Aquatic Insect Fauna of Three River Systems in the Akyem Abuakwa Traditional area of The Eastern Region of Ghana

R. Kyerematen[1] and C. Gordon[2]

[1] *Department of Animal Biology and Conservation Science, University of Ghana, Legon*

[2] *Institute for Environment and Sanitation Studies, University of Ghana, Legon*

Corresponding author; E-mail; nkyerematen@ug.edu.gh

Abstract

Three river systems in the Akyem Abuakwa Traditional Area: Ayensu, Birim and Densu were sampled over a period of one year during the wet, dry and intermediate seasons for aquatic insect fauna. Fifteen sampling sites were chosen based on certain parameters such as accessibility as well as the inclusion of high and low impact sites (i.e. close to or far from a town or village) or near areas with high human activity. Four sampling methods were employed: sweeping, core sampling, sieving and washing of stones, wood fragments and submerged objects as well as aquatic plants and leaves. Fifty seven (57) species of aquatic insects belonging to 26 families of 7 orders were recorded. Hemiptera, Ephemeroptera and Odonata were the most diverse and abundant orders with Hemiptera being the most diverse order with 17 species from 8 families. The most abundant species was *Rhagovelia obesa* (Hemiptera: Veliidae). The highest number of insects was collected in December whiles July recorded the lowest numbers. River Densu recorded the highest number of insects whiles River Birim recorded the highest diversity of insects with 36 species. River Ayensu had both the lowest numbers and diversity of insects.

Introduction

Insects have been both the delight and despair of mankind throughout recorded history. No other group of living creatures has such variety of form, colour, function and habitat. Insects have often been described as the most successful animals on earth due mainly to the number of species and individuals and the range of habitats they occupy and also by their adaptive radiation (Chinery, 1993). As living organisms, the success of insects can also be linked to their ability to adopt a wide range of food niches, most of which are phytophagous and several others that are carnivorous. Insects are by far the largest group of organisms on earth whether measured in terms of number of species or numbers of individuals and constitute about 75% of all animals. Estimates of species richness of insects vary from less than five million to as many as 80 million. They constitute a remarkably specious group of organisms attributed mainly to their small size, which allows them to occupy niches not available to larger organisms. (Gullen & Cranston, 1994).

Insect dominance applies to terrestrial and freshwater ecosystems but extends no further into the marine environment than the high tidemark and virtually all insects are terrestrial, though a few species, at least in their early stages inhabit rivers, ponds and lakes (Gullen & Cranston, 1994).

Insects that live in or on water are a remarkably diverse assemblage drawn from almost half of the orders of the class Insecta. Aquatic insects consist of whole orders (Ephemeroptera, Odonata, Plecoptera, Megaloptera, Trichoptera) or suborders (Hydrocorisae, Hydradephaga, Nematocera) that are completely or are very largely aquatic. There are also groups that are relatively small taxonomical entities drawn from larger orders, most members of which are terrestrial. These are Gerridae, Hydrometridae, Vellidae and Mesovellidae, many varied families of beetles and higher Diptera (Brachycera), a single family of Mecoptera (Nannochoristidae), some Lepidoptera and even a few species of parasitic Hymenoptera (Hynes, 1970).

There are some groups that have a different association with water in that they live in damp places along banks and shores or even run on the water surface. These include Collembola, Tridactylidae, Saldidae some staphilinid beetles and representatives of many dipteran families (Hynes 1970).

Adaptation to aquatic life include streamlining of the body, modifications of legs to form paddles, hair-fringed legs, breathing through air bubbles held somewhere on body, through gills or through subcutaneous respiration.

Study area

Fifteen sites were sampled from the three rivers; four from Ayensu, six from Birim and five from Densu. Selection was based on various parameters such as access availability, high and low impact sites (i.e. close to or far from a town or village) or near areas with high human activity.

River Ayensu

A1

The river Ayensu flows under a bridge at Anumapapam where sampling was done. The river was clear to the bottom and there was a lot of human activity such as fetching of water for domestic use here.

A2

Sampling was done close to a bridge near Kofi Pari Village where the water was clear to the bottom. Human activity here was high with many people fetching water for domestic use. It was observed that a lot of farming occurred along the river banks here.

A3

Sampling was done at Asuoko where there was a lot of human activity at the river bank such as fetching of water and washing of vehicles.

A4

Sampling was done at Nyanoa along the main road to Mankron. The water was clear to the bottom with the substratum being a mixture of sand and gravel. Human activity was high here with many people fishing, farming and washing clothes.

River Birim

B1

Sampling was done near a bridge close to the Cocoa College at Bunsu. The water here was clear to the bottom with tall grass and bamboo lining the river bank. There was little human activity here but sugarcane was grown close to the river bank

B2

Sampling was done close to a bridge on the outskirts of Osino where the water was clear. Some farming activity was observed close by. Vegetation here was a mixture of tall grass and some brushes

B3

Sampling was done under a bridge on the main Ayinam highway where there was some human activity such as fetching of water and farming. Vegetation around this site was mainly some bushes and tall grass.

B4
The river flowed under a bridge on the main road in the Kade township. Though the water was a bit muddy, the bottom could easily be seen. Disturbance here was at its highest with people fetching water, washing clothes, swimming, bathing and farming. The river bank was littered with all kinds of plastics and paper.

B5
The river flowed under a bridge on the Apoli road from Akim Oda where sampling was done. The water was slightly muddy but clear to the bottom. There was heavy human activity such as farms and wood processing industries. The river bank was littered with filth from polythene bags to cans containing coal tar.

B6
Sampling was done at Apoli near Etwereso with high human activity such as farming, fishing and fetching of water.

River Densu

D2
The river flowed under a bridge on the outskirts of Kukurantumi where the substratum was composed of gravel with the bottom visible from the top. Farming was done along the riverbank. A thin film of oil was seen on the water which could have come from the engine of a vehicle. The area is probably used in cattle rearing judging from the amount of cattle droppings in the immediate vicinity.

D3 UP
Sampling was done on the outskirts of Akwadum in a cocoa farm. The river banks were steep with a sandy substratum and the water was slow-moving with the bottom clearly visible from the top. Human activity included farming, fishing, alcohol distillation and fetching of water.

D3 DOWN
Sampling was done at Akwadum in the town centre where the river flowed under a bridge. Human settlement was close to the river bank which was steep at one side and covered with acacia and shrubs on the other side. Human activity here was very high with people farming, fetching water and fishing. Both litter and household waste littered the river bank.

D4 UP
Sampling was done at Koforidua waterworks just behind the reservoir. The bottom of the river was clear with a sandy substratum. Vegetation lined and sometimes overhang the riverbank. There was some fetching of water from this site.

D4 DOWN
Sampling was done about a kilometer's walk from the pumping station at Koforidua. The water was clear with large boulders at the bottom. Vegetation around the riverbank was mainly elephant grass, some brushes and Acacia. Farming and fishing were activities observed along the riverbank.

Methods

Sweep netting was done to collect adult insects on the surface of the water as well as around the vegetation along the river banks. Two types of sweep nets were used. Pond nets for the water skaters and other insects that live mainly on and just under the surface of the water and a bigger net composed of a lightweight aluminum frame with a metal handle and a cloth shaped like a bag with a curved tip to prevent insects escaping. Sweeping was done over and just underneath the water as well as through and over the vegetation along the river banks for aquatic insects that might just have emerged and resting on the vegetation before flying off. The contents of the nets were either emptied into plastic sorting trays and the insects collected with forceps or removed directly from the nets with pooters.

Sieve nets were also used to collect insects from pools along the banks of the rivers after the water had been disturbed or agitated. The insects were then scooped by the sieve nets when they came up to the surface of the pools.

Stones, small rocks, wood fragments and other bottom material were lifted from the water and river banks and washed in buckets and collecting trays and the water sieved. Larger rocks and boulders were turned over and specimens found underneath these were picked with forceps.

Wherever aquatic plants were found floating or submerged in the water, they were picked up (about ten for each site sampled) and their leaves, stems and roots washed in a tray for the presence of aquatic insect larvae and pupae.

Ten core samples were taken at each sampling site, washed through a sieve (500 micron mesh size) and any insects found collected with a pair of forceps. Where samples could not be retained by the corer due to unconsolidated sediment, a stainless steel sieve was used to scoop up bottom material which was subsequently washed through a 500 micron sieve.

All specimens collected were fixed with 4% formalin premixed with Rose Bengal in the field and taken to the lab for further sorting, identification and counting. Identification was done with reference to the collection in the Museum of the Department of Animal Biology and Conservation Science, Chinery (1993), Crowson (1956), Miller (1987), Harker (1989), Gullan and Cranston (1994) and Scholtz and Holm (1985) and Ownoyd (1970).

Data Analyses

Four diversity indices were computed:

- Total species: S – the number of species in each sample. i.e. species with non zero counts.
- Total individuals: N – The number of individuals in each sample.
- Species richness (Margalef): d = (S-1)/Log (N) – This is a measure of the number of species present, making some allowance for the number of individuals.
- Pielou's evenness: J'- this is a measure of equitability, a measure of how evenly the individuals are distributed among the different species.

(Zar, 1996).

Results and discussion

Seven insect orders were recorded from the three river systems: Coleoptera, Diptera, Ehphemeroptera, Hemiptera, Odonata, Plecoptera and Trichoptera, with Odonata, Ephemeroptera, Plecoptera and Trichoptera being completely aquatic orders (ie. all members of these orders are aquatic). Coleoptera, Hemiptera and Diptera have members that are mostly terrestrial but have a few members that have migrated to the aquatic environment.

Table 1 which shows a calculation of suite of diversity indices for species collected from the fifteen sites indicates that site D2 had the highest species richness (S = 22) which is corroborated by the highest Margalef index (d = 4.468) followed by site B2 (S = 18) with an equally high Margalef index of 3.676. Though diversity was highest at site D2, total numbers at this site was relatively low (N = 55) due perhaps to the impact of high human activity such as farming and washing of vehicles observed here. Site B2 which was close to a bridge on the outskirts of Osino had little human activity with clear water and the bottom easily visible from the top.

TABLE 1

Calculation of suite of diversity indices for species collected from the fifteen sampling sites (S, Species richness; N, number of individuals; d, Margalef's index; J', Pielou's evenness index)

Sites	*S*	*N*	*d*	*J*
A1	4	41	0.681	0.611
A2	8	11	2.265	0.758
A3	7	19	1.842	0.738
A4	11	17	2.836	0.737
B1	11	26	2.531	0.686
B2	18	58	3.676	0.648
B3	10	48	1.972	0.653
B4	3	3	1.674	0.896
B5	8	15	2.058	0.768
B6	12	128	1.984	0.550
D2	22	55	4.468	0.681
D3 DOWN	6	777	0.680	0.404
D3 UP	13	18	3.349	0.702
D4 DOWN	7	31	1.454	0.761
D4 UP	8	19	1.924	0.744

Lowest species diversity (S= 3) as well as abundance (N = 3) was recorded for site B4 and this is not surprising considering the fact that the river flowed right through the middle of the Kade township where the sampling was done. Disturbance here was at its highest with people fetching water, washing clothes, swimming, bathing and farming with the river bank littered with all kinds of plastics and paper. It is no wonder very few insects were found here both in numbers and diversity. All the sites sampled though, with the exception of sites B6 (J = 0.550) and D3 Down (J = 0.404) had a high evenness (J = 0.611–0.896) with individuals evenly distributed. The large number of *Ecdyonurus venosus, Potamanthus* sp and *Ameletus inopinatus* (Ephemeroptera) during the May sampling at site B3 and *Rhagovelia obese* (Hemiptera) during the December sampling accounted for the unevenness in distribrution in these two sites

River Ayensu

River Ayensu recorded the lowest number of insects as well as the lowest diversity of insect species (20). Sampling in December produced the highest number of species for three of the four sites. Sites A1 and A2 recorded no insects in both May and July and A3 recorded no insects in July. Human activity at all the sites from Ayensu was very high most likely accounting for the low diversity and abundance. Obviously this river is highly polluted and disturbed due to the impact of intense human activities such as fishing, washing of cars, bathing and farming. Chironomidae (with four unidentified species) was the most abundant family sampled from River Ayensu. In order to identify chironomids to specific level, slide preparations have to be made but this was not done in this study.

River Birim

36 species of insects were recorded from

TABLE 2

Aquatic insects sampled from River Ayensu

Order	Family	Species	*A1*			*A2*			*A3*			*A4*		
			May	*July*	*Dec*	*May*	*July*	*Dec*	*May*	*Jul*	*Dec*	*May*	*Jul*	*Dec*
Coleoptera	Carabidae	Sp 1							4					
	Hydrophilidae	*Amphiops* sp.										1	1	
Diptera	Chironomidae	Sp 1		1	37			4	1		6			
Ephemeroptera	Baetidae	*Centroptiliodes* sp												1
	Tricorythidae	*Dicercomyeon* sp												1
Hemiptera	Gerridae	*Gerris rimigis*							1					
	Mesoveliidae	*Mesovelia* sp.									3			1
	Nepidae	*Ranatra linearis*			2									1
	Pleidae	*Plea leachi*						2						2
	Veliidae	*Rhagovelia obesa*						1			1			1
Odonata	Aeshnidae	*Aeschna* sp.						1						
	Coenagrionidae	*Coenagrion* sp.			1									
		Sp 1										1		
		Argia sp.						1				1		2
	Gomphidae	*Gomphus* sp.						1						
	Lestidae	*Lestes dryas*										1		4
	Libellulidae	*Zygonyx* sp.						1						2

TABLE 3

Aquatic insects sampled from River Birim

			B1					*B2*			*B3*			*B4*			*B5*		*B6*	
Order *Dec*	*Family*	*Species*	*May*	*July*	*Dec*	*May*	*July*	*Dec*	*May*	*July*	*Dec*	*May*	*July*	*Dec*	*May*	*July*	*Dec*	*May*	*July*	
Coleoptera	Carabidae	Sp 1				1														
	Gyrinidae	*Orectogyrus vagus*				1														
	Hydrophilidae	*Amphiops* sp.						1												
			1		1															
Diptera	Chironomidae	Sp 1			2			9			3	1								
	Simulidae	Sp 1	2																	
Ephemeroptera	Baetidae	*Centroptiliodes* sp.						10												
		Centroptilum sp.	1								16			1						
		Afrobaetodes sp.			1															
		Sp 1															4			
	Caenidae	*Ecdyonurus venosus*								18							26			
	Ephemeridae	*Potamanthus* sp																20		
	Leptophlebiidae	*Thraulus* sp						1												
	Siphlonuridae	*Siphlonurus altenatus*		1																
		Ameletus inopinatus															70			
	Tricorythidae	*Dicercomyeon* sp.			1						1				1					
		Machadorythus sp															1			
Hemiptera	Gerridae	*Gerris rimigis*																1		
		Gerisella sp														3				
		Rhagodotarsus hatchii									1			1						
emiptera	Hebridae	*Merragata* sp						1												
	Naucoridae	*Pelocoris femoratus*			1															
	Nepidae	*Ranatra linearis*		1							1									
	Notonectidae	*Anisops e.f. sanclea*			1									2						
		Sp 1						1												
	Pleidae	*Plea leachi*			‘							2								
	Veliidae	*Rhagovelia obesa*	1		9		1	3			1	1						3		
		Trepobates sp																1		
Odonata	Coenagrionidae	*Coenagrion* sp.			5		5	1			4									
		Anomalagrion sp						1			2									
	Argia sp.							9												1
	Corduliidae	*Micromia magnitica*				1														
		Tetragoneuria sp																	1	
	Gomphidae	*Gomphus* sp.					2													
		Libellulidae	Sp 1															1		
Plecoptera	Perlidae	*Neoperla spio*					1								3					
Trichoptera	Leptoceridae	*Leptocella* sp					7												3	

TABLE 4

Aquatic insects sampled from River Densu

Order	Family	Species	*D2* May			*D3 Down* May			*D3 Up* May			*D4 Down* May			*D4 Up* May		
			May	*July*	*Dec*	*May*	*July*	*Dec*	*May*	*July*	*Dec*	*May*	*July*	*Dec*	*May*	*July*	*Dec*
Diptera	Chironomidae	Sp 1		7													
		Sp 2			2		1				1						3
		Sp 3			6												5
		Sp 4			2									3			
Ephemeroptera	Baetidae	*Cynigmula* sp		3			1										
		Afrobaetodes sp.			4												
		Cloeon sp			1												
Leptophlebiidae	*Thraulus* sp			3													
	Siphlonuridae	*Siphlonurus*		1													
		altenatus															
	Tricorythidae	*Dicercomyeon* sp.															6
		Ironopsis sp		1													
		Notonurus sp.							1								
		Tricorythus sp.	1								1						
Hemiptera	Gerridae	*Gerris rimigis*											1				
		Edrymetropsis carayoni						4									
		Eurymetra sp.						1									
		Rhagodotarsus hatchii			1									5			
		Trepobates sp.							6								
	Hebridae	*Merragata* sp															1
	Naucoridae	*Pelocoris femoratus*	3										3				
		Ilyocoris cimicoides	3														
		Diplonychus sp		2	3						1						
	Nepidae	*Ranatra linearis*			1						1						1
	Notonectidae	*Anisops e.f. sanclea*			1						1				2		
	Pleidae	*Plea leachi*												8			
	Veliidae	*Rhagovelia obesa*	2		3			770			1			11			1
Odonata	Coenagrionidae	*Argia* sp.									1						
	Gomphidae	*Gomphus* sp.							1								
	Libellulidae	Sp 2			1												
		Sp 3			1												
		Sp 4							1								
Plecoptera	Perlidae	*Neoperla spio*							2								
Trichoptera	Leptoceridae	*Leptocella* sp		1	2												

River Birim with *Ameletus inopinatus*, (Ephemeroptera: Siphlonuridae) being the most abundant species sampled from site B6 in May. Sites B4 and B5 did not record any insects at all in July and December whiles B3 recorded no insects in May and July. The river at these sites had completely dried out in December. During the May and July sampling, these sites were in accessible due to heavy rains and flooding. Though human activity in the Birim was quite high, some of the sampling sites were in areas where human activity was relatively low accounting for high diversity and abundance

River Densu

River Densu recorded the largest numbers of insects with *Rhagovelia obesa*, (Hemiptera: Veliidae) being the most abundant species. No insect fauna were recorded in May for sites D3 Down and D4 Down as well as in July for sites D3 Up and D4 Up. The rains were quite heavy in May and July making these sites completely inaccessible for sampling.

Conclusions and Recommendations

The survey revealed high levels of biodiversity among the aquatic insect fauna of Rivers Birim and Densu with River Ayensu having relatively lower numbers as well as diversity. Insects belonging to the orders Ephemeroptera, Odonata, Plecoptera, Hemiptera, Diptera, Coleoptera and Trichoptera were recorded from these rivers. Hemiptera, Ephemeroptera and Odonata were the most diverse and abundant orders with Hemiptera being the most diverse order with 17 species from 8 families. The most abundant species was *Rhagovelia obesa* (Hemiptera: Veliidae). The highest number of insects was collected in December whiles July recorded the lowest numbers. River Densu recorded the highest number of insects whiles River Birim recorded the highest diversity of insects with 36 species. River Ayensu had both the lowest numbers and diversity of insects. It is very evident that where human activity was intense, insect diversity and abundance was at its lowest. Many of the communities along these three river systems depended solely on the rivers for water for household and domestic chores, for their livelihood and for washing of vehicles among other things. These are activities that are essential for the survival of these communities and until pipe-borne or potable water is provided for the people here, their activities would continue to negatively affect the ecosystem and these water bodies. It is imperative that local governments enforce bylaws that do not allow any economic activities such as farming and logging within the buffer zones.

Many aquatic insects are very sensitive to changes in levels of pollutants in the water and are therefore used as indicators of the ecological well being of these river systems as well as the general well being of the ecosystem. It is therefore vital that they are preserved.

Insects are extraordinarily suited as ecological indicators and test animals for hierarchical and biogeographical reconstruction. Each insect species is part of a wider community and if lost, the complexities and abundance of other life will be affected (Gullan & Cranston, 1994). Insects play a major role in maintaining the health of the ecosystems. Aquatic insects play a major role in the aquatic system by being part of the food chain, cleaning up the system as scavengers and contributing immensely to decomposition of dead organic matter. Their demise will therefore result in the disruption of critical ecosystem services. There is therefore the need for the conservation and protection of these species. Indeed the forest canopy is the heart of biotic diversity and thus it is imperative that the forest be properly managed to ensure the persistence of such unique group of nature, which is critical for ecosystem health.

References

Chinery M. (1993). Insects of Britain and Northern Europe. Harper Collins Publishers.

Crowson R. A. (1956). *Coleoptera: Introduction and Key to families*. HIBI Vol. IV, Part 1.

Gullan P. J. and **Cranston P. S.** (1994). Insects. An Outline of Entomology. Chapman and Hall – Publishers.

Harker J. (1989). Mayflies. Richmond Publishers

Hynes H. B. N. (1970). The Ecology of running waters. University of Liverpool Press, Liverpool, England. 555pp. In: Resh, V. H. and Rosenberg, 1984 D. M. (Eds) The Ecology of aquatic Insects. Praeger Publishers, New York.

Miller P. L. (1987). Dragonflies. Richmond Publishers

Oldroyd H. (1970). Diptera: *Introduction and key to families*. HIBI Vol. IX, Part 1

Sholtz C. H. and **Holm, E.** (1989). Insects of Southern Africa. Butterworths Professional Publishers Ltd.

Zar, J. H. (1996). Biostatistical Analysis. 3rd Edition. Pentice-Hall Inc. Simon & Schuster/ A Viacom Company, N. J.