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Efficacy of tilapia, *Oreochromis niloticus* and *Tilapia zilli* for the control of mosquito larvae around Fincha Valley, Oromia region, Ethiopia

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Abstract
Oreochromis niloticus weighing 3.8±0.9gm and length 4.6±0.9cm and *Tilapia zillii* weighing 3.4±0.76 gm and length 4.7±1cm were tested for their efficacy on devouring of mosquito larvae (Anopheles and Culex) in an aquarium tank with a size of 30cm x38cm x30cm containing 2.5 litres of pond water. The number of III and IV instars of mosquito larvae consumed was recorded in three hour interval for 24hrs in day and night. The larvae were identified, stored and treated at the same time and separately with light and aeration on and off. A total of 3025 larvae were fed to the fishes; 1679 for Oreochromis niloticus and 1346 for *Tilapia zillii* during the experiment. *O. niloticus* and *T. zillii* consumed 111 and 89 mosquito larvae/fish/24hrs, respectively. Field experiment was carried out in a pond with a size of 6m (l) x 8m (w) x 0.42m depth. *O. niloticus* (3.5±0.8cm and 4.1±0.85gm) due its high larval devouring capacity were used for the field experiment. The results showed a significant reduction (92%) of mosquito larvae in the field experiment.

Keywords: Biological control, *O. niloticus, Tilapia zilli,* Culex and anopheles mosquito

1. Introduction
Mosquito borne disease is one of the most serious problems in tropics, chiefly in Africa, South America and Asia. They are responsible for threatening and debilitating diseases in man like *Malaria, Yellow fever, Dengue fever, Chikungunya, Filariasis, Encephalitis,* etc. (Ghosh *et al*. 2005) [8]. Infrastructure development including large dams and roads is key for sustainable economic development and poverty reduction (NEPAD, 2003 & World Bank, 2004) [23, 35]. Inadequate consideration of both environmental and public health impacts can undermine the benefit to be gained from such investment (McCartney *et al*. 2007) [15]. The excavations made during road construction forced to conserve the rain water which serve as major breeding grounds for malaria propagation. The current estimate of malaria in the world is about 2000 million or 40% of the world population. More than 90% of the cases occur in sub Saharan Africa. The disease is the leading cause of death of Africa's children, causing approximately 20% of all child deaths under the age of five (Renshaw & Silver, 2001; Malaney *et al.* 2004; WHO 2006 & Kouyate *et al.* 2007) [28, 14, 34, 13]. Malaria is ranked as a leading communicable disease in Ethiopia accounting for about 30% of the overall disability Adjusted Life Years Lost. Specially, 5-6 million clinical malaria cases and over 600,000 confirmed cases were reported from each facility each year (MoH, 2004) [18]. In epidemic year mortality rates were nearly 100,000. Approximately 75% of the country is prone to malarial infection, and it is reported that, malaria is causing 70,000 deaths each year (MoH 2008) [19].
There are various malaria control measures which include chemical, biological and environmental methods. Chemical methods have been widely used to control mosquito larvae (Raja and Venkatesan, 1997) [25]. Besides chemicals, certain plant oils have also been tried against mosquito larvae (Raja and Ignacimuthu, 2000) [26]. Nowadays LLIN are used as a major intervention in different parts of Africa especially in Rwanda and Ethiopia. In Ethiopia, in the past few years there has been a rapid scaling up of intervention to control malaria through different methods like; the distribution of more than 20 million bed nets for 10 million households in 2005. Doubling of DDT spraying in 2007 and 2008 had resulted in the decrease of malaria burden all over the country (MoH, 2008) [19].

Though all these measures are done, still malaria remains a major cause of mortality and severe economic losses to the population. Environmental protection agencies have banned or placed several restrictions on the use of many pesticides which are formerly used in mosquito control programmes (Collins & Blackwell, 2000) [4].

Biological control, particularly using larvivorous fish is important to malaria control program in the 20th century (Raghavendra and Subbarao, 2002) [27]. Made an attempt to mass rear two larvicidal fishes such as *Aplocheilus blochi* (Arnold) and *Oryzias melastigma* (McClelland) to control mosquito larvae. The study was aimed at mass rearing of larvivorious fishes through artificial feeding and by understanding the effect of stocking density, and environmental conditions such as temperature, pH, salinity on growth of fishes. The first larvivorous fish *Gambusia affinis* discovered from Texas in 1905 had later spread to over 60 other countries (Gerberich, 1965) [7]. The use of larvivorous fish to control mosquito larvae is well documented. Several investigations have reported that the introduction of larvivorous fishes to the breeding site of malaria is an effective and advisable method of malaria control (Hog *et al.* 1971; Menon and Rajagopalan 1977, 1978; Wee *et al.* 1991) [10, 16, 17, 33]. Larvivorous fishes are those fishes that feed on immature stage of mosquitoes. According to Job (1940) [11], larvivorous fish must be small, hardy and capable of living in shallow water among thick weeds where mosquito lays eggs. Biological control has a very positive role to play in the integrated control methodologies in which both pesticides and fishes or other biotic agents have their own roles (Mulla, 1968) [21]. The predator's adaptability to the introduced environment and the overall interaction with the indigenous organism need to be considered prior to the selection and introduction of larvivorous fish (Denoth. *et al.* 2002: Carlson *et al.* 2004) [5, 3]. This study was conducted to assess the bio control potentials of two fish species (*Oreochromis niloticus* and *Tilapia zillii)* collected from Fincha Reservoir, Ethiopia.

2. Materials and Methods

2.1 Experimental sites (Fig. 1): Fincha Reservoir is located between 9º10'30" to 9º46'45" north latitude and between 37º03'00" to 37º28'30" east longitude (Harza, 1975) [9]. The field study was conducted in Fincha Valley of Village E which is 47 km far from Fincha Reservoir to the west and has an altitude of 1400masl. The experimental pond located in Village E measures to 6m (L), 8m (W), and 0.42m (D) and contains different types of plankton and diatoms. Laboratory experiments were conducted in Ambo University Biology laboratory in six aquarium tanks each measuring 30cm x 38cm x30cm containing 2.5 litres of pond water per fish.

2.2 Collection, identification and transportation of fish species

Fish species that were collected from the Fincha Reservoir were kept in hapa nets ($1m^2$) in near shore waters to avoid stress before transportation. Fishes were transported in appropriate containers to Ambo University for evaluating their efficacy. Before and after transportation, the fishes were treated with 2% potassium permanganate as a disinfectant to avoid handling stress and any other infection by pathogens.

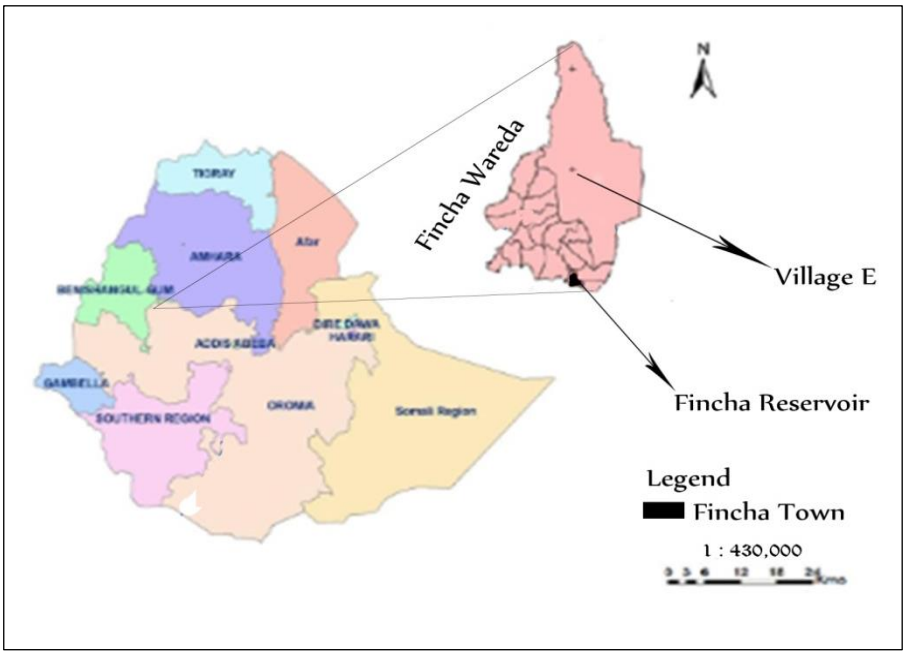

Fig 1: Location of Village E and Fincha Reservoir

2.3 Experimental Protocol

Cement tank (holding tank) with a dimension of 2x2x2m was used for acclimatization. The source water for the tank was from the nearby canal of the Huluka River which flows adjacent to the main campus of Ambo University. Water was retained in the tank for more than a month with marginal application of organic fertilizers (Cow dung) to develop natural fish food organisms. The fish species transported from the Fincha Reservoir were stocked in the tank and were observed for their survival. Supplementary diets were given at the rate of 3% of the body weight. The main water quality parameters such as temperature, dissolved oxygen and pH were measured using Mercury Thermometer, Winkler's Method and Litmus paper respectively.

2.4 Collection, transportation and identification of mosquito larvae

Collection of mosquito larvae was attempted in places where the area was prone to infection (Fincha Valley). Six sites from Fincha Valley were visited and a preliminary observation was made for the presence of mosquito larvae in such systems. The larvae were scooped out from the water bodies by a scooper. They were collected and released in 40 l capacity buckets, and were transported to the laboratory. A sample of larval population and adult mosquitoes were appropriately fixed and taken to Addis Ababa University Biomedical Science Laboratory for identification. III and IV instar larvae of mosquito were mounted on slides using gum chloral for species identification. Mosquito larvae and adults were identified using the details provided by Verrone (1962 a & b) [31, 32].

2.5 Safety precautions followed

Since adult female *Anopheles* mosquitoes are harmful to human beings, safety precautions to eliminate the adult mosquitoes were undertaken. Initial precaution was made by covering the body with PPE, then spraying the lights and walls of the laboratory by Deltamethrin and DDT, and finally applying a drop of sulphuric acid in petridish to kill pupae. The adult mosquitoes trying to escape from the lab were killed by spraying DDT and insecticide on the wall and lights.

2.6 Larval preparation, count and storage

Larvae of mosquito were pipetted directly from the rearing bucket to the flask. This was done after bringing the whole rearing buckets to the laboratory carefully. The doors of the laboratory were closed before opening the rearing bucket and incubator. The III and IV instars of *Culex* mosquito larvae and *Anopheles* were counted on petridish. These stage of larvae were selected since they are highly visible and easy to identify, count and feed them to the fishes. The counted larvae were kept in the incubator at 30 ^{o}C to feed the fishes per three hour interval.

2.7 Larval count and feeding

Larvae were arranged and counted and labelled by using a dropper (Trudel & Bomblies, 2011) [30]. Fixed number of larvae was given to the experimental fishes, and after 3hrs the number of larvae left in the aquarium was counted directly by using a hand lens. Then the number of larvae consumed by the fish was calculated and recorded at each 3 hrs interval for 24hrs. Thereafter, the number of larvae consumed was substituted to make the number equal to the initial number. Other external feed was not given to the fishes during the experimental period. Dead and morbid larvae were not included in the experiment (Ghosh *et al*. 2005) [8]. The experiment was replicated three times.

2.8 Evaluating the efficacy of fishes

Experiments were conducted first with light and aeration. III and IV instars of *Culex*, *Anopheles* both *Anopheles* and *Culex* larva were treated separately. The second experiment was conducted in the absence of light and aeration. Number of larvae consumed by the fishes was counted in three hour interval for 24 hrs. The feeding efficacy was calculated for both the treatments after 24 hrs. In the feeding efficacy, the species of larvae consumed by each fish when light and aeration was on and off were considered for comparison of Day and Night. Selection of fish was determined based on the best feeding efficacy of the fish species tested.

2.9 Field experiments

Before introduction, the collected fishes from Fincha Reservoir were acclimatized with the pond water for about three-six hours (Al-Amoudi, 1987) [1]. Larvae were sampled from both experimental and control ponds by standard larval sampling techniques as adopted by The larval population in the pond was assessed using a dipper of 250 ml capacity. During each time of sampling 30 dips were taken from different spots (n=30) and the mean density was calculated. This record was used to compare before and after the introduction of fish with the control pond. In order to understand the devouring efficacy of fish species in outdoor impoundments on mosquito larvae, fish species selected was introduced in the Village E pond. The size of the pond was 12 m x 8 m x 0.42 m (Area 40.32m^2) and it was partitioned into two equal parts using nylon net screen. One was experimental pond and another one was the control. 30 *O. niloticus* L (cm): 3.5±0.8: W (gm): 4.2±0.9) were introduced.

2.10 Stocking of fish in impoundments

The trench selected for stocking of fish species was cleared of for larvae or nymphs of larvivorous insects using fine nylon netting. The stocking density of fish species for mosquito control was based on density of mosquito larvae, water quantity and quality. The present study was conducted with three fish/2m^3.

2.11: Statistical analysis

One way ANOVA to compare two different mosquito larval densities before stocking and after stocking at 0.05% level of significance was used. SPSS16 and Microsoft excel windows were also used to analyse the data at different treatments for *Oreochromis niloticus* and *Tilapia zillii.* Finally gut content analysis was conducted to note the body parts of mosquitoes consumed by the fish.

3. Results and Discussion

3.1 Experimental fish species

Fincha Reservoir was surveyed for the distribution of fish species and was found that *Oreochromis niloticus, Tilapia zillii,* and the common carp, *Cyprinus carpio were* the common fish species in the reservoir. Since the availability of *Cyprinus carpio* was very much limited in the reservoir, *Oreochromis niloticus, Tilapia zillii were* selected for the study. Out of 186 fishes collected, 30 healthy fishes were selected which included 15 *T. zillii* with weight and length of 3.4±0.7 and 4.7±1 and 15 *O. niloticus* with weight and length of 3.8 ±0.9 and 4.6±0.9.

3.2 Water quality parameters

Table 1 provides the details on water quality characteristics of holding and experimental ponds. All water quality parameters were within the permissible level for the fishes to live except the secchi depth reading of filed pond (17 cm) which is turbid because of rain water accumulation than the holding thank (26cm). 15 species of plankton representing phytoplankton,

zooplankton, blue green algae and diatoms were found both in village E and holding tank at Ambo University (Table 2). The results present a picture that plankton population both at pond and tank were able to support the food requirement of fish in addition to the mosquito larvae.

Table 1: Water quality parameters of field pond at village E, holding tank and aquarium

Parameters	Field pond	Holding tank	Aquarium
Temperature (C^{o})	21.0-26.0	19.0- 23.0	19-21
pH	7.4-7.8	6.8-7.3	6.8-7.00
Dissolved Oxygen (mg/l)	5.1-6.0	6.1-6.5	6.3-6.8
Secchi depth (cm)	17.0	26.0-	

3.3 Collection, transportation and identification of mosquito larvae

Mosquito larvae were collected from six different breeding grounds in Fincha Valley. The larvae were scooped out slightly from the water bodies by scooper to the bucket of 40 lit capacity and placed outside the laboratory and reared. Two mosquito larval species were identified as *Anopheles (An. Gambiae*) and *Culex (Cu. Quinquefolius*).

Table 2: Phytoplankton, zooplankton and blue-green algae in the experimental Pond and holding tank

Plankton	Village E. Pond	Holding Pond
Phytoplankton		
Green algae (Chlorophyta)		
Volvox	Abundant	Abundant
Chlamydomonas	Rare	Rare
Chlorella	Rare	Rare
Pediastrum	Abundant	Abundant
Euglenophyceae		
Euglena	Abundant	Abundant
Phycus	Abundant	Abundant
Zooplankton		
Copepods	Rare	Abundant
Brachionus	Abundant	Abundant
Monostyla	Rare	Abundant
Blue-green algae		
(*Microcystis***)**	Rare	Abundant
Bacillariophyta (diatoms)		
Synedra	Rare	Abundant
Fragilaria	Rarer	Abundant
Melosira	Rare	Available
Navicula	Abundant	Abundant
Pinnularia	Abundant	Rare

3.4 Larval preparation, count, storage and feeding

Larvae of mosquito were pipetted directly from the rearing bucket to the flask. This was done after bringing the whole rearing bucket to the laboratory carefully. The III and IV instars of *Culex* mosquito and *Anopheles* were counted on pertidish separately and labelled. The counted larvae were kept in the incubator at 30^{o} C to feed the fishes per three hour interval. Larvae were arranged and counted (50 larvae per petridish) and labelled by using a dropper (Trudel & Bomblies, 2011) [30]. While feeding, 50 larvae were given to the experimental fishes. After 3hrs of giving the first 50 larvae, the number of larvae left in the aquarium was counted directly by using magnifier glass. Then the number of larvae consumed by the fish was calculated and recorded at each 3 hrs interval for 24hrs.

3.5 Evaluating the efficacy of fishes

Mosquito larval consumption by different fish species in the presence and absence of aeration and light in the day and night is presented in Table 3. The consumption of both fish species on different mosquito larvae (*Anopheles*, *Culex* and both *Anopheles* and *Culex* Mosquito larvae) increased in the presence of light and aeration and decreased in the absence of those factors significantly.

Table 3: Daily larval consumption of *O. niloticus* and *T. zillii* treated with different mosquito larvae in the presence and absence of aeration and light (M±SD).

Treatment			Time of larval count						
			Day		Mean	Night		Mean	Total/Day/fish
Light & Aeration	Larval species	Fish species	7:00 am-10:00am 1:00pm-4:00pm 10:00am-1:00pm 4:00pm-7:00pm			7:00pm-10:00pm 1:00am-4:00am 10:00pm-1:00am 4:00am-7:00am			
Off	*Anopheles*	*T. zillii* *O. niloticus*	12.3±0.5 10.8±1.9 13.8±0.7 11.6±0.7	12.6±1.2 10.0±0.2 13.1±0.7 13.4±1.5	 45.7 51.9	8.0±2.0 8.6±2.5 10.3±1.4 9.0±1.3	8.2±1.2 7.0±1.8 9.3±0.2 7.8±1.9	 30.45 36.6	 76.15 88.5
	Culex	*T. zillii* *O. niloticus*	9.30±0.2 10.1±0.7 10.8±0.2 10.5±1.3	8.4±0.5 11.1±0.2 11±2.30 11.8±0.2	 38.9 44.1	8.5±0.5 7.3±0.5 9.3±0.7 8.8±0.2	8.0±2.1 6.0±0.5 8.0±0.8 6.8±0.7	 30.6 32.9	 69.5 77
	Both	*T. zillii* *O. niloticus*	6.0±1.00 9.6±1.5 9.6±1.10 10.0±2.0	8.3±3.2 9.3±2.00 10.0±1.0 12.6±1.5	 33.2 42.2	6.6±1.5 7.0±3.0 6.3±1.5 6.0±2.4	4.6±1.5 4.3±0.5 6.0±3.6 6.0±0.3	 22.8 24.8	 56 67
			Total		256			178.05	
			Grand total						434.05
On	*Anopheles*	*T. zillii* *O. niloticus*	12.3±1.5 14.8±4.0 13.5±2.2 16.8±0.2	11.1±2.3 12.8±2.4 16.8±4.7 20.0±1.8	 51 56.9	9.5±2.1 8.0±0.7 10.8±2.2 9.4±0.7	8.1±0.2 8.8±0.7 11.3±1.2 10.1±0.2	 34.5 51.8	 85.5 108.7
	Culex	*T. zillii* *O. niloticus*	13.3±1.1 13.5±1.3 14.5±1.8 18.0±5.2	13.0±1.0 13.8±0.7 16.3±1.8 17.5±2.7	 53.5 66.3	9.8±1.6 9.1±1.5 12.1±1.6 12.5±1.5	9.1±0.2 9.8±0.2 10.7±1.2 10.0±-0.1	 38.5 45.7	 91.5 112
	Both	*T. zillii* *O. niloticus*	12.6±1.5 17±4.1 14.6±1.1 20.3±2.3	13.3±2.5 13.0±4.3 15.0±5.5 20.0±3.2	 55.9 69.9	9.3±2.5 10.3±2.5 12.0±1.0 10.0±0.0	8.6±1.5 7.6±2.8 12.3±3.5 9.3±1.5	 36.4 44.1	 92.3 114
			Total		353.5			251	
			Grand total						604.5

The number of Mosquito larvae consumed by both fish species in the day is highly significant than night. It was also significantly higher when there was aeration and light than when there were no aeration and light. This was due to the availability of light or photoperiod, dissolved oxygen and nature of mosquito larvae. Thus as Morgan (1972) [20] stated as during day time, when there is sun light, the concentration of DO in water is higher than the night which will also increase the feeding efficiency of the fish. This is in agreement with the works of some of the authors. (EL-Sayed, 2005; Biswas & Takeuchi, 2002; Karisa, 2006) [6, 2, 12]. It was also reported that, the feeding rate of tilapia species increased when there was aeration than there was no aeration (Teichert-Coddington & Green 1993) [29]. As stated in Table 3, the number of mosquito larvae consumed by both fish species has no significant variation while comparing it within the treatments but the mean number of Mosquito larvae consumed by *O. niloticus* is higher than *T. zillii* when light and aeration were on and off. Thus, when light and aeration were on, *O. niloticus* consumed *Anopheles, Culex* and both *Culex* and *Anopheles* at 108.7, 112, and 114 respectively per day, where as *T. zillii* consumed the larvae in the order of 85.5, 91.5 and 92.3 respectively per day. In the absence of light and aeration, *O. niloticus* consumed *Anopheles, Culex* and both *Culex* and *Anopheles* at 88.5, 77 and 67 respectively per day, and *T. zillii* consumed them at 76.1, 69.5 and 56 respectively per day. The efficacy of fish species (*O. niloticus* and *T. zillii)* was influenced by the species of mosquito larvae and vegetation in the pond.

Preferential feeding

Table 4 describes the preferential feeding efficacy of *Oreochromis niloticus* and *Tilapia zilli.* The number of *Anopheles* larvae consumed by both fishes during night was significantly lower than the day when light and aeration were on and off. The number of *Culex* larvae consumed by both fishes during day and night was not significantly different under light and aeration on and off. But there is mean variation for Culex larvae during night when light and aeration were off. Thus, the results clearly show that *Anopheles* mosquito larvae were preferred and consumed by both fishes in the day and night than in night. A non-significant number of *Culex* larvae were preferred by both fishes in the day and night. *Anopheles* were strongly devoured as they are less motile and stay on the surface of the water, while *Culex* are less devoured as they are highly motile and can move fast and escape from predation by the fish.

Introduction of *O. niloticus* in field conditions

For field experiments, 30 numbers of O. *niloticus* with a mean weight of 3.5±0.8g and mean length of 4.1±0.85 were introduced in Village E Pond in Fincha Valley. The size of the pond was 6m (l) x 8m (w) x 0.42m (d) or 20 m^3. The number of larvae was sampled by standard larval sampling methods.

Thus, per 250 ml dipper (n=30) there was 4.3 and 4.4 for control and 5.2 and 5.0 for treated ponds in day one and on day two respectively before introduction of the fishes. The results after introduction of fish showed a significant reduction from 6.7 to 0.6 per 250 ml dipper (92% reduction of mosquito larvae) for treated pond. Whereas, in control pond, the number of mosquito larvae fluctuated between 6.8 and 4.3 per 250 ml of dipper. The mean larval population of *Anopheles* and *Culex* of the field pond was sampled. A total of 54 larvae were counted of which 22 (40.7%) were *Culex* mosquito larvae and the remaining 32 (59.3%) were *Anopheles* mosquito larvae. Adult mosquito and larvae were identified as *Anopheles* (*An. gambiae* and *An. arabiensis*) and *Culex* (*Culex quinquefasciatus*).Finally, the gut content analysis for *Oreochromis niloticus* was carried out and found that it contained broken body parts of mosquito larvae, and the number of larvae in the introduced pond was significantly lower than the controlled pond. Hence *Oreochromis niloticus* were found to be effective biological control agents to control mosquito larvae.

Table 4: Larval preference of *Oreochromis niloticus* and *Tilapia zilli* for *Anopheles* and *Culex* mosquito larvae given at the same time within 24hrs when light and aeration was on and off (M±SD)

Treatment			**Time of larval count**						
			Day		**Mean**	**Night**		**Mean**	**Total/day/fish**
Light & Aeration	Fish species	Larval species	7:00 am-10: 00am 1:00pm-4:00pm 10:00am-1:00pm 4:00pm-7:00pm			7:00pm-10:00pm 1:00am-4:00am 10:00pm-1:00am 4:00am-7:00am			
OFF	*T. zillii*	Anopheles Culex	3.0±1.0 6.3±0.75 3.0±0.0 3.3±1.5	5.6±2.0 6.3±2.8 2.6±1.1 3.0±1.0	 21.2 11.9	3.0±0.0 1.4±0.57 3.6±1.5 5.6±3.2	1.3±1.1 0.3±0.57 3.3±0.57 4.0±1.0	 5.7 16.5	 27.3 28.6
	O. niloticus	Anopheles Culex	6.0±1.0 5.0±1.7 3.6±1.5 5.0±1.0	6.4±1.5 8.0±0.0 3.7±1.1 4.6±1.5	 25.4 16.9	3.3±1.5 1.6±1.5 3.0±0.0 3.0±1.1	1.4±1.5 2.0±1.0 4.6±1.5 4.4±2.5	 8.3 15.6	 33.6 33.3
			Total		75.4			45.5	
			Grand total						120.9
ON	*T. zillii*	Anopheles Culex	7.3±1.1 9.6±2.0 5.3±0.75 7.6±2.0	7.3±1.5 7.6±3.7 4.6±1.5 5.6±1.5	 31.8 23.1	5.0±2.0 4.6±1.1 4.3±2.5 5.6±1.5	3.6±0.5 3.0±1.7 5.0±1.7 4.6±1.1	 16.5 19.9	 48.3 43
	O. niloticus	Anopheles Culex	8.3±0.57 11.3±2.5 6.3±0.57 9.0±1.0	8.0±2.0 12.0±1.0 7.0±3.6 8.3±2.3	 39.6 30.6	4.6±0.75 5.0±1.0 7.3±0.5 5.0±1.0	3.3±1.5 3.3±1.5 5.6±1.5 6.0±1.0	 16.4 24	 56 54.6
			Total		124.1			76.8	
			Grand total						191.9

Conclusion

Fincha District has a number of small impoundments which were constructed mainly for infrastructure development. These impoundments are now serving as a source of disease spreading mosquitoes especially *Anopheles* and *Culex* species. To control disease spreading mosquitoes, the devouring efficacy of tilapia species, *Oreochromis niloticus* and *Tilapia zilli* collected from Fincha Reservoir was tested. Among the two species, *O. niloticus* was found suitable to control mosquito larvae. The devouring efficacy of fish species was influenced by the species of mosquito larvae, photoperiod, available dissolved oxygen and vegetation in the pond. The mosquito larval consumption of tilapia increased in the presence of light and aeration and decreased in the absence of these factors, and also statistically varied between day and night time. Small depressions formed by the foot print of cattle serve as potential breeding grounds for mosquitoes. This again revealed that in such areas, fish species cannot be stocked due to the size and quantity of water in such depressions.

Recommendation

Fincha Valley is known for its high incidence for malaria, and there are many impoundments which serve as breeding grounds for mosquitoes. The area is conducive to stock fish species in the breeding ground of mosquitoes. As fish species are available in abundance in Fincha Reservoir, it is recommend selecting *Oreochromis niloticus for* stocking in impoundments since this research found out that *O. niloticus* was the best suited species in the laboratory and field conditions. Secondly, Ethiopia is rich in fish species and there might be other types of fish species that can efficiently devour mosquito larvae than tilapia fish species, so it is recommended to evaluate the efficacy of other native fish species in the laboratory and field conditions in different parts of the country for diversified use.

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