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Comparative studies of the feeding capacity and preference of *Aphyosemion gularis* (Boulenger 1901) on some aquatic macroinvertebrates

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ABSTRACT

Background & objectives: An efficient larvivorous fish must show a predilection for mosquito larvae in the presence of alternative preys. This study compares the feeding capacity and preference of *Aphyosemion gularis* exposed to different kinds of aquatic macroinvertebrates.

Methods: Various prey organisms such as *Anopheles* larvae and pupae, *Culex* larvae, chironomid larvae and ostracods were either singly and/or jointly presented at different densities to the fish and the number of prey consumed in 12 h light and dark periods were recorded.

Results: The result showed that in terms of capacity and preference, the fish significantly consumed (p <0.05) more *Anopheles* larvae than pupae and more *Anopheles* larvae compared to *Culex* and chironomid larvae. It was also found that the fish preferred *Culex* larvae to chironomids larvae while significantly (p <0.05) more *Anopheles* larvae were consumed compared to the more abundant ostracods.

Conclusion: The results indicate that *A. gularis* is adapted to feed more on *Anopheles* than *Culex* larvae on one hand and generally preferred mosquito larvae to non-mosquito macroinvertebrates. The implication of this observation is that the presence of other non-mosquito organisms considered in this study is unlikely to divert the attention of the fish from mosquito larvae, especially *Anopheles* larvae. The fact that the fish are able to feed on some of the non-mosquito organisms such as chironomids and ostracods, means that they can subsist on these organisms in the absence of mosquito larvae.

Key words *Aphyosemion gularis;* feeding capacity; feeding preference; macroinvertebrates; mosquito larvae; vector control

INTRODUCTION

Mosquitoes transmit some of the most deadly human diseases and in order to combat them, one area of focus of the World Health Organization (WHO) is the integrated vector control. In the planning and execution of this approach, biological control of the mosquito larvae could be one of the major options. Possible alternatives for the biological control of mosquitoes include planaria[1], predatory insects[2], entomopathogenic fungi and bacteria[3–4]. Laboratory test on the use of planaria showed a low larval consumption rate[1] compared to other biological control agents such as fish. On the other hand, entomopathogenic organisms though have effectively been used in mosquito control, the consequences of overdose in the environment cannot be considered safe, since it involves the introduction of new pathogens into the environment. Larvivorous fish have been the oldest and most widely reported biological control agent against mosquitoes[5–13]. It is considered environmentally friendly because it does not introduce any toxin or pathogen into the environment. *Gambusia affinis* was particularly effective and selected for a worldwide control of mosquitoes; however this was overshadowed by its intrinsic aggressive nature which drove other native fish species into the brink of extinction[14]. Based on this, the WHO discouraged the use of exotic fish species as biological control agents. The topminnow, *A. gularis* was identified as one of the larvivorous fish, native to tropical and sub-tropical Africa[15]. It is one of the freshwater fishes inhabiting small bodies of stagnant water such as rainforest pools, ponds and streams in Nigeria[16] and has shown a great potential for the control of *Anopheles* larvae[17]. Job[18] stated that for a larvivorous fish to be declared efficient, one of the conditions to be satisfied compulsorily is that it must have a predilection for mosquito larvae in the presence of alternative food materials. This study therefore evaluates and compares the feeding capacity and preference of the *A. gularis* on different kinds of aquatic macroinvertebrates.

MATERIAL & METHODS

All the aquatic macroinvertebrates used in the experiments were field collected. With a 250 ml dipper, *Culex* larvae were collected from shallow stagnant pools and outdoor tanks while chironomid larvae and ostracods were collected from a shallow part of the Awba dam, and some pools in the zoological garden of the University of Ibadan. *Anopheles* larvae were collected from rain fed pools at different points along the Ojoo-Iwo-road expressway in Ibadan. Only III and IV instars of the mosquito larvae were used in the experiments.

The selected group of five fish (3.5–4.5 cm total length) were exposed to *Culex* larvae at three larval densities (50, 150 and 250) for a separate 12 h light and 12 h dark periods giving a cumulative total of 200, 600 and 1000 larvae respectively for each of the period. The experiments were conducted using the method reported earlier[17]. In another experiment, only *Anopheles* pupae were presented at a density of 50, adding up to 200 pupae for a 12 h light period. For the preference test, there were joint presentations of equal number (50 each) of *Anopheles* larvae and pupae, *Anopheles* and *Culex* larvae, and *Anopheles*, *Culex* and chironomid larvae to separate groups of fish summing up to a total of 200 each in separate 12 h light periods. In the other preference test between mosquito and non-mosquito prey organisms, 200 *Anopheles* larvae and 300 ostracods were jointly presented to a different group of fish for a separate 3 and 6 h periods at a stretch. Also, another group of fish was exposed to equal numbers of *Culex* and chironomid larvae presented jointly at two separate densities of 50 (25 *Culex* + 25 chironomids) and 150 (75 *Culex* + 75 chironomids) for a separate 12 h light and 12 h dark periods. The cumulative total for each larval type presented in the 50 and 150 larval density set-ups were 100 and 300 respectively. All the data were statistically analyzed using student's *t*-test.

RESULTS

The feeding capacity of the fish with respect to *Culex* larvae separately presented for the light and dark periods is shown in Fig. 1. At the density of 50, there was 100±0% larval consumption in both periods. However, at the density of 150, a total of 73±11.31% and 34±17.13% *Culex* larvae were consumed for the light and dark periods respectively. At the 250 larval density, the fish consumed 55±13.21% during the light period and 36±16.14% during the dark period. In the separate presentation of *Anopheles* pupae at the density of 50, 93±2.31% of the cumulative total of 200 pupae were consumed. When *Anopheles* and *Culex* larvae were jointly presented, a total of 99±1.53% *Anopheles* and 62±6.51% *Culex* larvae were respectively consumed (Fig. 2). In the other joint presentation of *Anopheles* larvae and pupae to the fish, the total number of prey consumed were 55±2.52% larvae and 35±4.93% pupae respectively, as summarised in Fig. 3. Percentage larval consumption by the fish in a joint presentation of three prey types as expressed in Fig. 4 were 64±20.55, 35±13.75 and 25±16.7% for *Anopheles*, *Culex* and chironomid larvae respectively. The fish consumed 85±9.29% *Anopheles* and 8±2% ostracods, and 99±2.65% *Anopheles* and 16±3.79% ostracods in the 3 and 6 h joint exposures respectively, as presented in Fig. 5. The result of the preference test between *Culex* and chironomid larvae, shown in Fig. 6, was that the fish consumed a total of 100±0.58% *Culex* and 92±9.81% chironomid larvae at the density of 50 in the light period. However, at the density of 150, 73±24.76 and 48±23.68% larval consump-

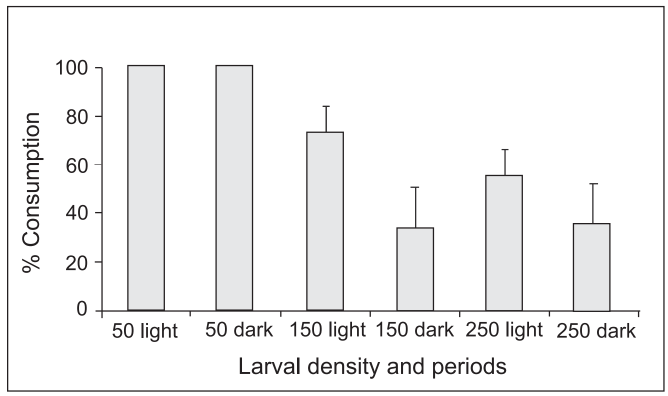

Fig 1: Percentage predation of *Culex* larvae presented separately in the 12 h light and dark periods.

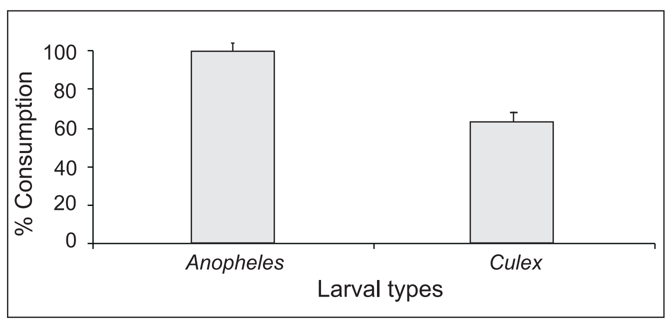

Fig 2: Percentage predation of *Anopheles* and *Culex* larvae jointly presented in the 12 h light period.

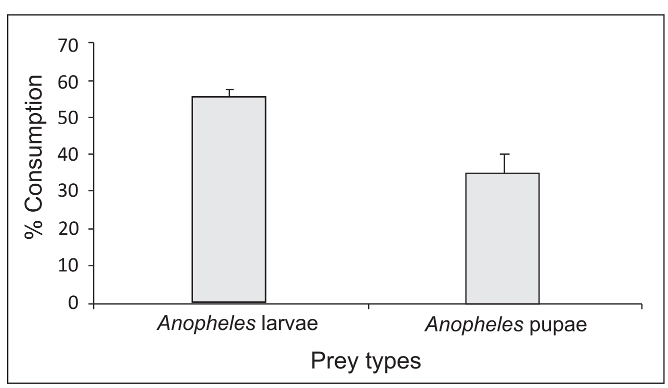

Fig. 3: Percentage predation of *Anopheles* larvae and pupae jointly presented in the 12 h light period.

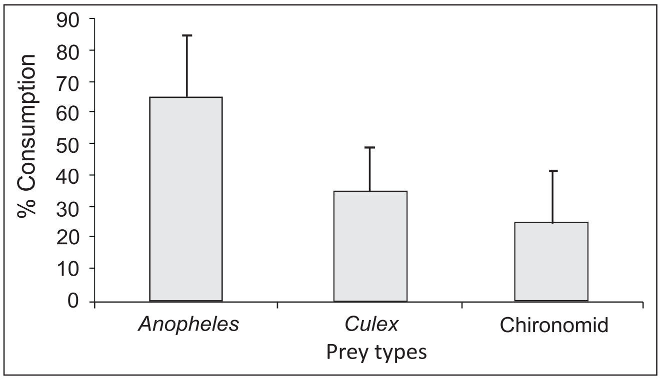

Fig. 4: Percentage predation of *Anopheles, Culex* and chironomid larvae jointly presented in the 12 h light period.

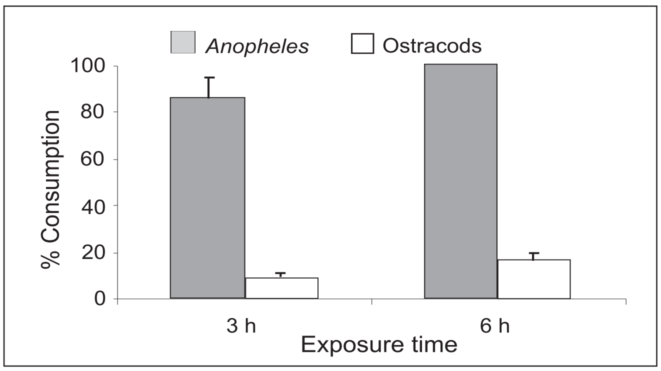

Fig. 5: Percentage predation of *Anopheles* larvae and ostracods jointly presented in the 12 h light period.

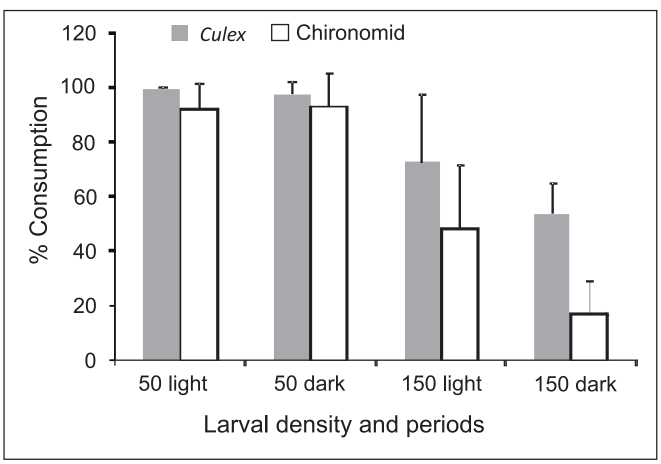

Fig. 6: Percentage predation of *Culex* and chironomid larvae jointly presented in the 12 h light and dark periods.

tion were respectively recorded for *Culex* and chironomid larvae. On the other hand, during the dark period, the fish respectively consumed 98±4.62 and 93±12.12% of *Culex* and chironomid larvae at the larval density of 50, while 54±11.55% and 17±12.16% were the total consumption for *Culex* and chironomid larvae respectively at the larval density of 150.

DISCUSSION

At the three larval densities considered in the experiment involving the presentation of *Culex* larvae, the number of larvae consumed by the fish in the light and the dark periods were considerable. This is however lower compared to that of *Anopheles* larvae consumption we reported earlier[17]. Going by this previous report, the feeding capacity of the fish at prey density of 50 on *Anopheles* larvae during the light period was significantly (p <0.005) higher (1.08 times) compared to the number of *Anopheles* pupae consumed in the present work. This was also the case when the *Anopheles* larvae and pupae were jointly presented. The larval consumption was 1.55 times higher compared to that of the pupae. This could most likely be due to the more hardened exoskeleton of the pupae and their ability to escape faster. The work of Ghosh *et al*[19] which reported that *Cyprinus carpio, Ctenopharyngodon idella, Oreochromis niloticus niloticus* and *Clarias gariepinus* consumed more when exposed to *Anopheles stephensi* larvae than the pupae is in harmony with this work. The fish *Pseudotropheus tropheops* have also been reported to consume more of *Anopheles stephensi* larvae than the pupae[20]. This implies that a larger number of the fish may be required when the *Anopheles* breeding sites contain a lot of pupae since the escape of one vector can be very costly. We are also of the view that the fish should be introduced early enough in order to prevent the development of the larvae to pupae stage.

The joint presentation of *Anopheles* and *Culex* larvae to the fish showed that it prefers *Anopheles* to *Culex*, consuming significantly (p <0.005) more (1.62 times) *Anopheles* compared to the *Culex* larvae. When the three prey types (*Anopheles*, *Culex* and chironomid larvae) were jointly presented, it was observed that the fish significantly (p <0.005) consumed more *Anopheles* larvae (1.81 times) than *Culex*, and more *Culex* larvae (1.43 times) than chironomids. The preference of the fish for *Anopheles* compared to *Culex* and chironomid larvae might not be unconnected with their upturned mouth and surface feeding behaviour as reported by Umeh[16]. Bearing in mind that *Anopheles* larvae lie parallel on the water surface, the *Culex* diagonally, and the chironomid larvae bottom dwelling, it could be presumed that the view presented by the three prey types to the fish will be different. The diagonal positioning of the *Culex* larvae presents a smaller outline, lowering their possibility of being sighted by the fish from below the water surface while the chironomid larvae in the sediments will be hidden from view. In consonance with this result, Matias and Adrias[13] in a preference test had reported that *Nothobranchius guentheri* consumed 100%

of *Culex* larvae and only 12% of chironomid presented to it in a 60 min exposure. Also Romand[6] had initially reported a feeding preference in descending order of *Aedes*, *Anopheles* and *Culex* for a West African Cyprinodontidae, *Aplocheilichthys normani*. This work therefore demonstrates that the fish will be more efficient as a bio-control agent of *Anopheles* mosquitoes, the efficient vectors of malaria. The consumption of more *Anopheles* than *Culex* by *A. gularis* does not preclude its use for *Culex* mosquito control. It should be noted that the five size-matched fish in this work, consumed 100% of a cumulative total of 200 *Culex* larvae in 12 h compared to *Pseudomugil signifer* and *Gambusia holbrooki*, reported by Willems *et al*[10], which consumed approximately 85% of 50 IV instar *Culex* larvae in 24 h.

For the mosquito and non-mosquito preference test involving *Culex* and chironomids combined, there was no significant difference at 50 larval density. However, at 150 larval density, there was a significant (p <0.005) difference, with *Culex* larval consumption 1.52 and 3.18 times more than chironomid larvae in the light and dark periods respectively.

The result also show that *Anopheles* larval consumption was significantly (p <0.005) more (4.21 times) than that of the ostracods. The difference observed here was the widest, perhaps due to the fact that the ostracods dart about throughout the water column and may be difficult to target at any particular point compared to *Anopheles* larvae that appear more or less motionless on the water surface. In addition, the ostracods are too small and hardened by their exoskeletal plates making them difficult to haunt. The implication of this result in practical field conditions is that the presence of ostracods (sometimes found in large numbers in mosquito breeding sites) might not encumber the mosquito control potential of the fish. On the other hand, the fact that the fish are able to feed on some of the non-mosquito organisms such as chironomids and ostracods, means that they can be sustained by these organisms in the absence of mosquito larvae.

CONCLUSION

Strong points in favour of *A. gularis* include the fact that they can be used for the control of both *Anopheles* and *Culex* mosquitoes. However, their bio-control efficacy will be most exploited against *Anopheles* larvae. The fish will most likely do well even in the presence of alternative preys such as the ones considered in this study. We recommend that they should be introduced early enough before the larvae become pupae because larger number of fish will be required at pupal stages.

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