Journal of Advances in Biology & Biotechnology
11(4): 1-9, 2017; Article no.JABB.31081
ISSN: 2394-1081

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Diptera (Arthropoda: Insecta) of Potential Importance in Human and Animal Health in Bayelsa State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SNO, COU and MAEN designed the study. Author VIA undertook the field work under the supervision of authors SNO, COU and MAEN. Author MAEN did the literature search and wrote the Initial drafts. Author SNO wrote the final version. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JABB/2017/31081
Editor(s):
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(5) Garba, Muhammad Haruna, Malaria and Trypanosomiasis Research Unit, Federal University of Technology, Minna, Nigeria.
Complete Peer review History: http://www.sciencedomain.org/review-history/17990

Original Research Article

Received 19th December 2016
Accepted 21st February 2017
Published 28th February 2017

ABSTRACT

The insect order Diptera has often been considered as the Medical and Veterinary order, because it contains families that affect humans and animals directly and indirectly. The focus on insect borne diseases in Bayelsa State had been on Malaria, although the contiguous States of Rivers and Delta, with similar vegetation, topography and climate contain foci of other dipteran-borne diseases: Human African Trypanosomiasis (HAT), lymphatic filariasis (LF) but none of these had been extensively studied in Bayelsa State. It was therefore decided to investigate the occurrence of dipterans of potential importance in human and animal health in Bayelsa State. Five sites, three in freshwater swamp forest (Sagbama, Odi, Sampou) and two in the mangrove swamp forest

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(Nembe, Igopiri) were selected. The Challier-Laveissiere biconical trap and the Malaise trap were used. Collections were over a 7-month period. A total of 1311 species in 6 families: Musccidae (1142), Culicidae (118), Calliphoridae (35), Tabanidae (13), Glossinidae (2), Oestridae (1) were caught in freshwater mangrove forests. In the freshwater swamp forest, a total of 1014 were collected; the six families were recorded at Sampou, only 3 families at Odi, while 2 families were recorded at Sagbama. In the mangrove swamp forest, only 5 families: Muscidae (244), Tabanidae (07), Culicidae (28), Glossinidae (1), Calliphoridae (15). The implications of these results with respect to human and animal health for action by the Ministries of Health, Agriculture and Natural Resources are discussed.

Keywords: Dipterans; potential effects; human and animal health; swamp forest; Bayelsa State.

1. INTRODUCTION

Diptera has often been considered as the "Medical and Veterinary" order [1]. It contains families that affect humans and animals directly and indirectly. These include Culicidae (mosquitoes), vectors of the causative organisms of malaria, lymphatic filariasis, yellow fever, Dengue fever, etc.; Psychodidae (Moth & Sandflies), vectors of the causative organisms of leishmaniasis, sandfly fever, etc; Simuliidae (Blackflies), vectors of the causative organisms of Onchocerciasis, Mansonellosis, etc.; Glossinidae (Tsetseflies), vectors of the causative organisms of human and animal trypanosomisases; Tabanidae (Horse & Deer flies), vectors of causative organisms of loiasis, Tuleremia, Anaplasmosis, etc; Muscidae (Houseflies and relatives), mechanical vectors of numerous pathogenic microorganisms [1]. Several families, including Calliphoridae (blowflies), Oestridae (botflies), Sarcophagidae (flesh flies), affect humans and livestock directly. They are myiasis-causing dipterans [1].

Malaria is responsible for 9.4 - 24 annual deaths per thousand children under 5 years in Africa [2] and costs over US$12 billion annually in lost GDP [3]. It is responsible for 30% and 11% annually of child and maternal deaths respectively in Nigeria [4]. The percent malaria deaths and corresponding percent disability adjusted life years (DALYS) in tropical Africa were estimated at 9.0 and 10.1% respectively. In contrast, indices for other regions were in the range, 0.00-1.5% [5]. Lymphatic filariasis (Lf) is a major cause of acute and chronic morbidity affecting humans in tropical and subtropical areas in Asia, Africa, the western Pacific and some parts of the Americas. More than 1.2 billion people are estimated to live in areas where they are at risk of the disease [6], and of the 120 million actual cases of Lf, currently thought to occur in 83 endemic countries, 91% are caused by *Wuchereria bancrofti*, while *Brugia malayi* and *B. timori* account for 9% [7]. The WHO [8] conservatively estimated that about 17.7 million people are infected in Africa and Yemen, 140,500 in tropical America with approximately 270,000 cases of blindness and about 500,000 with severe visual impairment. Leshmaniasis is a complex of sand fly-borne disease widely distributed in tropical and subtropical areas of the Americas, Europe, Asia and Africa. Worldwide, about 20 million people in 88 countries are at risk of leishmaniasis with an incidence of some 2 million cases per year [9]. Loiasis is confined to Africa, in an area spanning from Benin Republic to Gabon. Prior to Ivermectin treatment, it was considered to be only a nuisance infection because of the lack of debilitating phenotypes [10].

The focus on insect-borne diseases in Bayelsa State had been on malaria [11-13]. Records indicate that Delta and Rivers States, contiguous to Bayelsa State, with similar vegetation, topography and climate, contain foci of some dipteran-borne diseases: Human African Trypanosomiasis (HAT) is endemic in Delta State [14,15]; lymphatic filariasis in Gokana and Tai-Eleme Local Government Areas (LGAs) in Rivers State [16]. It was therefore decided to investigate the occurrence of dipterans of potential importance in human and animal health in Bayelsa State, so that surveillance is initiated.

2. MATERIALS AND METHODS

The study was conducted in Bayelsa State, Nigeria, located within 04°15'-05°23'N and 05°22'-06°45'E. It is contiguous with Delta State on the west and North, Rivers State on the East and bordered by the Atlantic Ocean on the West and South. It lies in the rainforest zone, dominated by freshwater and mangrove swamp forests, with humid equatorial climate (Fig. 1). Five sites, three in the fresh water swamp forest

(Sagbama, Odi and Sampou) and two in the mangrove swamp forest (Nembe, Igopiri) were selected. The coordinates and altitudes of sites are presented in Table 1.

The Challier-Laveissiere biconical trap [17] was used for collecting riverine tsetse populations; the attractiveness of flies is entirely visual, with a dark cavity, into which flies enter [18].

Table 1. Coordinates and altitudes of study sites, Bayelsa State

Sites	Latitude (N)	Longitude (E)	Altitude (M)
Sampou	05°85'	06°21'27	13
Odi	05°10'54	06°18'04	10
Sagbama	05°08'44	06°10'57	7
Igopiri	04°32'35	06°23'51	6
Nembe	04°32'21	06°24'02	8

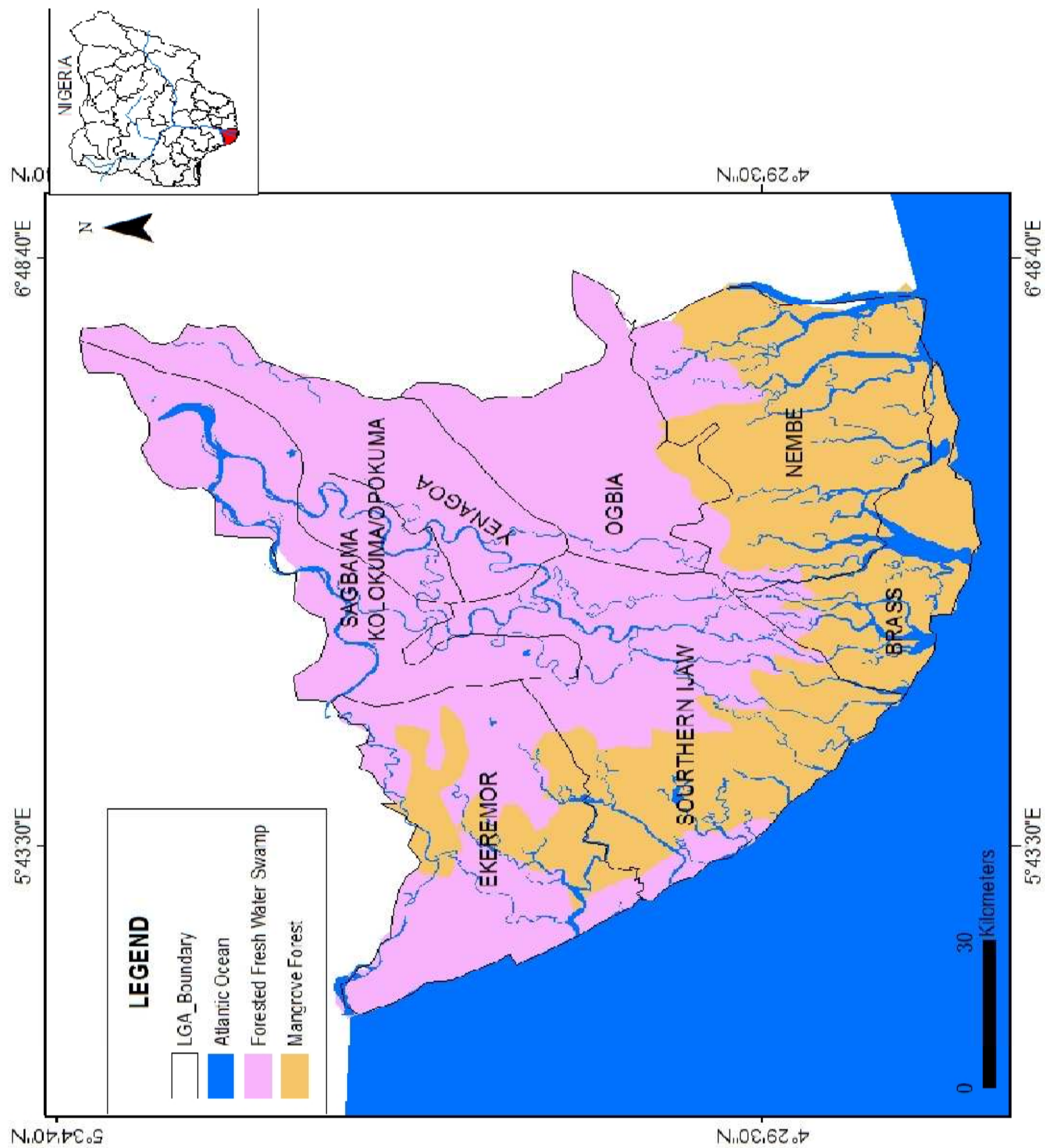

Fig. 1. Study sites on the vegetation map of Bayelsa State

The Malaise trap, invented by the Swedish Entomologist, Rene Malaise, is remarkably simple and based on the shape of a two-man tent [19]. Malaise traps act as interceptors of flying insects. The Malaise Trap was used for the other flying dipterans. Two Biconical and one Malaise traps were used at each location. It is important to note that since behavioral differences among species affected their attraction to traps, special numbers would vary.

Collections were made twice daily at 06.00 hr and 18.00 hr over a 7-month period. Trapped insects were killed with insecticide and placed in fully labelled containers with time, date and site recorded. They were transported to the laboratory for identification with keys [20] and type specimens from the Insect Museum, Department of Animal and Environmental Biology, University of Port Harcourt. Students't-test was used to assess the difference in species richness between freshwater and mangrove swamp forests.

3. RESULTS

A total of 1131 insects in 6 families: Muscidae (1142), Culicidae (118), Calliphoridae (35), Tabanidae (13), Glossinidae (2), Oestrididae (1) were caught. In the freshwater swamp forest, a total of 1014 were collected; the six families were recorded at Sampou, only 3 families at Odi, while 2 families were recorded at Sagbama (Table 2). Although the Muscidae yielded nearly 90% of specimens collected, species richness was higher in the Calliphoridae and Culicidae (Table 2). The Glossinidae and Oestridae yielded a species each. Mean numbers per site in freshwater swamp forest was more than 500/site (Table 2) while it was less than 200/site in the mangrove forest (Table 3). In the mangrove swamp forest, only 5 families: Musicdae (244), Tabanidae (07), Culicidae (28), Glossinidae (1), Calliphoridae (15) were recorded. Species richness among families was more evenly distributed in the mangrove swamp forest (Table 3). The distinguishing features of families appear on Table 4.

Table 2. Dipterans collected from the freshwater swamp forest

Families	Species	Sampou	Odi	Sagbama
Muscidae	*Musca domestica*	408	197	89
	Musca sorbens	109	59	39
	Musca spp	1	0	0
	Haematobia minuta	4	0	0
	Sub-Total	**522**	**256**	**128**
Tabanidae	*Chrysops sileacea*	3	0	0
	Tabanus pluto	1	0	0
	Hematopota spp.	1	1	0
	Sub-Total	**05**	**01**	**00**
Culicidae	*Culex spp.*	1	0	0
	Aedes aegypti	2	0	0
	Culex quinquefasciatus	81	2	0
	Anopheles gambiae	2	1	0
	Mansonia Africana	1	0	0
	Sub-Total	**87**	**03**	**00**
Calliphoridae	*Sarcophagi nodosa*	7	0	0
	Sarcophaga furcadosalis	1	0	0
	Sarcophaga spp	7	0	1
	Hemipyrellia fernandica	2	0	0
	Blaesoxipha filipjevi	1	0	0
	Lema sjostedi	1	0	0
	Sub-total	**19**	**00**	**01**
Glossinidae	*Glossina palpalis*	01	00	00
Oestridae	*Oestrus ovis*	01	00	00
Grand total		**635**	**260**	**129**

Table 3. Dipterans collected from the mangrove swamp forest

Families	Species	Nembe		Igopiri	
		Species no	Family total	Species no	Family total
Muscidae	*Musca domestica*	68		85	
	Musca sorbens	32		52	
	Musca spp	3		1	
	Haematobia minuta	1		2	
	Sub-total		**104**		**140**
Tabanidae	*Chrysops silacea*	4		1	
	Hematopota decora	0		1	
	Hematopota	0		1	
	Exiquicornuta	0		1	
	Sub-total		**4**		**4**
Culicidae	*Culex quinquefasciatus*	17		7	
	Anopheles gambiae	3		0	
	Culex spp	0		1	
	Sub-total		**20**		**8**
Glossinidae	***Glossina palpalis***	**1**	**1**	**0**	**0**
Calliphoridae	*Sarcophaga nodosa*	4		3	
	Sarcophagi furcadosalis	2		1	
	Hemipyrellia fernandica	1		1	
	Sarcophaga spp	0		3	
	Sub-total		**7**		**8**
Grand total			**136**		**160**

Table 4. Distinguishing features of some dipteran families

Culicidae (Mosquitoes)	Wings	Legs	Abdomen	Head
Body - covered with scales, setae and fine pile **Thorax** - stoutly built and slightly humped being oval in cross section	- Narrow, -Elongate - Third Vein straight	- Thin, - Long, - Slender	- Slender, - Clearly Segmented - Capable of Extensive Expansion and Movement. - Distended When fully fed or when ovaries are well developed	Two compound eyes wrap around the front and sides of the head Antennae arise between the eyes. The head possesses a prominent forwardly projecting with palps which have held straight and right and which are pendulous head, small in relation to thorax
Tabanidae (Horse Flies)	**Wings**	**Legs**	**Abdomen**	**Head**
Body (Variation in size from the size of a housefly to very large flies) -Stout flies without scales or bristles, covered only by a few hairs **Thorax**: Stout	- Many marginal cells clear wings but some have grey markings	Moderate length	-Segmented -Usually broad and stout -Usually flattened dorsoventrally but some are cylindrical -colours and markings help in distinguishing species	-Large head with large eyes. - In life, eyes usually iridescent

Glossinidae (Tsetseflies)	**Wings**	**Legs**	**Abdomen**	**Head**
	-two surfaces pressed closely together like a flat paper bag with one side stuck to the other	The end (fifth) segment of the tarsus ends in a pair of claws used when walking on rough surfaces	8-segmented, although the first and last are usually not visible from above	-Two large compound eyes an three ocelli -three segmented antennae with the arista joined to the 3rd or bottom segment - unique to Glossina
Muscidae (Houseflies)	**Wings**	**Legs**	**Abdomen**	**Head**
Body Non-bristly, medium-sized flies measuring 6-9mm **Thorax** Stout, with black longitudinal dorsal stripes	Not uniform to distinguish them from other families Vein 4 bends sharply to join the costa close to vein 3	Three pairs similar. Last tarsal segment ends in claws	- Varying size grey with bands or patches of light orange of varying size. - Moderately short and broadly oval, composed of 4 segments	Viewed from above is oval. The mouthparts collectively known as proboscis are capable of extension and retraction.
Oestridae (Bot flies)	**Thorax**		**Abdomen**	**Head**
Body -Robust and hairy with a general appearance of honeybees or bumble bees	-no typically grey and black stripped thorax - lack the typically gray and black stripped thorax			- Mouth opening small - Mouthparts vestigial
Calliphoridae (Blowflies)	**Thorax**		**Abdomen**	**Head**
	Rarely or never with black stripes on a grey background			Arista usually plumose beyond basal half body often metallic
Sarcophagidae (flesh flies)	**Thorax**		**Abdomen**	**Head**
Body			Have distinct black and gray longitudinal thoracic stripes and a checkered abdomen	The arista are bare or plumose and to the basal half.

4. DISCUSSION

The dominance of Muscidae was not surprising as humidity and temperature provide ideal environment for the breeding of Muscids and their rapid increase in numbers [21]. Their biology has made them ideal vectors of some diseases of man and animals, including species of *Salmonella*, which cause enteric infections and protozoans *Entomoeba histolytica*, which cause amoebic dysentery. *Musca domestica* is one of the most important transmitters of diarrheal diseases and also involved in the transmission of bacterial eye infections [22]. As noted earlier, since behavioural differences among species influenced attraction to traps, numbers of species collected were only indicative of trends in populations. The full complement of important culicid vectors (*Anopheles gambiae s.l.*, *Culex quinquefasciatus*, *Aedes aegypti* and *Mansonia* spp.) were encountered. It is therefore not surprising that malaria is endemic and widely distributed in the State [11-13]. *An. gambiae s.l.* and *Cx. Quinquefasciatus* are vectors of rural and urban lymphatic filariasis, major cause of acute and chronic morbidity [23]. A recent study confirmed the occurrence of lymphatic filariasis in the State [24]. *Aedes aegypti* is the vector of yellow fever and dengue fever. Yellow fever exists in two epidemiological forms: the enzootic form, maintained in forests by monkey populations and transmitted in sylvan cycle and an epidemic form, spreading rapidly by urban mosquitoes [25]. These urban vectors are particularly effective because they rest in houses. Dengue fever in humans represented is either mild or severe form, which may be fatal Nigeria has been identified as an area with *Ae. aegypti* and dengue epidemic activity [25]. The brachyceran family Tabanidae, breeding in both freshwater and mangrove swamp forests, including *Chrysop silacea*, *Tabanus pluto* and *Haematopota* spp are vectors of some species of filarial worms (*Loa loa*) and mechanical vectors of the blood pathogen trypanosomes. *Loa loa* is confined to Africa, in an area extended from Benin to Gabon and transmitted by Tabanid species in the genus *Chrysops*. The adult worms migrate freely through the subcutaneous tissues, where they can easily be observed [26]. *Glossina palpalis* was the only species of Glossina collected and the first record of this species in the State. It is the vector of *Trypanosoma brucei gambiensis*, the causative organism of Human African Trypanosomiasis (HAT) [27]. The family Calliphoridae was the third dominant family. The Calliphoridae and Oestridae are among some of the most important myiasis-causing families. Myiasis is the invasion of a living vertebrate animal by fly larvae. Myiasis is classified based on the degree to which a fly species is dependent on a host. Three types of myiasis are generally recognized: Accidental, facultative and obligatory myiasis. Livestock and wildlife are at greater risk of attack by myiasis-causing flies than are humans. This is a result of greater exposure and the tendency to have more untreated open wounds as sites for fly exploitation [28]. They are also important in forensic entomology. Forensic entomology is the study of insect biology as it relates to societal problems that come to the attention of the legal profession and that often must be resolved by legal proceedings [29]. These legal cases may involve liability (structural Entomology, stored products Entomology, Occupational Hazards Associated with Arthropods, Veterinary and Wildlife Entomology) or Homicides, suspicious and accidental deaths, and abuse and neglect [30-31].

5. CONCLUSION

The results have established the occurrence of potential vectors of important human and animal diseases. It is recommended that the Ministries of Health, Agriculture and Natural Resources establish surveillance units. Information on the number of cases can be gathered from morbidity and mortality records maintained by State Governmental agencies for human populations. More detailed investigations are recommended on the epidemiology and epizootiology of these vector-borne human and animal diseases respectively.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/17990