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Original Article

Occurrence of *Orthetrum abbotti* Calvert (1892) (Odonata, Libellulidae) and intraguild predation on *Clarias gareipinus* Burchell, 1822 (Suliformes, Clariidae) and *Oreochromis niloticus* L., 1758 (Perciformes, Cichlidae) fry in Lagos fish farms

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Abstract: Intraguild predation occurs when species competing for the same resource prey upon or parasitize one another. This may result in economic losses under commercial circumstances. A survey of the insect species of fish farms in Badagry and Ojo Areas of Lagos State, Nigeria was carried out followed by an evaluation of the predatory ability of *Orthetrum abbotti* nymphs on fish fry. Nymph predation was evaluated in the laboratory against fry of *Clarias gariepinus* and *Oreochromis niloticus*. Samples of insects were randomly collected from 10 earthen ponds, 10 concrete ponds and the vegetation surrounding the ponds and identified over a period of 12 weeks from three study fish farms. Six species of insects belonging to four orders namely *Notonecta unifasciata*, *Gerris remigis*, *O. abbotti*, *Aedes aegypti*, *Dysticus marginalis* and *Acentria ephemerella* syn. *niveus* were collected from the ponds. Studies on feeding preference of 5th nymphal instar of *O. abbotti* on fry of *C. gariepinus* and *O. niloticus* over other food types revealed that the dragonfly preferred to feed more on *C. gariepinus* fry than on *O. niloticus* although there was no significant difference in the number of *O. niloticus* and *C. gariepinus* fry preyed upon by *O. abbotti* nymphs.

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Introduction

Insects play important roles in the aquatic ecosystem, apart from being tools to reveal information about the water quality and ecology of a particular water body; they are also crucial in balancing the aquatic ecosystem. More importantly, Odonates are good indicators for monitoring anthropogenic impacts on freshwater ecosystems. In small water bodies such as ponds, myriads of insect such as dragonflies, caddisflies and mayflies spend most of their lives in the pond feeding on larvae of other insect, plant matter, decaying vegetation and algae (Cardoba-Aguilar, 2008).

Most aquatic insects are predacious feeders, and the predatory effect of dragonflies larvae on aquatic organisms, including catfish and tilapia fry are becoming alarming leading to annual colossal losses (Adeyemo et al., 1997). The predatory habit of dragonfly larvae on other co-occurring species may be as a result of competition for limiting resources such as food and is referred to as Intraguild Predation (IGP) (Berg *et al*., 2012). Vashini and Ganagappan (2014) stated that odonate nymphs are very efficient predators in lowland streams and ponds. According to Sulem and Brummett (2006), about 9% of total *Clarias gariepinus* larval mortality in earthen pond in Cameroun was attributed to predation by aquatic insects. Nguenga et al. (2000) identified predation as the major cause of low and viable survival of *C. gariepinus* in Cameroun. Basically, predation by birds, amphibians and other fishes are believed to be more than in aquatic insects although, Rashed (2005)

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explained that aquatic insect's predation may exceed avian predation in some localities.

Considering the importance of *C. gariepinus* and *Oreochromis niloticus* to fish farming in African countries, it is imperative to understand the feeding preference of dragonfly *(Orthetrum abbotti)* nymphs for fry of *C. gariepinus* and *O. niloticus.* The first part of this study reported here assessed the entomofauna of three fish farms and the second evaluated the feeding preference of the dragonfly, *O. abbotti.*

Materials and Methods

Study sites: Three farms were studied in Ojo and Badagry area of Lagos State, namely Lagos State University (LASU) farm (site A) (in Ojo area), Anetekhai farm (site B) and Bombata farm (site C) (sites B and C are located in Badagry area). The farms rear *C. gariepinus* and *O. niloticus* for research and commercial purposes. In all the three farms, ponds are in close proximity to vegetation growing on sandy loam soil.

Site A (LASU Farm) is surrounded by few buildings and tall grasses with vegetable farm about 500 metres away from the fish ponds and hatching earthen ponds and hatchery. Site B (Anetekhai farm) and Site C (Bombata farm) were surrounded respectively with few buildings and sparse vegetation. Fish is reared in earthen ponds in site B while in Site C, fish is reared in concrete tanks. Anetekhai farm uses rectangular earthen ponds, while Bombata farm use only concrete ponds. All the farms are very close to the vegetation. At each site, sampling areas were demarcated with the use of measuring tapes, into Zones A-D. Each sampling zone is about 500 m apart and collection was done at different parts of the zones.

Insect collection and identification: Collection of insect was done fortnightly for a period of six months. Sampling was started in August 2005 which represent the period of "break" in rain in Lagos State. Light traps, pitfall traps and sweep nets were used to collect larvae as well as adult insects from 10 earthen ponds and 10 concrete ponds and the vegetation around the ponds, respectively. Insect collection was done twice daily, in the early morning 0700-1000 hr and later in the afternoon 1400-1800 hr. Insects were collected from the ponds and the surrounding vegetation. The collected insects were killed in hot boiling water and thereafter placed in 70% alcohol for preservation and identification was done by comparison with already identified specimens in insect collections at University of Lagos and University of Ibadan, respectively (Denloye et al., 2014).

Feeding preference of O. abbotti: Nymphs of *O. abbotti* were obtained from the Lagos State University pond. Only the 5th nymphal instars were used following Suling et al. (2004). Nymphs were acclimatized with aquatic weeds to simulate their natural habitat in pond water for 48 hours before commencement of the experiment.

Fry of *C. gariepinus* and *O. niloticus* weighing 0.1 g and mean length of 0.92±0.03 cm and 0.87±0.02 cm, respectively were obtained from the hatchery of Lagos State University. The fry (6-8 days post hatching) were scooped with the pond water.

Fifteen nymphs of *O. abbotti* already starved for 24 hours were introduced into 20 L plastic tanks filled with pond water. Fifty fry of *C. gariepinus* were subsequently introduced into each tank in three replicates. The same set up was used for fry of *O. niloticus.* A mixed culture of both *C. gariepinus* (25 fry) and *O. niloticus* (25 fry) was also set up. Control experiment had no nymph of *O. abbotti.* All experimental and control set up were replicated three times each. The tanks were covered with mosquito net of mesh size 0.25 cm to prevent adult mosquitoes from depositing batches of eggs during the experiment. Predation was counted hourly after 24 hours. The number of fry preyed by the nymphs was recorded. In addition, the feeding behaviours of the larvae on the fry were observed.

Data analyses: Insect species collected from earthen pond or concrete ponds were identified, counted and expressed as percentage and means of the total from each pond type. The mean number of insect taxa collected from the pond types and those from

Table 1. Insects collected from ponds and surrounding vegetation.

Insect Orders	Species	Ponds		Surrounding Vegetation (%)
		Earthen (%)	Concrete (%)	
Hemiptera	*Notonecta unifasciata*	44.59	54.31	-
	Gerris remigis	35.06	26.72	-
Odonata	*Orthetrum abbotti*	12.12	12.09	2.79
Coleoptera	*Dysticus marginalis*	4.76	2.59	4.58
Diptera	*Aedes aegypti*	3.46	4.31	
Lepidoptera	*Acentria niveus*	-	-	4.88
Hymenoptera	*Crematogaster herculeanis*	-	-	73.17
Orthoptera	*Catantops melanosticum*	-	-	8.80
	Zonocerus variegetus	-	-	2.00
Homoptera	*Hermetia illucens*	-	-	3.88

surrounding vegetation as well as feeding preference treatments were compared by Analysis of Variance (ANOVA) to determine significant differences between them ($P \leq 0.05$).

Results

Species occurrence in pond area: Four insect orders and six species were collected from all the fish ponds (Table 1). The result showed that *Notonecta unifasciata* had the highest occurrence with 44.59% in earthen ponds and 54.31% in concrete ponds. The least represented were the Dipterans and Coleopterans.

Five species of insects were collected from all the farms, but not at every site, while *Crematogaster herculeanus* had the highest occurrence (73.17%) in the surrounding vegetation at all the sites larvae and adult *O. abbotti* and *Dysticus* sp. occurred both in the ponds and in the surrounding vegetation having widespread occurrence in all the farms.

The mean number of taxa collected in the ponds was less than that of surrounding vegetation; although numerically more insect species were collected from the ponds in all the farms (Table 1). Bombata farm having concrete ponds had the least number of insects of the Order Lepidoptera and Odonata. Analysis of variance reveals a significant difference for all order of the insects collected at the farm.

Feeding preference of *O. abbotti* nymphs for fry of *C. gariepinus* and *O. niloticus:* The results showed that nymphs of *O. abbotti* feed highly on fish fry of the two fish species when introduced into the tanks. The number of fry reduced as the period of exposure increased. After a period of 24 hours, only 16% of the *C. gariepinus* and 32% of *O. niloticus* remained in the experimental tanks relative to the control.

In the mixed culture, it was observed that the nymphs exhibited a preferential feeding, consuming more *C. gariepinus* than *O. niloticus*. At the end of 24 hours all the *C. gariepinus* introduced had been consumed by *O. abbotti* nymphs while 45% of the *O. niloticus* fry remained. Comparison of feeding preference of *O. abbotti* on fry of *O. niloticus* and *C. gariepinus* and control shows that the feeding rate of *O. abbotti* was significantly higher ($P \leq 0.05$) in the experiment than in the control.

Discussion

The objectives of this study were to evaluate the diversity of insect species found in the ponds and vegetation of three farms in Ojo and Badagry areas of Lagos State and to test if *O. abbotti* actually select its prey while feeding on fish fry. The ponds and fish farm are breeding grounds for a wide diversity of insect species, while some insects lay their eggs on the water surface, others find the ponds as an excellent feeding ground, feeding on larvae of other insects and even fish fry. Man-made ponds attracts a wide array of insect species, selection of the pond as a preferred habitat by such insects cannot be unconnected with the fact that it provides for them a wide variety of food sources and effective breeding ground, so much that they can locate the ponds soon after their construction.

The diversity of insects in a pond and the vegetation around the ponds is related to the number of available predators around. Foltz and Dodson (2009) reported that the abundance of *Notonecta undulate*, was positively correlated with shallow, fishless ponds, while Cooks and Streams (1984), reasoned that fish predation is an important determinant of *Notonecta* habitat utilization pattern. Another factor that determines aquatic insects' abundance is the fish species composition in the aquatic body. Wittwer et al. (2010) reported that the major determinant of the dragonfly community in Swedish lakes is its fish species composition, and that this in turn affects the lower trophic levels, although different fish will affect the dragonflies population differently. The presence of vegetation also affect the species richness of the aquatic insects, since the vegetation covers serve as a place of refuge, although these cannot change the level of risk among prey species significantly (Cook and Streams, 1984).

The common belief that some aquatic insects such as Odonates and Notonectids are general feeders can be erroneous when considering the predatory behavior exhibited by *O. abbotti* in this study. Zalom (1978) reported that Notonectid populations exhibited cannibalistic tendencies in the laboratory with special preference to certain species of insects. In another study by Tave *et al.* (2008), Dragonflies fed selectively on black *O. mossambicus* as compared to gold coloured ones when presented with the two fishes in a 1: 10 ratio. Earlier studies have also shown that dragonflies were more likely to attack smaller prey than larger ones (Rashed, 2005).

The results of this study support the position that dragonfly nymphs are predatory on fish species. In this study, *C. gariepinus* and *O. niloticus* fry which are generally considered to be one of the most important tropical catfish and tilapia species respectively were slightly larger than the *O. abbotti* larvae. Although there was no significant difference between the number of *C. gariepinus* and *O. niloticus* fry fed upon by the dragonflies nymph, results show that *O. abbotti* nymphs exhibited selective and preferential feeding on *C. gariepinus* and *O. niloticus* relative to the control.

The results indicate that dragonflies preyed upon fry of test fish species. Farmers need to be equipped with this information which shows that fry missing in the ponds may be as a result of predation by dragonfly nymphs. Moreover Abowei and Ukoroije (2012) reported that it was better to have the knowledge of the biodiversity, biology, behaviour, roles and so on of aquatic insects to allow for sustainable aquaculture management. The result of this study supports that assertion.

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