

**A Report of Integrated Vector Surveillance in Belauri Municipality of
Kanchanpur District**

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Submitted by:

Hem Raj Joshi

VCSO, PHD Doti

Prakriti Pant

Entomologist, PHD Doti

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Team members:

1. Hem Raj Joshi (Vector Control Supervisor Officer, PHD, Doti)
2. Dipendra Singh Rawal (Vector Control Supervisor Officer, Health Office, Kanchanpur)
3. Prakriti Pant (Entomologist, PHD, Doti)
4. Hari Prasad Bohara (Lab Technician, Daijee Health Post, Kanchanpur)
5. Bali Mahato (Retired Entomology Field Technician)
6. Shiv Shankar Jha (Retired Entomology Field Technician)
7. Dipak Chand (Lab Assistant, Shreepur PHC, Belauri)

Hem Raj Joshi

Prakriti Pant

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ABSTRACT

Vector borne diseases are one of major public health problems in Sudurpashchim Province of Nepal. Entomological surveillance enables us to understand composition, abundance and distribution of vector species in any locality, and is an essential component of malaria vector control programs, operational activities and research. Belauri Municipality of Kanchanpur district lies in the southern part of the district and connected to India border as well. The present survey was conducted from 2080/03/04 to 2080/03/09 to know the current status of mosquito vectors in this area. Total 387 mosquito specimens were collected during the field work of which most abundant was *Culex* sp. (251 individuals, 64.86%), followed by *Armigeres* sp. (62 individuals, 16.02%). *Anopheles annularis*, *Anopheles culicifacies* and *Phlebotomus argentipes* were also recorded during this study. Anopheles mosquitoes were collected from indoor resting collection and light trap, animal bait and larval collections, while sandfly *Phlebotomus argentipes* was trapped in light trap only. In spite of the vector control interventions still there were found vector species for malaria, so it is important to focus on management of breeding habitats and minimizing human-vector contact in this area.

Key Words: Belauri, indigenous malaria, Anopheles, Culex, *Phlebotomus argentipes*

1. INTRODUCTION

Insects belong to the largest phylum in the animal kingdom, arthropoda, and play key roles in ecosystem. Yet, blood-feeding i.e. hematophagous arthropods such as mosquitoes, sandflies, ticks, mites etc. serve as vectors for devastating parasitic and viral human diseases and show tremendous individual variation in their capacity to transmit diseases (Baxter et al., 2017). Vector-borne diseases (VBDs) are caused by parasites, viruses and bacteria and transmitted to humans by different vectors. VBDs are major public health problems particularly in tropical and sub-tropical regions of the world. In the WHO South-East Asia Region (SEAR), the VBDs that are of major public health importance are malaria, dengue, Japanese encephalitis (JE), chikungunya, lymphatic filariasis and kala-azar (WHO, 2014). In addition to these, scrub typhus has been a major public health problem in Nepal since 2015 (Dhimal et al., 2021).

Mosquitoes are medically important insects as they act as vectors for major prevalent vector borne diseases in Nepal such as Malaria, Dengue, Lymphatic filariasis and Japanese encephalitis. Mosquitoes are being searched and studied in Nepal from 1958 in connection with "Malaria Eradication Program". Malaria was such a disaster back then in Nepal, so to reduce its burden different program were launched by the Government. First Malaria Control project was launched in 1954 with the support from USAID then National Malaria Eradication Program in 1958 again Malaria Control Program in 1978. To address perennial occurrence of malaria in foot hills, inner terai, valleys, and hard core forests of both terai and hills Roll Back Malaria (RBM) Program was launched in 1998 following the call of WHO to revamp the program. Nepal is working currently in Malaria Elimination Program 2014-2025 with the goal of malaria free Nepal by 2025 (EDCD, 2018). The high risk of acquiring the disease is attributed to the abundance of vector mosquitoes, mobile and vulnerable population, relative inaccessibility of the area, suitable temperature, environmental and socio-economic factors. Since presence and abundance of vector species affects disease burden proportionally, so National Malaria

Strategic Plan (2014-2025) endorsed vector surveillance as core intervention to reduce and interrupt the malaria transmission (EDCD, 2020a).

Malaria is a complex disease caused by protozoan parasites (Genus: *Plasmodium*) and transmitted by blood-feeding infectious *Anopheles* mosquitoes (Dutta & Dutt, 1978). Mosquitoes are bilaterally symmetrical belonging to the family Culicidae. These are delicate, slender flies; legs are two or three times as long as body, antennae filiform. Body is strongly humped; both head and abdomen drooping downwards. Larvae and pupae are aquatic. A total of 3,618 extant species of Culicidae are currently formally recognized worldwide (Mosquito Taxonomic Inventory, 2021). About 537 are species of *Anopheles* (Harbach, 2013) were reported and only 70-80 are known to transmit human malaria worldwide. Of these, 41 are considered to be the dominant vector species and capable of transmitting malaria by large (Sinka et al., 2012).

In 1990, Darsie and Pradhan published an extensive account of the mosquitoes of Nepal, recording 130 species in 14 genera. A total of 24 species of *Aedes* mosquitoes were reported from Gandaki, Janakpur, Mahakali, Seti, Koshi, Bagmati, Narayani and Karnali Zones of Nepal. This genus has been reported from low to high altitudes of Jumla district. The recorded 45 species of *Anopheles* mosquitoes are distributed from the Terai and inner Terai areas to the hills and mountains of the country. Among 45 *Anopheles* species only seven have been reported as malaria vectors of primary importance. These include: *Anopheles minimus*, *An. fluviatilis*, *An. annularis*, *An. maculatus*, *An. dravidicus*, *An. pseudowillmori*, and *An. willmori*. After *Anopheles* another largest genus of mosquito distributed in Nepal is *Culex* with 29 recorded species. Like *Anopheles*, *Culex* are also distributed throughout the country except high mountains but has been reported in the high altitudes of Jumla from various habitats. Over the last decades, deforestation and effective malaria control program using Dichloro- Diphenyl Trichloroethane (DDT) eliminated *An. minimus* during 1960s (Parajuli et al, 1981). *An. fluviatilis* is now the primary malaria vector in Nepal, *An. annularis* the secondary malaria vector and the *An. maculatus* complex members are seasonal malaria vectors in the mountain region of Nepal (Darsie & Pradhan, 1990; Rana, K.J., 2001).

Malaria has remained as a major public health problem impacting on the health and lives of a large proportion of people particularly in remote areas with low economies and concentrated along international borders (Dhimal et al., 2014a). As entomological surveillance can be defined as the regular, systematic collection, analysis and interpretation of entomological data for risk assessment, planning, implementation, monitoring and evaluation of vector control interventions; all the surveillance activities must be clearly linked to programme decisions to ensure optimal vector control (EDCD, 2020b). Effective vector control is reliant on knowledge of local vector species and their susceptibility to insecticides, as well as on vector and human behaviours that may allow mosquitoes to avoid contact with interventions and thereby maintain residual transmission (Afrane et al., 2005). It is well established that effective vector control programmes can make a major contribution towards advancing human and economic development. Vector control interventions have one of the highest returns on investment in public health. Aside from direct health benefits, reductions in vector-borne diseases will enable greater productivity and growth, reduce household poverty, increase equity and women's empowerment, and strengthen health systems (EDCD, 2020b).

Malaria is a significant public health concern in Nepal, especially during the monsoon season when mosquito breeding is more prevalent. The government and various organizations have been working to control malaria transmission through vector control measures, improved diagnosis, and timely treatment. Periodic collection of vector data is essential to inform vector control strategies and track their impact on malaria transmission. According to malaria micro-stratification- 2022, three provinces are under moderate to high risk. These provinces collectively have 14 high risk wards and 39 moderate risk wards (EDCD, 2023). Sudurpaschim Province has most number of high and moderate risk wards. Of total 734 wards in Sudurpaschim Province; 9 wards are under high risk, 29 are under moderate risk, 589 are under low risk and only 107 are under no risk category. So the present preliminary survey aimed to investigate mosquito vector composition and population in Belauri Municipality ward number 6 of Kanchanpur district, which was classified as low risk ward according to recent malaria micro stratification 2022. This study will eventually help to launch disease control strategies in that area.

2. MATERIALS AND METHODS

2.1. Study Area

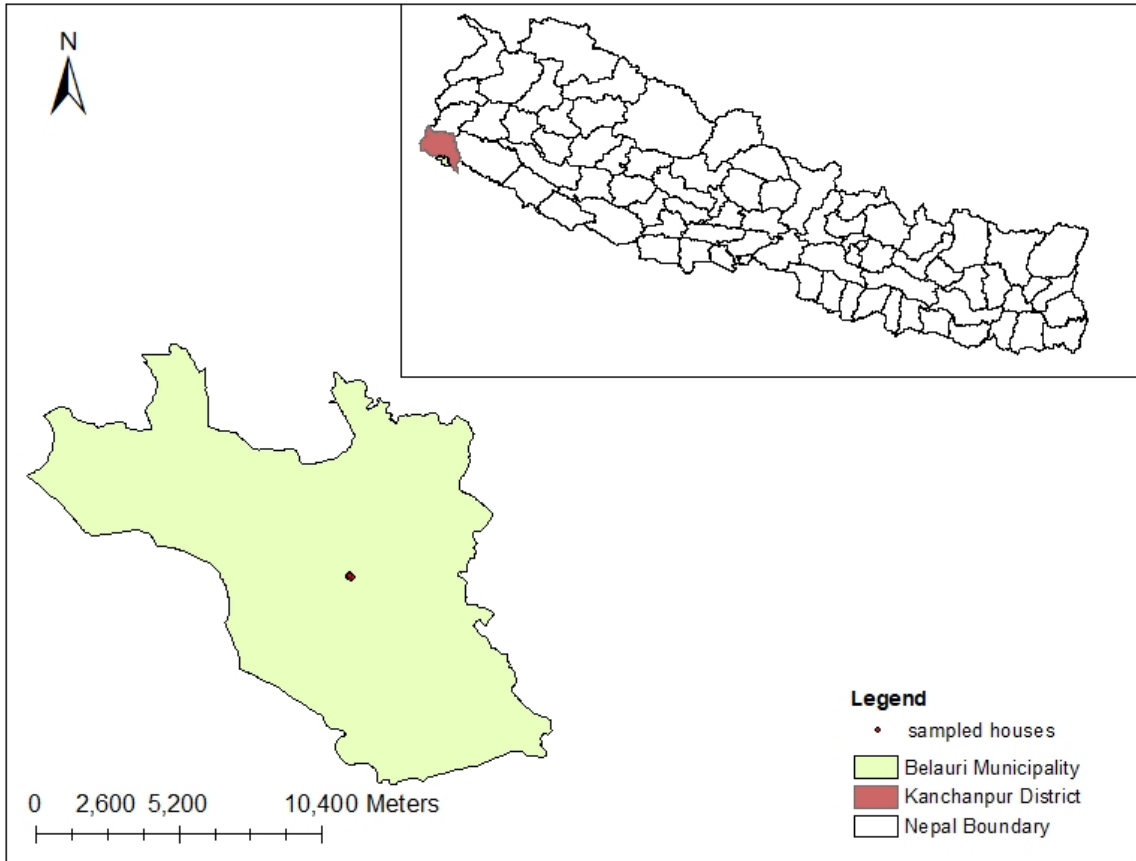


Figure: 1. Map of Study Area

Kanchanpur district of Nepal is located in Sudurpaschim Province having the spatial extent between latitude 28°38'N to 29°28'N and longitude 80°03'E to 80°33'E, covering an area of 1610 km². Belauri Municipality lies in southern part of the district and has most of area near India border. Belauri Municipality lies in between longitudes 80.259E to 80.430E and latitudes 28.627N to 28.772N. The Municipality is surrounded by Punarbas Municipality in the east, Beldadi RM in the west, Laljhadi RM and Shuklaphanta National Park in north, and west, and India in the south. The survey was conducted in Ward no. 6, Hattibhoja of Belauri Municipality, where one indigenous malaria case has been reported last year.

2.2. Materials

- ✓ Aspirators
- ✓ Hand Torch
- ✓ Light Trap
- ✓ Plastic Cups
- ✓ Dipper and Dropper
- ✓ Vials
- ✓ Cotton, Mask, Gloves
- ✓ Chloroform
- ✓ Petri dishes
- ✓ Stereoscope

2.3. Vector Sampling and Identification

The entomological survey was performed from 19th-24th June, 2023 (2080/03/04 to 2080/03/09 B.S.). Both adult and immature were sampled. For the adult collection 10 households around the patient's house were selected randomly taking patient's house at centre and fixed for everyday collection. Indoor and outdoor resting mosquitoes were collected using torchlights and aspirators in the morning and evening. For indoor resting collection houses and cattle sheds were inspected while for outdoor collection natural shelters such as tree holes, bushes near cattle shed were inspected. River beds, irrigation canal, artificial containers were searched for immature stages and collection were made by using dippers and droppers. GPS points for each sampling sites were recorded along with temperature and humidity.

Oral informed consent was taken from each household before starting the collection mosquitoes either in houses or in animal shelters. In cases where household member disagreed, the house was excluded from the collection plan and the immediate next one was chosen for study.

All the collected samples were brought to Entomology Laboratory of Province Health Directorate at Mahendranagar, Kanchanpur. Immature stages were reared in laboratory conditions, and adults emerged were identified. Adult mosquitoes, both collected and emerged from larval collection, were immobilized using Chloroform and identified using relevant taxonomic keys (Darsie & Pradhan, 1990; WHO, 2020)

2.4. Data Analysis

Data were managed in Microsoft Excel 2013, analysed and interpreted using its tools.

3. RESULTS

3.1. Species composition of vectors

Four different mosquito species and one species of sandfly were collected and identified during present study. Two species of *Anopheles* and one species of each *Culex* and *Armigeres* were recorded (Table 1). *Culex* sp. were found to be most abundant (64.86%), followed by *Armigeres* sp. (16.02%), *Phlebotomus argentipes* (15.25%), *Anopheles annularis* (2.84%) and *Anopheles culicifacies* (1.03%). Density of malaria vectors was low in this area i.e. only 11 specimens of *Anopheles annularis* were recorded. Sandflies were collected through light traps which were found in large numbers. Both male and female individuals were recorded and counted for analysis.

Table 1: Species composition of Vectors in Belauri Municipality

Species	Total	Relative Abundance(%)	Collection Methods
<i>Culex</i> sp.	251	64.86	AIRC, HIRC, LT, AB, LC
<i>Armigeres</i> sp.	62	16.02	AIRC, HIRC, LT, AB
<i>Anopheles annularis</i>	11	2.84	AIRC, LT, AB, LC
<i>Anopheles culicifacies</i>	4	1.03	AIRC, LT
<i>Phlebotomus argentipes</i>	59	15.25	LT
Total	387		

(AIRC= Animal dwelling Indoor Resting Collection, HIRC= Human dwelling Indoor Resting Collection, LT= Light Trap, AB= Animal Bait, LC= Larval Collection)

3.2. Indoor Resting Collection

Total 240 mosquito specimens were collected through indoor resting collection from both animal and human dwellings. *Culex* sp. was the most dominant mosquito species followed by *Armigeres* sp. in both animal and human dwellings. *Anopheles annularis* and *Anopheles culicifacies* were found in animal dwellings only, and the density was found to be low (Figure 2). Many male specimens were also collected. Further abdominal condition of indoor resting female mosquitoes was also investigated and most individuals were found to be fulfed (Annex 1).

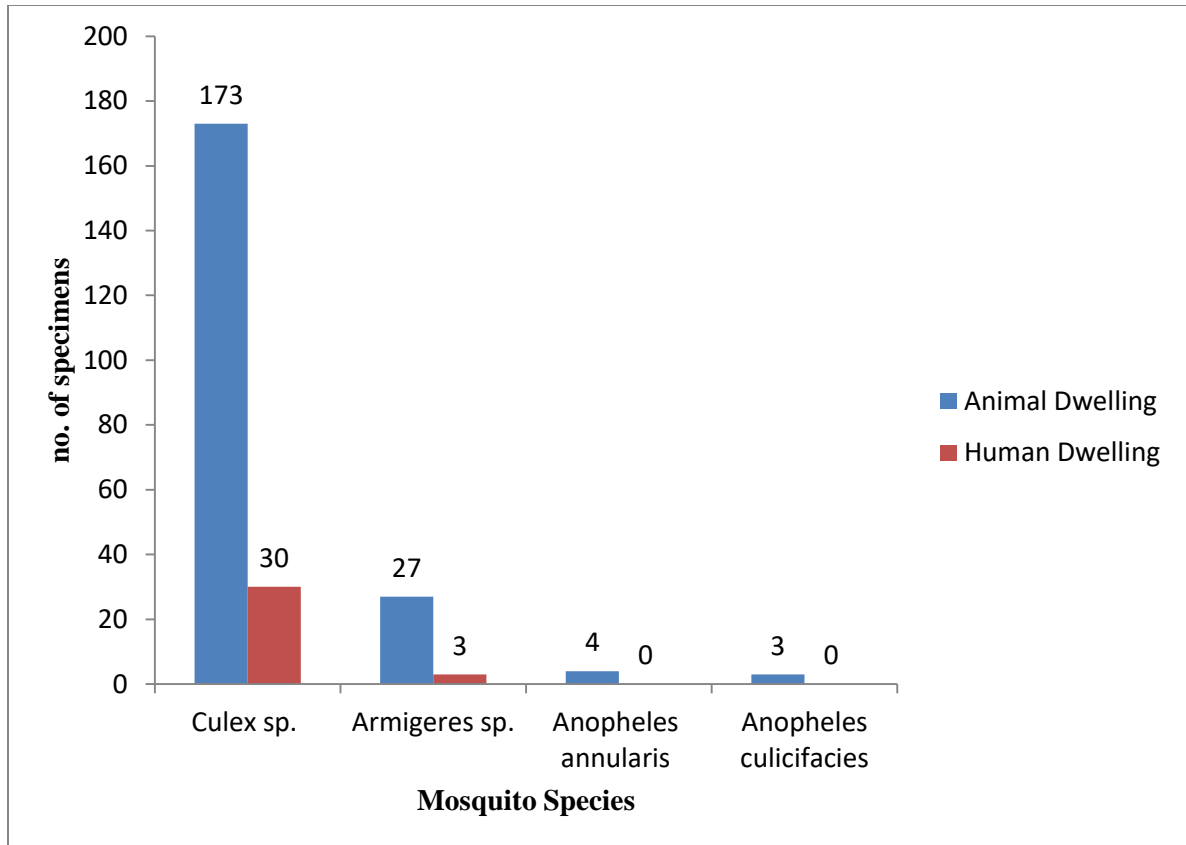


Figure 2: Abundance of vector species in IRC

3.3. Light Trap

Two light trap nights were performed, one night in the patient's house and another night in another neighbor house. Through the light traps *Culex sp.*, *Armigeres sp.*, *Anopheles culicifacies*, *Anopheles annularis* and *Phlebotomus argentipes* were collected among which most abundant were sandflies (Figure 3). Among the collected sandflies abundant were male specimens i.e. 45 specimens than the females i.e. 14 specimens. Abdominal condition of all collected females was also investigated and most of them were found to be unfed (Annex2).

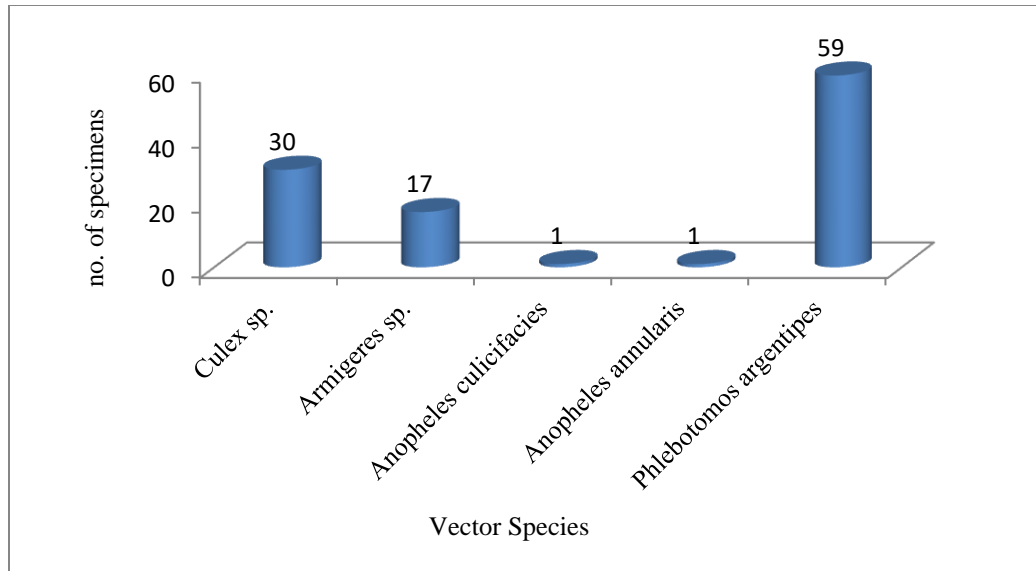


Figure 3: Abundance of Vector Species through Light Trap

3.4. Animal Bait

Animal bait was done for 2 hours from 7-9pm at study site. Three species of mosquitoes were found biting domestic animals during collection time they were *Armigeres* sp., *Culex* sp. and *Anopheles annularis* (Figure 4).

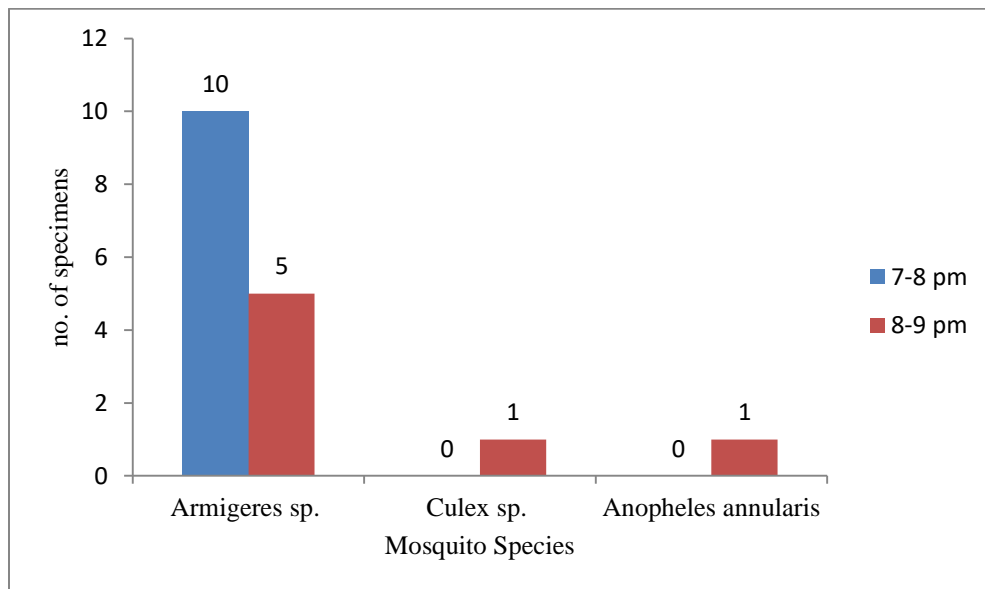


Figure 4: Vector species biting domesticated animals

3.5.Larval Collection

Mosquito breeding habitats were searched for larval presence in study area. Collected larvae were reared in laboratory from which five individuals of *Anopheles annularis* and 17 individuals of *Culex* sp. were found emerged.

4. DISCUSSIONS

Anopheles annularis was found to be present at studied area in very low density. Individual Focus Investigation report provided by Save the Children reveals the presence of malaria vectors *Anopheles annularis*, *Anopheles fluviatilis* and *Anopheles maculatus* complex at the study area. The low density of Anopheles species during this study might be due to recent Indoor Residual Spraying (IRS) in that area. Vectors of malaria has been reported from different geo-ecological areas of Nepal (Dhimal et al., 2014b; Pradhan et al., 1970) and in this study as well one malaria vectors were recorded. Further *Phlebotomus argentipes* was recorded in large numbers from the study area.

5. CONCLUSIONS AND RECOMMENDATIONS

In spite of the interventions there is still adult vector population and many breeding sites were found available nearby. Although their density was very low for now, the population may rise during rainy season. Since this area already has one indigenous malaria case so precautions need to be adopted. Timely management of breeding sources and minimizing human-vector contact will be important measure to reduce the chances of disease outbreak at the study area.

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PHOTOPLATES







Annex: 1

Abdominal conditions of indoor resting mosquitoes from animal and human dwelling collection

Species	Male	Female	Total	Fulfed	Unfed	Gravid	Half-gravid
Animal Dwelling							
<i>Culex</i> sp.	74	99	173	19	28	28	24
<i>Armigeres</i> sp.	8	19	27	12	4	0	3
<i>Anopheles annularis</i>	1	3	4	3	0	0	0
<i>Anopheles culicifacies</i>	2	1	3	0	0	0	1
Human Dwelling							
<i>Culex</i> sp.	11	19	30	7	5	5	2
<i>Armigeres</i> sp.	1	2	3	0	1	0	1

Annex: 2

Abdominal conditions of different vector species collected through light traps

Species	Male	Female	Total	Unfed	Fulfed	Half-gravid	Gravid
<i>Culex</i> sp.	17	13	30	7	4	1	1
<i>Armigeres</i> sp.	0	17	17	6	11	0	0
<i>Anopheles culicifacies</i>	0	1	1	0	1	0	0
<i>Anopheles annularis</i>	0	1	1	0	1	0	0
<i>Phlebotomus argentipes</i>	45	14	59	7	0	1	6
Total	62	46	108	20	17	2	7

Annex: 3

GPS points of houses (IRC)

House	Longitude	Latitude
1	80.364124	28.696501
2	80.364498	28.696522
3	80.363917	28.696919
4	80.364018	28.696961
5	80.363646	28.696598
6	80.363225	28.69623
7	80.363256	28.696367
8	80.364159	28.695525
9	80.364717	28.695942
10	80.36404	28.696356