trypanosomes are recorded in Ethiopia and the most important trypanosomes in terms of economic loss in domestic livestock are the tsetse-transmitted species: *T. congolense*, *T. vivax* and *T. brucei* [19].

Currently about 3 million livestock die every year due to tsetse fly-transmitted trypanosomiasis in 10 million km^2. A recent study estimated the direct annual cost of trypanosomiasis to be about 1.34 billion US $. African livestock producers are administering an estimated 35 million curative and prophylactic treatments annually, which costs the producers and the government at least US$35 million [20].

Trypanosomiasis of domestic livestock covers a greater area than human trypanosomiasis. It has major importance in cattle and, in some regions, in camels, pigs and other domestic animals. The reduced capacity for work animals is also a very important factor, where 80 % of the traction power in African agriculture is provided by animals. Generally there is a great threat of trypanosomiasis, which is a major obstacle to the economic development of the African continent and also reasonable for the incalculable toll on human health [2].

Over the past decades, studies have shown that the distribution of tsetse flies is related to ecological and climatic conditions as well as the availability of suitable hosts [21]. The tsetse fly requires a habitat strongly influenced by ecological and climatic features, particularly temperature, rainfall, soil and vegetation type and other climate variables [22]. Tsetse lives in habitats that provide shade for developing pupae and resting and breeding sites for adults [6] Their development is temperature- and humidity-limited, like that of many invertebrates. Temperature extremes, particularly below ten degrees Celsius, lead to adult fly mortality through starvation and water loss via respiration. Low humidity or moisture levels (directly related to precipitation) are also involved in fly mortality [5]. Therefore, determining the distribution and apparent density of vectors in the study area is the goal of the current investigation. Therefore, determining the distribution and apparent density of vectors in the study area is the goal of the current investigation.

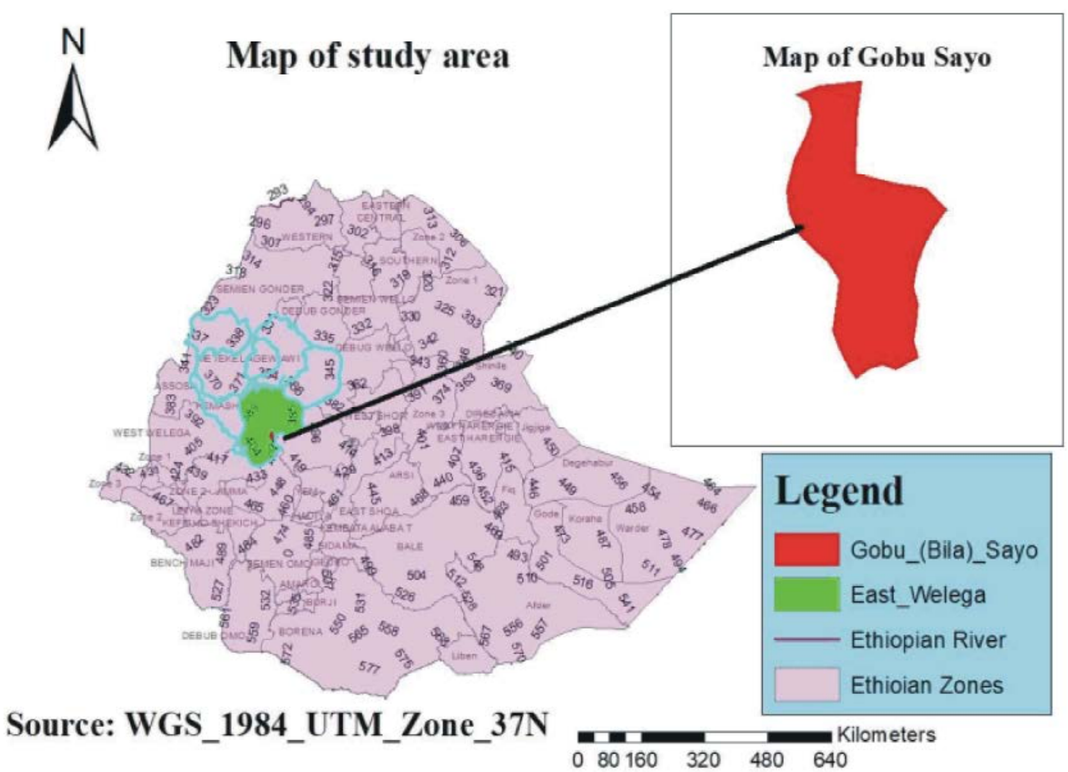
MATERIALS AND METHODS

Study Area: A cross-sectional study was conducted from December to April 2020 in two peasant associations (PAs) of Gobu Sayo district (Adere and Sayo). Gobu Sayo District is located in the eastern Wollega zone of the Oromia region, in the western part of Ethiopia, about 263 km from Addis Ababa. It's the midland area with a hot and humid climate. The mean annual temperature of the district ranges between 15°C 20°C, whereas the mean annual rainfall may reach to 2000 mm (the District Agricultural and Rural Development Office). The district has an altitude range from 1500 to 1750 m.a.s.l. with an average altitude of 1625 m.a.s.l. [23].

In the study of peasant associations, there are Anger river basins that flow throughout the year to the Didessa river and other seasonal river states are tributes to the Anger river. The area is covered with a variety of vegetation patterns of cultivated land, bush land, savannah grassland and patches of dense forests and strips of riverine forests along the riverbanks. The areas have a number of wild animals such as bush pigs, warthogs, bush bucks, kudu, crocodiles, hyenas and snakes, which are claimed to serve as sources of food for the vector of trypanosomes.

Study Population: Total area of Gobu Sayo district is about 33,153 hectares of land with annual population of 226,791 5334 sheep, 9283 goats, 72 horses, 3300 donkeys, 601 mule and 24954 poultry [23].

Study Design and Sampling Techniques: Gobu Sayo woreda was selected purposely based on the extent of the existing problems of trypanosomosis, the complaints of farmers and the level of low to medium tsetse challenge in the area. A cross-sectional study design was employed and two peasant associations (Adere and Sayo) were selected based on the veterinarian and farmers reports of the trypanosomosis and tsetse infestation in the woreda. During the study period, 47 baited traps were deployed along livestock grazing areas, watering points, wild game reserve areas, savanna grassland and sub-savanna areas of dense riverside forests in the districts. Out of 47 traps, 25 were deployed in Adere Hunger River and 22 were deployed in Sayo village.



The apparent density was determined based on the mean catches of flies in traps deployed and expressed as the number of fly catches per trap per day [24]. This entomological survey was conducted by deploying a total of 47 mono pyramidal baited traps, which were the most important to catch riverine species. The cage and trap were supported externally by poles; the cone is supported internally by a center of pole end [25]. It was deployed just before the sunrise in the morning in different positions (riparian and savannah) that were very suitable areas for tsetse habitats. This helps to assess apparent densities, distributions and species of tsetse flies and other biting flies, which are responsible for trypanosomosis transmission.

All traps were baited with acetone and octenol (1-3-octane) was dispensed from open vials through an approximately 'O'-sized hole while cow urine was filled separately in an open bottle into which a quarter of tissue paper was used and deployed at an interval of 200-250 m. All odors were placed on the ground about 30 cm upwind of the trap. The coordinates of each trap position were recorded with a Global Positioning System (GPS) and found in the range between 1565 and 1866 meters above sea level (Table 1). After 48 h of trap deployment, the cages were collected and captured flies were identified and sexed according to morphological characteristics and counted [26].

The tsetse flies were identified to the species level and the other biting flies to the genus level [24]. The apparent density elements were the amount of flies collected from the traps deployed, the number of the traps deployed and the period of deployment in days and it is calculated as the number of flies collected per functional trap per period of deployment in days [24].

Statistical Analysis: The apparent density of fly population was calculated by dividing the number of flies caught by the number of traps deployed and the number of days of deployment and expressed as fly/trap/day (FTD) [27].

RESULTS

Entomological Survey Result: A total of 8 tsetse flies were trapped by deploying 47 mono-pyramidal traps. The tsetse fly caught during the study period was *G. tachnoides* (Table 2). The overall apparent density of tsetse flies was 0.085 flies/trap/day (FTD). An entomological survey was conducted and a total of 8 tsetse flies, 13 Stomoxys and 29 Tabanus were caught from the two selected PAs during the study period.

A total of 8 tsetse flies caught during the study period were subjected to sexing. Accordingly, 87.5% were females and 12.5% were males. Other biting flies, including Stomoxys (13) and Tabanus (29) species, were also caught. The apparent densities of Tabanus and Stomoxys were 0.31 and 0.14 f/t/d, respectively.

Separation of Tsetse from Other Blood-Sucking Flies: Tsetse are crudely similar to other large flies, such as the housefly, but can be distinguished by various characteristics of their anatomy either with the aid of the naked eye or with the microscope. The species of tsetse and other biting flies were identified based on morphological characteristics such as size, color, wing venation and proboscis at the genus level. Tsetse folds their wings completely when they are resting so that one wing rests directly on top of the other over their abdomens. The arista of the antenna has branched hairs on its upper surface. They also have a long proboscis, which extends directly forward and is attached by a distinct bulb to the bottom of their heads; they have a hatchet cell on the wings. But other blood-sucking flies (mechanical transmitters) have a proboscis that is angled at its base and has no bulb; arista has unbranched hairs on its upper surface; they have no hatchet cell on the wing; and their wings are held out at an angle to the abdomen at rest.

Also, it needs clarification to distinguish tsetse flies among themselves. For instance, Glossina morsitans has a dark ring on the 4th tarsal segment of the front leg and the dark last two tarsal segments of the hind leg. Glossina pallidipes has the pale 4th tarsal segment of the front leg, the dark last two tarsal segments of the hind leg and the long median scutellar bristles. Glossina fuscipes has the dark color of most of the tarsal segments of the hind leg and it has a very narrow pale area that crosses each abdominal segment. But, in the case of Glossina tachinoides, there is a dark color on most of the tarsal segments of the hind leg.

Apparent Densities of Tsetse Flies Based on Sex and Vegetation Types: Sexes of the tsetse flies were determined just by observing or palpating the posterior end of the ventral aspect of the abdomen with microscopic lenses; as a result, male flies were easily identified by the enlarged hypophgeum in the posterior ventral part of the abdomen (Table 2).

Table 1: Entomological survey based on peasant associations

Pas	Longitude	Latitude	Altitude	Number of traps dyed	Types and species of flies		Sex F	M	Total	(F/T/D)
Adere	36.94900-37.31838	7.41844-9.50506	1565-1866	25	Tsetse flies Biting flies	*G. tachnoids*	4	1	0.1	
						Total	4	1	5	
					Biting flies	*Stomoxy*	2	3	5	
						Tabanus	3	9	12	
Sayo	37.31413-37.34030	7.39597-7.44767	1549-1896	22	Tsetse flies		-	-	-	0.0682
						G. tachnoides	3	-	3	
						Total	3	-	3	
					Biting flies	*Stomoxy*	5	3	8	
						Tabanus	11	6	17	

NB: PAs = Peasant Associations. Associations, *G. = Glossina, G.m. = Glossina m. morsitans, Male,* F = Female. F/t/d = fly-trap- day

Table 2: Apparent densities of tsetse fly species (F/t/d) in different sex and vegetation types

	Mean fly catches/trap/day			
Variables	*G. tachnoides*	*G. m. sub morsitans*	*G. pallidipes*	*G. fuscipes*
Vegetation type				
Riverine	0.085	-	-	-
Savanna	-	-	-	-
Forest	-	-	-	-
Sex				
Male	0.01	-	-	-
Female	0.074	-	-	-

NB: F/t/d = Fly-trap-day

DISCUSSION

The study was conducted from December to April 2020 in two peasant associations (PAs) of Gobu Sayo district (Adere and Sayo) of Eastern Wollega zone, Oromia regional state, to assess the distribution and apparent density of tsetse and other blood-sucking flies in the study area. In the present study, an entomological survey was conducted by deploying traps in different positions at approximate intervals of 200-250 m for 48 h in watering and grazing points in which the fly and vector are believed to have frequent contacts. The altitude levels, kebelles, numbers of traps, tsetse species caught, other biting flies, days and vegetation types were recorded during the sampling period. In Gobu Sayo district, a very large number of factors may reduce the apparent density of tsetse flies; e.g., the climate, the topography and the type of vegetation affect the outcome. In addition, since the method involves the use of bush clearing, every precaution must be taken to avoid the major effect of air pollution rather than for the effectiveness.

Accordingly, a total of 8 tsetse flies (one species of) with an apparent density of 0.085 flies per trap per day were caught from the two selected PAs during the study period. Apparent densities of tsetse flies with respect to trapping sites were recorded as 0.1 and 0.0682 F/T/D at Adere and Sayo, respectively. Additionally, about 42 other blood-sucking flies or mechanical transmitters (13 *Stomoxys* and 29 *Tabanus*) were caught. From the total of tsetse flies collected, the majority of them (87.5 %) were females. The higher number of females than males might be related to the longer lifespan of females than male tsetse flies [28].

In the present entomological survey, the density of tsetse flies was lower than expected. This is because traps were deployed during the late dry season, which indicates low fly density since season is an important factor determining the distribution of tsetse flies [28].

This result was relatively in line with Lelisa [29], who reported that a prevalence of bovine trypanosomosis and apparent density of tsetse and other biting flies in Mandura District, Northwest Ethiopia, reported 0.06 flies/trap/day, was recorded in the district and lower than the finding of Leak *et al.* [24], in which they reported 0.31 and 29.62 flies/trap/day in two sites in selected villages of Arba Minch, southern Ethiopia and Bakele and Desta [27] also reported 1.45 flies/trap/day of *Glossina* in East Wollega, Ethiopia.

The low apparent density of tsetse flies by this study may be due to bush clearing by resident farmers for farming systems and attributed to the application of tsetse control measures such as target-impregnated insecticides and insecticide treatment of cattle from neighboring kebeles.

Catching of female tsetse flies showed a high degree of deviation from the expected 1:3 ratio with a significant relationship. Females accounted for 87.5% of the catch during this study. This result is high density to the report of Bekele [30] and Bancha [31], where this indicated about 63.2% and 60% catch of female, respectively.

The result of the study indicated that *G. tachnoides* was a tsetse fly species caught in the study area along with other biting flies, which was in agreement with the Annual Report of the National Tsetse and Trypanosomosis Investigation and Control Center (NTTICC), which reported that G. was in the Mandura District along with other biting flies during the epidemiological period [32]. Glossina tachinoides was the only species of tsetse fly caught in the study area. Similar findings were reported previously by various researchers that the dominant species of Glossina in the upper Anger and Didessa river valley was *G. tachinoides* [33].

The geographical distributions of the tsetse flies were concentrated in the lowland area, as climatic conditions are more favorable. Typical habitat patterns found in riverine species (*G. tachnoides*). Most of the tsetse flies were caught in the lowland areas and the apparent density decreases as altitude increases. Even though the finding indicated that tsetse and other biting flies were less prevalent, the finding is supported by earlier 88 works in the Tsetse and Trypanosomosis Survey of Ethiopia. Ministry of Overseas Department UK, Altitudinal distribution of tsetse flies in the Fincha valley (western part of Ethiopia), Tsetse Biology and Ecology, Their Role in the Epidemiology and Control of Trypanosomosis in association with the ILRI and Epidemiological Survey of Bovine Trypanosomosis in Sayo District of Kellem Wollega Zone, Western Ethiopia, who indicated that climate, which is largely dependent (influenced) by altitude, has an impact on tsetse population [34].

CONCLUSION AND RECOMMENDATIONS

Tsetse flies are responsible for transmitting trypanosomosis in Gobu Sayo district either biologically or mechanically. The current situation may not get worse as the prevention and control of trypanosomosis is undertaken in the area. Educating the farmers in the area on how to control the vectors and expanding appropriate tsetse control methods (pour-on animal and insecticide-impregnated targets) to reach tsetse-infested areas in a sustainable manner, giving attention to reinvasion of the reclaimed area to effectively utilize the control efforts and advising people not to take their cattle to infested rivers and the known main tributaries can be additional solutions until the control program brings about the desired result.

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