ASSESSMENT OF *POECILIA RETICULATA* (PETERS, 1859) ON *CULEX* (LINNAEUS, 1758) MOSQUITO LARVAE IN MAGWAY TOWNSHIP

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Abstract

Larvivorous fishes feeding on immature stages of mosquito form an efficient bio-control agent. Observation on predation activities of *Poecilia reticulata* on mosquito larvae was carried out under laboratory conditions at 21.5±1.3˚C and 80.78±5.7% RH, during October 2018 to October 2019. Male and female guppies were used as predators for predation experiments on the 3rd and 4th instars of mosquito larvae. The female guppies consumed more mosquito larvae than male guppies did. The data indicated that *P.reticulata* have different mean consumption rates on 3rd 100 mosquito larvae with 1 liter of water volume (64 ± 17.1 by female, 28 ± 6.7 by male, with an average of 56 ± 8.8 (female) and 26 ± 4.8 (male). The data indicated that *P.reticulata* have different mean consumption rates on 3rd 200 mosquito larvae with 1 liter of water volume (187 ± 13.5 by female, 75 ± 11.6 by male, with an average of 175 ± 15.6 (female) and 72 ± 11.8 (male). The data indicated that *P.reticulata* have different mean consumption rates on 4th 100 mosquito larvae with 1 liter of water volume (25 ± 4.3 preys by female and 12 ± 2.7 preys by male with an average of 24 ± 1.8 (female) and 12 ± 0.9 (male) preys). The data indicated that wild guppies have different mean consumption rates on 4th 200 mosquito larvae with 1 liter of water volume (70 ± 17.8 preys by female and 34 ± 9.4 preys by male with an average of 68 ± 10.2 (female) and 33 ± 5.3 (male) preys). Larval consumption increased when the densities of prey increase until satiation level is reached, that is, when the fish becomes overwhelmed. Prey densities also influences predation activities and feeding rate.

Keywords: Predators, consumption rate, preys, instars

Introduction

Insects, invertebrate animal of the class Insecta of the phylum Arthropoda, like other arthropods, an insect has a hard outer covering, or exoskeleton, a segmented body and jointed legs. Adult insects typically have wings and are the only flying invertebrates.

There are about 900,000 known insects' species, three times as many as all other animal species together, and thousands of new ones are described each year. They are commonly grouped in 27 to 32 orders, depending upon the classification used (Borror and Delong, 2015).

There are about 3,500 species of mosquitoes throughout the world, and roughly 176 of them can be found in the United States. Thirty four mosquito species of five different genera were recorded within the altitudinal range of 300 to 2000 m from Garhwal region. Effect of natural factors like temperature, humidity and rain fall also have impact on the mosquitoes. Climate has been established as an important determinant in the distribution of vectors and pathogens (Pemola and Jauhari, 2006).

Mosquito larvae differ greatly in appearance and morphology from adults. Larvae are adapted for an aquatic existence, and their feeding and breathing structures reflect this. In general, mosquito larvae are easier to identify to species than are adults. This is because of the characteristic patterns of setae (hairs) that can be studied in microscopic slide-mounted specimens (Eldridge, 2008).

According to Job (1940), larvivorous fishes feeding on immature stages of mosquito form an efficient bio-control agent. Larvivorous fish must be small, hardy, drought resistant and a

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prolific breeder in confined water with a short life span. It should be a surface feeder and carnivorous in habit with a preference for mosquito larvae.

Guppies, whose natural range is in Northeast South America, were introduced to many habitats and are now found all over the world. Male guppies, which are smaller than females, have ornamental caudal and dorsal fins, while females are duller in color. Guppies generally feed on a variety of food sources, including benthic algae and aquatic larvae (Allen, 2002).

In the 21st century, biological control using larvivorous fish, was become an important tool for mosquito borne diseases control, particularly in urban and periurban areas **(**Karlekar and Andrew, 2016).

The present investigation has been undertaken to find the consumption level of larvivorous fish on mosquito larvae. Hence, the present work was conducted with the following objectives:

- to elucidate the consumption rate of *Poecilia reticulata* on third and fourth instars of *culex* mosquito larvae
- to compare the consumption rate between male and female of *Poecilia reticulate* on third and fourth instars of *culex* mosquito larvae
- to assess the relationship of feeding rate with the number of prey densities.

Materials and Methods

Study Area

Magway Township has tropical climate and it is located in the central dry zone. It lies between 20° 07′ to 20° 15′ N and 94° 55′ to 94° 92′ E. Zoology Department, Magway University Campus is situated between 20° 08′ N and 94° 56′E. (Fig -1)

Source: Google Earth (2019)

Figure 1 A map of Magway University Campus

Study Period

Duration of study period was from October 2018 to October 2019

Plate1(A)The place where the mosquito fish were taken for experiment

Plate1(B) The place where the mosquito larvae were taken for experiment

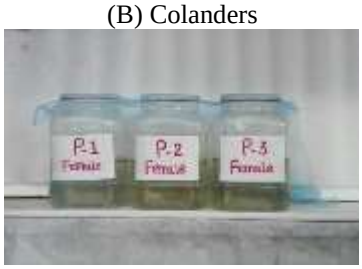
Equipments used for experiment

(A) Mosquito fish net

(B) Colanders

(C) Mosquito larvae counted spoon

(D) Dissecting microscope



(E) Experiment on the consumption rate of predator female on mosquito larvae

(F) Experiment on the consumption rate of predator male on mosquito larva

Plate 2 Equipment used during the experiment

Collection of Specimen

Poecilia reticulata and *Culex* mosquito larvae were collected from a natural ditch habitat, located at Moe Kaung street, Soe Kaw Min quarter. (Plate1. A, B)

The fishes were then taken to the laboratory. For investigation of consumption rate, *P.reticulata* (male and female) were kept separately in two liters plastic troughs (12x12x17cm) together with mosquito larvae. Three replications (three males and three females) were made for each of 3rd and 4th instars. The number of larvae consumed per fish during 24 hours period was recorded. After 24 hrs, uneaten larvae were removed and counted. Daily consumption rates of female and male of *P.reticulata* on 3rd and 4thinstar of mosquito larvae were recorded after every 24 hrs for one week. Fresh 3rd and 4th instar of mosquito larvae were provided every 24 hrs after scoring.

The second experimental setup was to assess the relationship of feeding rate with the number of prey densities. This procedure was done in three replicates for each instar the experimental protocols used is: female fishes (1x1x100): single fish with 1 liter of water volume and 100 3rd instar of mosquito larvae. Male fishes (1x1x100): single fish with 1 liter of water volume and 100 3rdinstar of mosquito larvae. Female fishes (1x1x200): single fish with 1 liter of water volume and 200 3rdinstar of mosquito larvae. Male fishes (1x1x200): single fish with 1 liter of water volume and 200 3rdinstar of mosquito larvae.

Female fishes (1x1x100): single fish with 1 liter of water volume and 100 4thinstar of mosquito larvae. Male fishes (1x1x100): single fish with 1 liter of water volume and 100 4thinstar of mosquito larvae. Female fishes (1x1x200): single fish with 1 liter of water volume and 200 4thinstar of mosquito larvae. Male fishes (1x1x200): single fish with 1 liter of water volume and 200 4thinstar of mosquito larvae.

Data Analysis

Larva consumption rate was calculated by Microsoft Excel Software.

Identification of the Specimens

The identification of Poeciliid predators and mosquito larvae were carried out according to Talwar and Jhingran (1991), Dehghan and Sadraei, (2016) and Froese and Pauly (2017).

Results

Consumption Rate of Predator *Poecilia reticulata* on Prey *Culex* Mosquito larvae

The consumption rate of *Poecilia reticulata* (male and female) on 100 preys 3rd mosquito larva with 1 liter of water volume is shown in Table 1. It was observed that differential consumption rates of guppies on mosquito larvae were found.

The maximum numbers of 95 larvae were consumed by the fishes *Poecilia reticulata* (female) in the first replicate followed by 68 in the second replicate and 66 in the third replicate. The maximum numbers of 39 larvae were consumed by the fishes *Poecilia reticulata* (male) in the first and third replicates followed by 33 in the second replicate.

The minimum numbers of 40 larvae were consumed by the fishes *Poecilia reticulata* (female) and 17 larvae by the fishes (male).The data indicated that *Poecilia reticulata* have different mean consumption rates on 3rd mosquito larvae (64 ± 17.1 preys by female, 28± 6.7 preys by male, with an average of 56 ± 8.8 (female) and 26 ± 4.8 (male). It showed that prey consumption rate of female was higher than the male. (Fig. 2)

The prey consumption rate of *Poecilia reticulata* (male and female) on 200 prey 3rd mosquito larva with 1 liter of water volume is shown in Table 2. The maximum numbers of 200 larvae were consumed by the fishes *Poecilia reticulata* (female) in the first and second replicates followed by 194 in the third replicate. The maximum numbers of 98 larvae were consumed by the fishes *Poecilia reticulata* (male) in the third replicate followed by 91in the second replicate and 87 in the first replicate.

The minimum numbers of 134 larvae were consumed by the fishes *Poecilia reticulata* (female) and 51 larvae by the fishes (male). The data indicated that guppies have different mean consumption rates on 3rd mosquito larvae (187± 13.5 preys by female and 75 ± 11.6 preys by male with an average of 175 ± 15.6 (female) and 72 ± 11.8 (male) preys). It showed that prey consumption rate of female was higher than the male. (Fig.3).

The prey consumption rate of *Poecilia reticulata* (male and female) on 100 prey 4th mosquito larva with 1 liter of water volume is shown in Table 3. The maximum numbers of 32 larvae were consumed by the fishes *Poecilia reticulata* (female) in the second replicate followed by 28 in the third replicate and 27 in the first replicate. The maximum numbers of 16 larvae were consumed by the fishes *Poecilia reticulata* (male) in the second replicate followed by 14 in the first and third replicates.

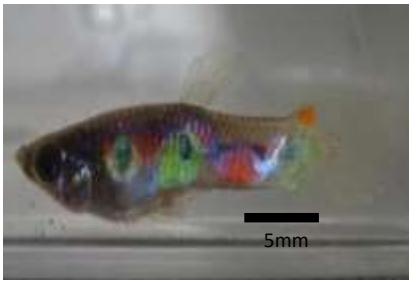
The minimum numbers of 19 larvae were consumed with by the fishes *Poecilia reticulata* (female) and 9 larvae by the fishes (male).The data indicated that guppies have different mean consumption rates on 4th mosquito larvae (25 ± 4.3 preys by female and 12 ± preys by male with an average of 24 ± 1.8 (female) and 12 ± 0.9 (male) preys). It showed that prey consumption rate of female was higher than the male. (Fig. 4)

The prey consumption rate of *Poecilia reticulata* (male and female) on 200 prey 4th mosquito larva with 1 liter of water volume is shown in Table 4. The maximum numbers of 109 larvae were consumed by the fishes *Poecilia reticulata* (female) in the second replicate followed by 97 in the third replicate and 95 in the first replicate. The maximum numbers of 48 larvae were consumed by the fishes *Poecilia reticulata* (male) in the second replicate followed by 45 in the third replicate and 41 in the first replicate.

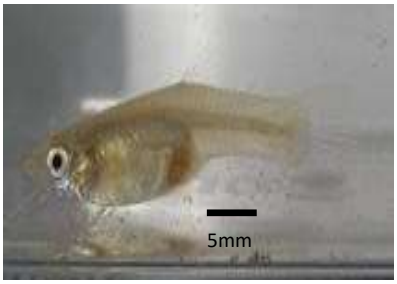
The minimum numbers of 43 larvae were consumed by the fishes *Poecilia reticulata* (female) and 15 larvae by the fishes (male).The data indicated that guppies have different mean consumption rates on 4th mosquito larvae (70 ± 17.8 preys by female and 34 ± 9.4 preys by male with an average of 68 ± 10.2 (female) and 33 ± 5.3 (male) preys). It showed that prey consumption rate of female was higher than the male. (Fig. 5)

In this study, 100 and 200 3rd instars of mosquito larvae with 1 liter of water volume were used in the predation experiment. The average numbers of 56±8.8 larvae were consumed with 100 3rd instars of mosquito larva by the fishes *Poecilia reticulata* (female) and 26±4.8 larvae by the fishes (male). The average numbers of 175±15.6 larvae were consumed 200 3rd instars of mosquito larva by the fishes *Poecilia reticulata* (female) and 72±11.8 larvae by the fishes (male).

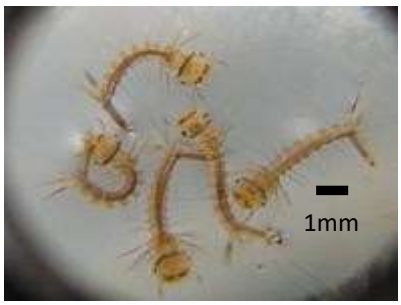
In this study, 100 and 200 4th instars of mosquito larvae with 1 liter of water volume were used in the predation experiment. The average numbers of 50±2 larvae were consumed with 100 4th instars of mosquito larva by the fishes *Poecilia reticulata* (female) and 30±2 larvae by the fishes (male). The average numbers of 37±7.7 larvae were consumed with 200 4th instars of mosquito larva by the fishes *Poecilia reticulata* (female) and 16±1.8 larvae by the fishes (male). Larvae consumption increased, as there was an increase in prey densities, until satiation level was reached. (Table. 5, Fig.6).



(A) *Poecilia reticulata* (Male)



(B) *Poecilia reticulata* (Female)



(C) Third instar stage of mosquito larvae

(D) Fourth instar stage of mosquito larvae

Plate 3 Mosquito fish (male and female) and *Culex* mosquito larvae (3rd and 4th instars)

Table 1 Consumption rates of predator (*Poecilia recticulata*) on 100 preys (3rd instar of *Culex* mosquito larva) with 1 liter within 24 hrs in laboratory condition

Sr. No.	Date	No. of 3rd instar mosquito larva consumed / 24 hrs							
		P1♀	P2 ♀	P3♀	Mean ± SD	P1♂	P2♂	P3♂	Mean ± SD
1	2.1.2019	44	48	47	46±1.7	17	25	23	22±3.4
2	3.1.2019	43	40	46	43±2.4	19	29	18	22±5.0
3	4.1.2019	77	68	66	70±4.8	24	18	27	23±3.7
4	5.1.2019	66	47	55	56±7.8	27	27	26	27±0.5
5	6.1.2019	68	55	53	59±6.6	23	22	36	27±6.4
6	7.1.2019	57	58	50	55±3.6	30	20	29	26±4.5
7	8.1.2019	95	48	48	64±22	39	33	39	37±2.8
	Mean±SD	64±17	52±9	52±6	56±8.8	26±6.8	25±5	28±7	26±4.8

Replica P1, P2, P3

Table 2 Consumption rates of predator (*Poecilia recticulata*) on 200 preys (3rd instar of *Culex* mosquito larva) with 1 liter within 24 hrs in laboratory condition

Sr. No.	Date	No. of 3rd instar mosquito larva consumed / 24 hrs							
		P1♀	P2♀	P3♀	Mean ± SD	P1♂	P2♂	P3♂	Mean ± SD
1	2.1.2019	167	166	134	156±15	51	59	62	57±4.6
2	3.1.2019	193	191	139	174±25	71	76	73	73±2.1
3	4.1.2019	200	199	194	198±3	65	79	83	76±7.7
4	5.1.2019	165	162	143	157±9.7	51	59	62	57±4.6
5	6.1.2019	193	191	134	173±27	71	91	74	79±8.8
6	7.1.2019	198	200	194	197±2.5	87	86	98	90±5.4
7	8.1.2019	192	190	137	173±25.5	75	78	72	75±2.4
	Mean±SD	187±14	186±14	154±26	175±15.6	67±12	75±11	75±12	72±11.8

Replica P1, P2, P3

Table 3 Consumption rates of predator (*Poecilia recticulata*) on 100 preys (4th instar of *Culex* mosquito larva) with 1 liter within 24 hrs in laboratory condition

Sr. No.	Date	No. of 4th instar mosquito larva consumed / 24 hrs							
		P1♀	P2♀	P3♀	Mean ±SD	P1♂	P2♂	P3♂	Mean ± SD
1	9.1.2019	27	20	28	25± 3.6	14	13	11	13±1.2
2	10.1.2019	23	23	25	24±0.9	14	9	12	12±2.0
3	11.1.2019	21	21	24	22±1.4	12	15	10	12±2.1
4	12.1.2019	19	28	19	22±4.2	13	10	12	12±1.2
5	13.1.2019	22	30	28	27±3.4	12	9	9	10±1.4
6	14.1.2019	24	24	26	25±0.9	11	16	10	12±2.6
7	15.1.2019	20	32	27	26±4.9	9	10	14	11±2.2
	Mean±SD	22±3	25±4	25±3	24±1.8	12±2	12±3	11±2	12±0.9

Replica P1, P2, P3

Table 4 Consumption rates of predator (*Poecilia recticulata*) on 200 preys (4th instar of *Culex* mosquito larva) with 1 liter within 24 hrs in laboratory condition

Sr. No.	Date	No. of 4th instar mosquito larva consumed / 24 hrs							
		P1♀	P2 ♀	P3 ♀	Mean ± SD	P1 ♂	P2♂	P3♂	Mean ± SD
1	9.1.2019	47	51	61	53± 5.9	41	18	41	33±10.8
2	10.1.2019	45	53	72	57±11.3	37	38	45	40±3.6
3	11.1.2019	79	77	97	84±9.0	25	32	35	31±4.1
4	12.1.2019	53	53	85	64±15.1	18	48	41	36±12.8
5	13.1.2019	71	61	79	70±7.4	41	35	36	37±2.6
6	14.1.2019	95	72	51	73±18	32	18	15	22±7.4
7	15.1.2019	79	109	43	77±26.9	39	31	28	33±4.6
	Mean±SD	67±18	68±19	70±18	68±10.2	33±8	31±10	34±9	33±5.3

Replica P1, P2, P3

Table 5 Feeding rate of male and female guppies in 24 hour on arvae of mosquito with the variations in mosquito densities

Sex of guppy	Mosquito larva stage	Fish (n)	Water volume	Mosquito densities	Mean ±SD
Female Guppy	3rd instar	1	1	100	56±8.8
male Guppy	3rd instar	1	1	100	26±4.8
Female Guppy	4th instar	1	1	100	24±1.8
male Guppy	4th instar	1	1	100	12±0.9
Female Guppy	3rd instar	1	1	200	175±15.6
male Guppy	3rd instar	1	1	200	72±11.8
Female Guppy	4th instar	1	1	200	68±10.2
male Guppy	4th instar	1	1	200	33±5.3

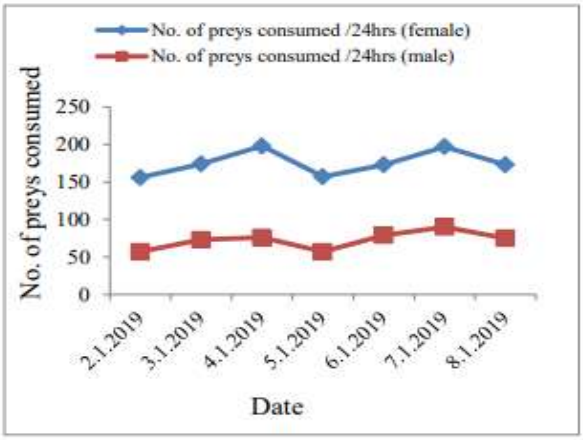


Figure 2 Consumption rate of predator on prey (3rd 100) with 1 liter within 24 hrs during one week

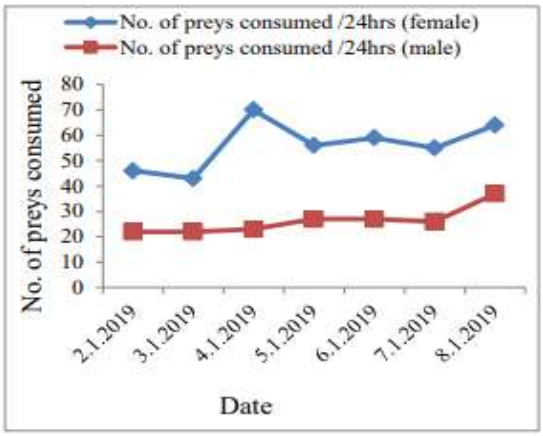


Figure 3 Consumption rate of predator on prey (3rd 200) with 1 liter within 24 hrs during one week

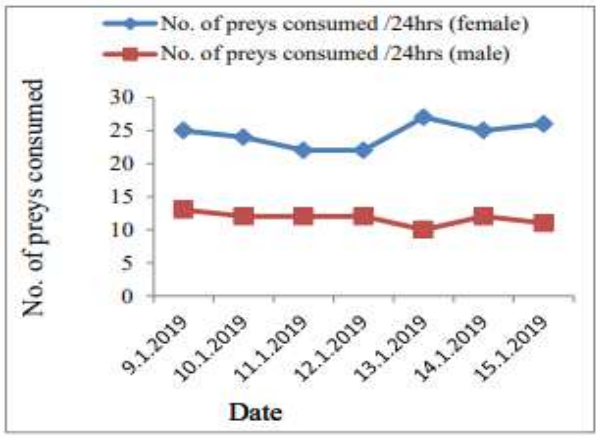


Figure 4 Consumption rate of predator on prey (4th 100) with 1 liter within 24 hrs during one week

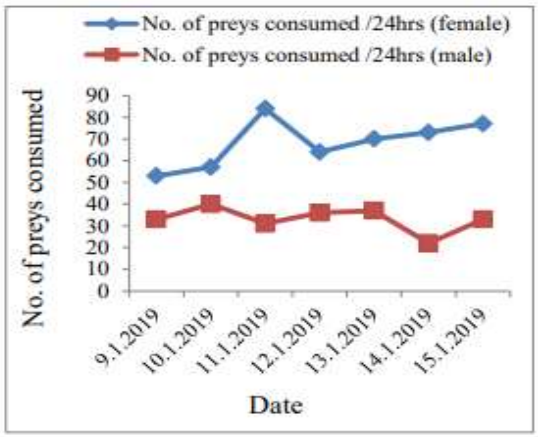


Figure 5 Fig 5. Consumption rate of predator on prey (4th 200) with 1 liter within 24 hrs during one week

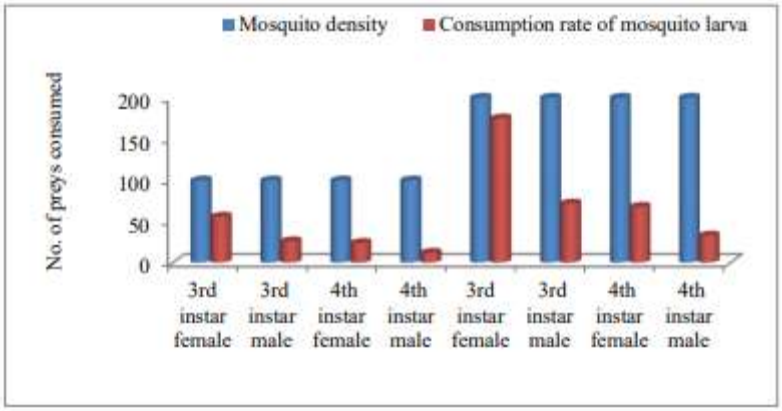


Figure 6 Consumption rate of predator on prey (3rd 100,200 and 4th100,200) within 24 hrs during one week

Discussion

This research investigated the under laboratory condition at 21.5±1.3˚C and 80.78±5.7% RH. In this study guppies were used as predators against *Culex* mosquito larvae in Magway University.

The consumption rate of *Poecilia reticulata* (male and female) on prey one hundred larvae of 3rd instar stage is shown in Table 1. It was observed that differential consumption rates of guppies on 3rd instar mosquito larvae were found. The data indicated that *P.reticulata* have different mean consumption rates on 3rd mosquito larvae (64 ± 17.1 by female, 28 ± 6.7 by male, with an average of 56 ± 8.8 (female) and 26 ± 4.8 (male). In this study, it was observed that female wild guppies ate 3rd mosquito larvae more than male guppies did.

The consumption rate of *P. reticulata* (male and female) on prey two hundred larvae of 3rd instar stage is shown in Table 2. The data indicated that *Poecilia reticulata* have different mean consumption rates on 3rd mosquito larvae (187 ± 13.5 by female, 75 ± 11.6 by male, with an average of 175 ± 15.6 (female) and 72 ± 11.8 (male). In this study, it was observed that female guppies ate 3rd mosquito larvae more than male guppies did.

This result supports the findings of Seng *et al* (2008): female guppies ate more than male guppies. This is due to the larger size of the female guppies. Therefore, female guppies can consume more mosquito larvae than male guppies can. Karlekar and Andrew (2016) found that the consumption rate on fifty larvae of 3rd instar stage of *Culex* with 800 ml of water volume on average of 27±2.5, which is comparatively different to the results of the present findings. Because of feeding rate increased with the increase in prey and predator densities.

The consumption rate of *Poecilia reticulata* on prey 4thinstar stage is shown in Table3. The data indicated that wild guppies have different mean consumption rates on one hundred larvae of 4thinstar stage (25 ± 4.3 preys by female and 12 ± 2.7 preys by male with an average of 24 ± 1.8 (female) and 12 ± 0.9 (male) preys).

The consumption rate of *Poecilia reticulata* on prey 4thinstar stage is shown in Table 4. The data indicated that guppies have different mean consumption rates on two hundred larvae of 4thinstar stage (70 ± 17.8 preys by female and 34 ± 9.4 preys by male with an average of 68 ± 10.2 (female) and 33 ± 5.3 (male) preys).

This result also supports the finding by Cavalcanti *et al* (2007) who report that the efficacy as predator depends on its weight and sex. Saleeza *et al*., (2014) found that the consumption rate on Two hundred larvae of 4th instar stage with on average of 50±5.2 (male) and 94±6.3 (female),

which is comparatively different to the results of the present findings. Manna *et al* (2008) the number of prey consumed varies with the difference in body size. This means that prey consumption increases with body size.

In term of feeding rate in this study, female guppies had their feeding rate increased when the prey densities were increased. This result supports the findings of Anyaele and Obembe (2010). They reported that larval consumption increased when the densities of prey increase until satiation level is reached, that is, when the fish becomes overwhelmed. Guppy fish have been described as effective biological agents for the control of mosquito larvae (Rozendaal, 1997).

Mosquito borne diseases or mosquito borne illnesses are diseases caused by bacterial, viruses and parasites transmitted by mosquitoes. Nearly 700 million people get a mosquito borne illness each year resulting in greater than one million deaths. Mosquito cause more human suffering than any other organism (Douglas**,** 2004).

Biological control of mosquitoes was very popular during the early part of the 20th century, but this type of control has been replaced with the insecticidal control due to easy availability of chemicals such as organochlorines and organophosphates. However, because of problems with insecticide resistance and greater awareness of environmental contamination, there has been renewed interest in biological methods (Service, 2000).

Saleeza *et al* (2011) reported that the three common mosquito larvae are commonly found in residential areas in both urban and sub urban areas. A number of studies have indicated that guppies of the *Poecilia reticulata* species are good predators, as they can control mosquito larvae population. Saha *et al* (1986) studied on the use of *Poecilia reticulata* (guppy) as a powerful biocontrol agent in the field of mosquito eradication.

Conclusion

Jayapriya and Shoba, (2014) stated that Biological control has many advantages as compared to chemicals. Because it can be effective and safe to human and non-target populations. It has low cost of production and lower risk of resistance development. *Poecilia reticulata* is excellent agents for use as biological control of mosquito larvae. Thus, it can be seen that there is a great need for the identification of the Mosquitofish and mosquito species of economic importance.

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References

Allen, G. R., S. H. Midgley and Allen, M., (2002). Field guide to the freshwater fishes of Australia. Western Australian Museum, Perth,Western Australia 394p.

Andreadis, T.G., Thomas, M.C., and Shepard, J. J., (2005). *Identification guide to the mosquitoes of Connecticut*.The Connecticut Agricultural Experiment Station; 123 Huntington Street, New Haven, CT 06511.1- 161pp.

Anyaele O, Obembe A. (2010). Laboratory evaluation of the biocontrol potential of *Aphyosemion gularis* against *Anopheles* larvae *J Vector Borne Dis*; 47:181-4**.**

Borror, D.J. and Delong, D.M., (2015.)*An introduction to the study of insects.*Holt, Richard and Winston, N.Y.341pp.

Cavalcanti LP, Pontes RJ and Regazzi AC., (2007). Efficacy of fish as predators of *Aedes* larvae, under laboratory conditions. 41:638-44.

Christophers S.R., (1933). The fauna of British India, ceylon and Burma.Taylor and francis, red lion court, Fleet Street London.Vol-4: 1-371pp.

Dehghan and Sadraei, (2016). A pictorial key for *Culex pipens* complex (Diptera : Culicidae) in Iran. Journal of arthropod, 2016-ncbi.nlm.nih.gov.

Douglas, E.N. and Norris,S. K., (2004). Mosquito-borne Diseases as a Consequence of land use change. *Eco Health.* Vol. 1.Pp.19-24.

Eldridge, B. F., (2008). Biology and control of mosquitoes.1001 1Street, P.O.Box 4015, Sacramento, California 95812-4012.

Froese, R. and Pauly, D. (2017). *Poecilia reticulata* Peter, 1859. Fish Base. Available: http://fishbase.org/summary/ *Poecilia reticulata*.html. (February,2018)

Gullan, P.J.; and Cranston, P.S., (2010). *The Insects: An outline of Entamology.* Fourth Edition, Oxford: ISBN 1-4443-3036-5.

Karlekar, S.R. and Andrew, R.J., (2016). Assessment of Mosquito larvivorous prospective of the mosquito fish. *Biological forum-An International Journal* 8(2):326-329Pp.

Manna B, Aditya G and Banerjee S., (2008). Vulnerability of the mosquito larvae to the guppies in the presence of alternative preys. *J Vector Borne Dis*; 45:200-6.

Pemola Devi, N. and Jauhari, R. K., (2006). Climate variables and malaria incidence in Dehradun, Uttaranchal, India.J.Vect. Borne Dis.; 43.pp.21-28.

Saha D, Biswas D, Chatterjee KK and Chandra G., (1986). Guppy (*Poecilia reticulata*)as a natural predator of *Culex quinquefasciatus* larvae. *Bull Calsh Med*: 34: 1-4.

Saleeza SNR, Norma-Rashid Y and Sofian-Azirun M., (2011). Mosquitoes larval breeding habitat in urban and suburban areas, Peninsular Malaysia. *World Acad Sci Technol*. 58:569-73.

Saleeza SNR, Norma-Rashid Y and Sofian-Azirun M., (2014). Guppies as predators of common mosquito larvae in Malaysia.45: 299-308.

Service, M. W**.,** (2000). Medical Entomology for students. 2nd ed. Cambridge: Cambridge University.

Steven, A.J.; Lounibos, L.P. and George, F., (2004). A field test for competitive effects of *Aedes albopictus* on *Aedes aegypti* in South Florida: differences between sites of coexistence and exclusion? *Oecologia.*Vol.139. Pp.583-593.

Sumit M.Vyas., (2008.)Certain studies on mosquitoes of Rajkot city. *Thesis PhD*, Saurashtra University. Rajkot 360 005.1-200pp.

Talwar, P.K. and Jhingran, A. G., (1991). *Inland Fishes* of India and adjacent countries, Oxford: ISBN Vol 2 81-204-0641-9.1158pp.