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LARVAL EATING CAPACITY OF INDIGENOUS LARVIVOROUS FISHES AGAINST LARVAE OF *CULEX QUINQUEFASCIATUS* SAY IN FIELD OPERATIONAL CONDITIONS IN COUFFO DEPARTMENT IN SOUTH-WESTERN REPUBLIC OF BENIN, WEST AFRICA

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ABSTRACT
Because of problems with insecticide resistance, alternative vector control methods are necessary. These methods include the use of biological control agents, such as larvivorous fishes. This study aimed to study larval eating capacity of indigenous larvivorous fishes against larvae of *Culex quinquefasciatus* Say in field operational conditions in Couffo department in south-western Republic of Benin, West Africa.Alive local *Heterobranchus longifilis* fish and alive exotic fish adapted to local life conditions *Oreochromis niloticus* were bought immediately once catched and carried by car from Agricultural Technical Lyceum of Adjahonmè to two districts which were Dogbo and Djakptomey. Field operational evaluation for larvivorous efficacy was conducted with unfed fishes weighed 30g, 40g and 50g respectively and in sump water in Dogbo district and abandoned rectangular piscicultural basins water in Djakptomey district. The results showed that after the introduction of *Oreochromis niloticus* fishes of 30g, 40g and 50g respectively in the sump water, the larval eating capacity of these fishes when they measured 50g was the highest. In similar way, after the introduction of *Heterobranchus longifilis* fishes of 30g, 40g and 50g respectively in the abandoned rectangular piscicultural basin water, the larval eating capacity of these fishes when they measured 30g was the highest. Good results were obtained in field operational conditions regarding the use of the larvivorous fishes against larvae of *Culex quinquefasciatus* in Couffo department in the current study.

KEYWORDS: Larvivorous fish, *Culex Quinquefasciatus*, biological control, field operational conditions, Benin.

1. INTRODUCTION

Culex quinquefasciatus Say, a member of the *Culex pipiens* group, is a medically important mosquito and major pest species with a worldwide distribution.[1] *Culex quinquefasciatus* is known to be a major vector of filariasis,[1] St. Louis encephalitis virus (SLEV),[2] West Nile virus (WNV),[3] and Rift Valley Fever virus (RVFV).[4,5] It is considered to be an opportunistic feeder, and while host choice is regionally variable, it feeds on many species of birds, mammals, and occasionally reptiles and amphibians.[6,7] In North America, the human blood index (HBI) of *Cx. quinquefasciatus* varies from 1%[8] to 50%.[9] In studies conducted in Kenya, HBIs ranged from 12-88% for indoor-collected mosquitoes and 3-23% for mosquitoes collected out doors.[10,11]

Current researches have to explore several alternative avenues of controlling the bites of adult *Cx. Quinquefasciatus*, and one particular approach that appears to be gaining attention is an environmental management strategy that aims to reduce adult vector population by targeting their aquatic immature stages (i.e., mosquito eggs, larvae and pupae).

Among the biological control agents of mosquitoes, fishes are the most extensively used species in several countries since the beginning of the twentieth century.[12] Certain exotic fishes such as *Poecilia reticulata*, *Gambusia affinis* and *Oreochromis mossambicus* have been used in various ecological conditions in India for mosquito control.[13,14,15] Use of these exotic fish has raised environmental concerns in view of their suspected adverse effects on local aquatic fauna.[16]

Consequently, fish fauna surveys and evaluation of larvivorous potential of native fishes have been of high research priority in the area of biological control of vectors of disease.

The goal of the current study was to evaluate the larval eating capacity of indigenous larvivorous fishes against larvae of *Culex quinquefasciatus* Say in field operational conditions in Couffo department in south-western Republic of Benin, West Africain in a context where integrated vector control is necessary.

2. MATERIALS AND METHODS

2.1. Study area

The study area is located in Republic of Benin (West Africa) and includes the departments of Couffo. Couffo department is located in the south-western Benin and the study was carried out more precisely in Dogbo and Djakotomey districts. (**Figure 1**). The choice of the study site took into account the economic activities of populations, their usual protection practices against mosquito bites, and peasant practices to control farming pests. We took these factors into account to evaluate the larval eating capacity of indigenous larvivorous fishes against larvae of *Culex quinquefasciatus* Say in field operational conditions in Couffo department in south-western Republic of Benin, West Africa. Couffo has a climate with four seasons, two rainy seasons (March to July and August to November) and two dry seasons (November to March and July to August). The temperature ranges from 25 to 30°C with the annual mean rainfall between 900 and 1100 mm.

Figure 1: Map of Republic of Benin showing districts surveyed.

2.2. Fish collection

Alive local *Heterobranchus longifilis* fish and alive exotic fish adapted to local life conditions *Oreochromis niloticus* were bought immediately once catched in Agricultural Technical Lyceum of Adjahonmè. They were then weighed. For each specie, the different considered weights were: 30g, 40g and 50g.Then, fishes were put in some jars contained water with oxygen and carried by car from Agricultural Technical Lyceum of Adjahonmè to both districts in Couffo department which are Dogbo and Djakotomery districts.

Figure 2: *Heterobranchus longifilis.*

Figure 3: *Oreochromis niloticus.*

2.3. Field operational evaluation for larvivorous fish efficacy

To determine the natural propensity of the samples of local fish *Heterobranchus longifilis* and exotic fish adapted to local life conditions *Oreochromis niloticus* to prey upon mosquito larvae, field operational evaluation was conducted in two different breeding sites: sump water in Dogbo district and abandoned rectangular piscicultural basins water in

Djakotomey district. Each breeding site measured about $5m^2$. Five fishes of each specie were released in a breeding site test identified in each district the morning at 8 a.m. Another breeding site with five fishes of the same type as that used for the test but containing no mosquito larvae serve as control for biological tests in each district. These dispositives were protected during the period of larvivorous fish efficacy evaluation in each district. The field operational evaluation for larvivorous fish efficacy was done for each specie of fish for the different weights of 30g, 40g and 50g. Total larval consumption was recorded at the end of 24 hours through the dissection of fishes and after catching with nets these fishes in the different breeding sites used**.** In case of rain or flood, the test was invalid and repeated. The test was done to establish the maximum devouring capacity of the fishes when there were in sump water comparatively to when there were in the abandoned rectangular piscicultural basin water.

2.4. Dissection of fishes

After the field operational evaluation for larvivorous fish efficacy was done, the fishes used was dissected to determine their intestinal contained.

Figure 4: Dissection of fishes in progress in laboratory LaRPET.

2.5. Data analysis

The data collected in the current study were analyzed with the logiciel SPSS software (version 10 of windows, SPSS inc. Chicago, IL) and ANOVA.

3. RESULTS

3.1. Larval eating capacity of *Oreochromis niloticus* fishes in sump water in Dogbo district

The analysis of figure 5 showed that after the introduction of *Oreochromis niloticus* fishes of 30g, 40g and 50g respectively in the sump water, the larval eating capacity of these fishes when they measured 50g was the highest. Otherwise, the devouring capacities of these fishes when they were in sump water were 69, 77 and 89 *Culex quinquefasciatus* mosquito larvae for 30g, 40g and 50g respectively ($p<0.05$). All the fishes introduced in the breeding site which was the sump water was dissected. There was no mosquito larvae identified inside fishes in the sump water which served as control.

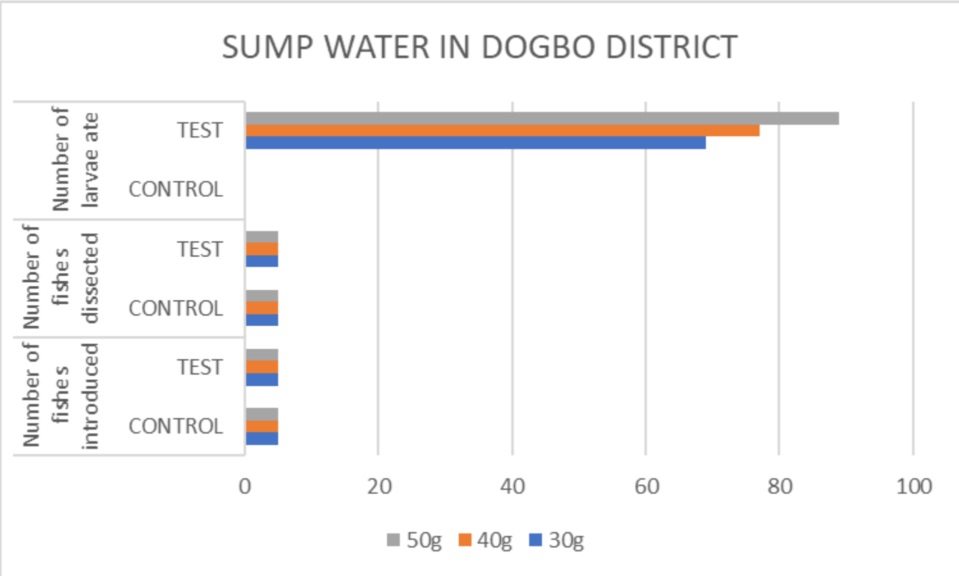

Figure 5: Larval eating capacity of *Oreochromis niloticus* fishes of 30g, 40g and 50g on larvae of *Culex quinquefasciatus* in sump water in Dogbo district.

3.2. Larval eating capacity of *Heterobranchus longifilis* fishes in abandoned piscicultural basin water in Djakotomey district

In similar way, the analysis of figure 6 showed that after the introduction of *Heterobranchus longifilis* fishes of 30g, 40g and 50g respectively in the abandoned rectangular piscicultural basin water, the larval eating capacity of these fishes when they measured 30g was the highest. Otherwise, the devouring capacities of these fishes when they were in the abandoned piscicultural basin water were 90, 74 and 82 *Culex quinquefasciatus* mosquito larvae for 30g, 40g and 50g respectively ($p<0.05$). All the fishes introduced in the breeding site which was the abandoned piscicultural basin water were dissected. There was no mosquito larvae identified inside fishes in the abandoned piscicultural basin water which served as control.

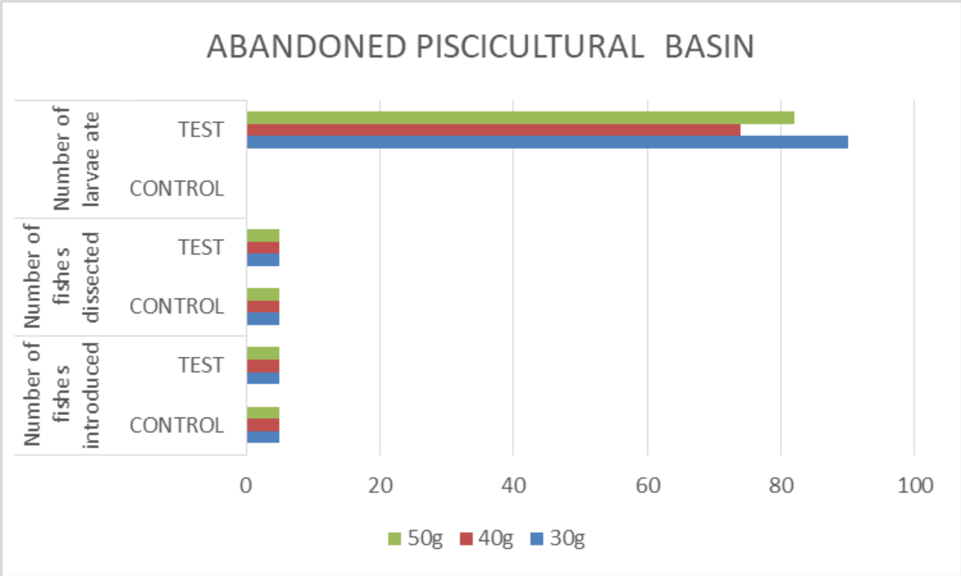

Figure 6: Larval eating capacity of *Heterobranchus longifilis* fishes of 30g, 40g and 50g on larvae of *Culex quinquefasciatus* in abandoned piscicultural basin water in Djakotomey district.

4. DISCUSSION

In the current study, after the introduction of *Oreochromis niloticus* fishes of 30g, 40g and 50g respectively in the sump water, the larval eating capacity of these fishes when they measured 50g was the highest. In similar way, after the introduction of *Heterobranchus longifilis* fishes of 30g, 40g and 50g respectively in the abandoned rectangular piscicultural basin water, the larval eating capacity of these fishes when they measured 30g was the highest. So, *Oreochromis niloticus* fishes of 50g and *Heterobranchus longifilis* fishes of 30g can be recommended in field operational conditions regarding the use of indigenous larvivorous fishes against larvae of *Culex quinquefasciatus* Say in lymphatic filariasis vector control.

There is growing of the effects of insecticide used controlling the vectors of human diseases. Manipulating or introducing an auto-reproducing predator into the ecosystem may provide sustained biological control of pest populations. The selection of a biological agent should be based on its self-replicating capacity, preference for the target pest population in the presence of alternate natural prey, adaptability to the introduced environment, and overall interaction with indigenous organisms. In order to achieve an acceptable range of control, a sound knowledge of various attributes of interactions between the pest population and the predator to be introduced is desirable. Biological larviciding for the control of mosquito borne diseases is feasible and effective only when breeding sites are relatively few or are easily identified and treated. Larval control appears to be promising in urban areas, given that the density of humans needing protection is higher than the limited number of breeding sites. Since 1937, fish have been employed for controlling mosquito larvae. Different types of fish have been used so far in this operational technique. However, use of fish of indigenous origin is found to be more appropriate in this operation.

A study carried out by Bhattacharjee *et al*[17] in field conditions showed that in the field, the presence of three fish species which were *Anabas testudineus*, *Clarias batrachus* (specie of same genus as *Clarias gariepinus*) and *Heteropneustes fossilis* in large experimental macrocosms significantly lowered the abundance of mosquito larvae. In their study, the suitability of these three indigenous, air-breathing fishes as predators of mosquito larvae were assessed under field and laboratory conditions using *Culex quinquefasciatus* as prey. The three fish species, support their use as biological resource in the mosquito larval habitats like rice fields and temporary pools to regulate the pest and vector mosquito populations. The habitat similarity with the mosquito immatures and the ability of these fishes to tolerate low level of oxygen in aquatic systems favor their augmentative release as a part of a biological control program.

5. CONCLUSION

The use of larvivorous fishes against larvae of *Culex quinquefasciatus* has given good results in field operational conditions in the current study. The results of the current research can be recommended to National Malaria Control Programs (NMCP) of different countries where lymphatic filariasis is endemic. The use of larvivorous fishes against larvae of *Culex quinquefasciatus* in field operational conditions is important in a context where it is useful to search for alternative solutions to damages cause by chemical insecticides to environment and human health.

Ethical statement

Not applicable

Conflict of Interest

The authors declare that they have no known competing financial interests.

Consent for publication

Not applicable.

Availability of supporting data

The data is made available on request from the authors.

Funding

Not applicable

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