FISH FRY KILL BY HYDRA AND PLANARIA

MIR S. MULLA AND SHAN-CHING TSAI

Department of Entomology, University of California, Riverside, CA 92521

ABSTRACT. The killing of fish fry, *Tilapia zillii*, by the mosquito biological control agent, *Hydra americana*, was studied in enamel pans, glass aquaria, in the laboratory and in outdoor ponds. It was found that the hydras readily killed the fish fry under all test conditions. The planarian mosquito predator, *Dugesia dorotocephala*, was found less lethal than the hydra to the fish fry at stocking rates needed for mosquito control or above these rates.

INTRODUCTION

Freshwater invertebrate predators such as hydras and planarias are known to regulate and decimate populations of immature mosquitoes and chironomid midges (Legner 1977, Qureshi and Bay 1969, Yu and Legner 1976, Yu et al. 1974). Recent progress in mass culture techniques (Lenhoff and Brown 1970, Loomis and Lenhoff 1956, Tsai and Legner 1977 and unpublished work) have made it feasible to produce large quantities of these predators to be evaluated in mosquito breeding sites. However, the potential hazard of these predators to fish fry and embryos has not been examined. Fish kill is a problem that has to be taken into consideration when one weighs the risk-benefit balance in employing these biological control agents in integrated mosquito control programs. This study was designed to elucidate the killing of fish fry by hydras and planarias.

MATERIALS AND METHODS

The hydra *Hydra americana* Hyman (Hydroida: Hydridae) prevailed in abundant numbers in our aquaria used for planaria cultures as well as in outdoor earthen ponds at Midgeville (Aquatic Research Facility), University of California-Riverside. The hydra colony for testing was raised from 20 hydras collected from the aquaria 3 wk prior to the experiments. They were kept in 2 aquaria, each containing 20 liters artificial culture medium (Lenhoff and Brown 1970), a sand filter bed and the aquatic plant *Elodea densa*. The hydras were fed daily on *Daphnia* and copepods collected from outdoor ponds.

Fry of the fish, *Tilapia zillii* Gervais (Teleosteii: Cychlidae), were bred in earthen ponds. The fry were 6.6 ± 0.3 mm long (avg. 4.0 mg) on the 2nd day after leaving their parent's mouth cavity. The planarians, *Dugesia dorotocephala* Woodworth (Tricladida: Planariidae), were cultured and handled as described by Tsai and Legner 1977, (and unpublished).

The killing by hydras or planarias of fish fry was observed in enamel pans, glass aquaria, and outdoor earthen ponds. Each pan was 30 x 20 x 5 cm containing 2 liter hydra culture medium (Lenhoff and Brown 1970). An aliquot of the chilled hydra suspension (Lenhoff and Loomis 1957) was added to each pan to obtain a predetermined hydra population density. When the hydra attached to the pan 4 hr later, ten 3-day old *T. zillii* fry were put into each pan, and mortality was assessed periodically thereafter. The fish fry mortality, due to planarian predation, was estimated in a similar way except that the culture medium for planarians (Tsai and Legner unpublished) contained 150 ppm more NaCl than that for the hydra.

The aquaria test units for both hydras and planarias had a capacity of 10-gal., each holding 20 liters water. Each planarian aquarium contained about 3,000 *D. dorotocephala* yielding about 1.6 planarian per cm^2 of the submerged side walls; and the aquaria for hydras had 3 and 6 hydras per cm^2. In each aquarium, 20 *T. zillii* fry were put in for exposure and their mortality assessed periodically thereafter.

In outdoor studies, 1.0 x 1.0 x 0.1 m redwood framed earthen ponds were used. The water level in the ponds was kept constant by float valves, each pond receiving 3/1/min inflow water with the excess water drained through an overflow tube covered with 60-mesh nylon screen. At first, 2,000 hydras and 4 hr later 100 2-day old *Tilapia* fry were put into each pond. Fish mortality was assessed periodically thereafter as in the other tests. The % mortality of fish at each interval are presented in the tables.

RESULTS AND DISCUSSION

The hydras are sessile carnivorous organisms and procure food by paralyzing food organisms which pass by their extended tentacles (Fig. 1). Nematocysts discharged from these tentacles have the power to paralyze small-size food organisms including fish fry in a matter of a few seconds. Therefore hydras have been reported to become a nuisance in fish hatchery operations. This potential hazard of *Hydra americana*, a good candidate for biological control of mosquitoes, was therefore assessed under various laboratory and field conditions.

In the shallow enamel pans containing 4.8 hydras/cm^2 water surface (density higher than that found effective for mosquito control) all the 3-day old fish fry were killed in 10 minutes; at a practical and lower population density of 0.68 hydras/cm^2, all the fish were killed in 4 days (Table 1). This density is only 2–3 X the larvicidal density. By comparison, the planaria at the rate of 1/cm^2 (much higher

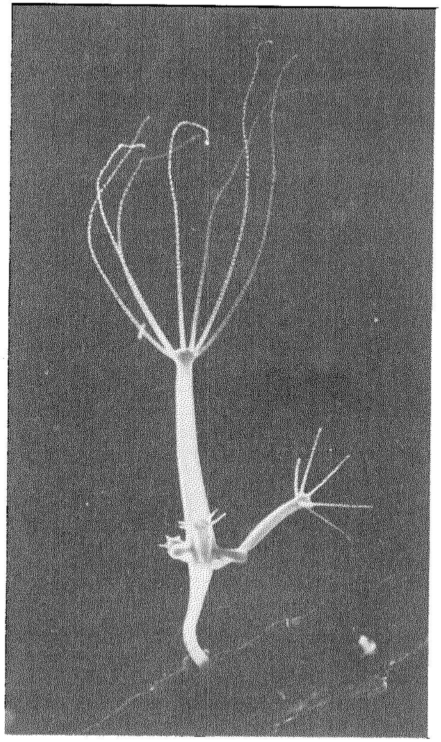

Fig. 1. *Hydra americana* with 5 buds. Nematocysts which paralyze fish fry and other food organisms in seconds are discharged from the tentacles.

Table 1. Killing of 3-day old *Tilapia zillii fry* (%) in enamel pans by *Hydra americana* [a]

Exposure time, hr.	Stocking density of hydra/cm^2						
	0	0.17	0.38	0.68	1.2	2.4	4.8
0.16	0	0	0	10	10	70	100
2.2	0	0	0	10	10	90	100
12	0	0	0	10	20	90	100
24	0	0	0	30	30	100	100
48	0	0	0	40	40	100	100
72	0	10	0	80	100	100	100
96	0	30	40	100	100	100	100

[a] 10 fry 2.1 water in each pan (30 x 20 x 5 cm.)

than larvicidal density) killed only 40% of the fish fry on the 1st day; and no more fish mortality occurred thereafter. At the lower rates of 0.4 and 0.1 planaria/cm² (still higher than larvicidal rates), mortality was 10% and 0% respectively. The hydras thus possess more potent and lasting fish killing power than the planarians. One possible reason for the difference is that the effective stocking rate of hydras is much higher than that for the planarias for effective mosquito control. The rate of 0.1 hydras/cm² is equal to 0.0025 planarians/cm² in producing the same mosquito larval mortality (Legner 1977, Yu et al. 1974). The hydras in contrast to planarias therefore pose a greater danger to fish fry, and therefore will have greater adverse affects on fish fry in inland waters.

In the rearing aquaria, both 2- and 3-day old *Tilapia* fish fry were vulnerable to hydra attack (Table 2). The fish mortality increased as the hydra density increased. It was noted that 2 or 3 hydras were attacking a single fish simultaneously, paralyzing it in minutes (Fig. 2). On the other hand, planarias would not attack 3-day or older *Tilapia* fry, although they readily preyed upon the 2-day old fry. Chemical antifeedants might be involved in protecting the older fish against predators. It was observed that feeding activity of planarias on the red worm *Tubifex* spp. was completely impaired when the worms were served with freshly detached skins of old mosquito fish *Gambusia affinis affinis* (unpublished data). This pattern might also operate for *T. zillii*.

After noting the high level of destructiveness of the hydras to fish fry, we tested them further in outdoor ponds. In these habitats they killed 85% of the 2-day old *Tilapia* fry in 24 hrs (Table 3) at the stocking rate of 2,000 hydras/m² water surface, a density needed for effective mosquito control (Yu et al. 1974).

Table 3. Mortality (%) of fish dry *Tilapia zillii* in outdoor ponds infested by *Hydra americana* [a]

Exposure time, hr.	Cumulative
24	85
48	93
72	94
120	97

[a] 2 replicates. 100 2-day old fry and 2,000 hydras per pond (1 x 1 x 0.1 m).

In our assessment, *Tilapia* is one of the fish least vulnerable to hydra attack because it is protected in the parent's mouth during embryonic stages. The early stages of most game and food fish, which are scattered on the substrata of streams, ponds, and lakes, will probably suffer high mortality than *Tilapia* fry in nature.

The lethal effects of hydras on fish fry are clearly demonstrated herein. It is advisable to avoid stocking of spawning grounds of game and food fish with hydras, especially during the breeding seasons. It is possible that inoculation or stocking of mosquito breeding sources may not be compatible with fish and hydras at the same time.

Table 2. Mortality (%) of fish fry (*Tilapia zillii*) after being introduced into the rearing aquaria containing the hydra *H. americana* and the planarian *D. dorotocephala*

Fish Age (day)	Exposure time (hr.)	Predator density		
		3 hydras/cm²	6 hydras/cm²	1.6 planaria/cm²
2	24	90	100	95
3	24	60	100	0
	48	83	100	–
	72	93	100	–
	96	100	100	–

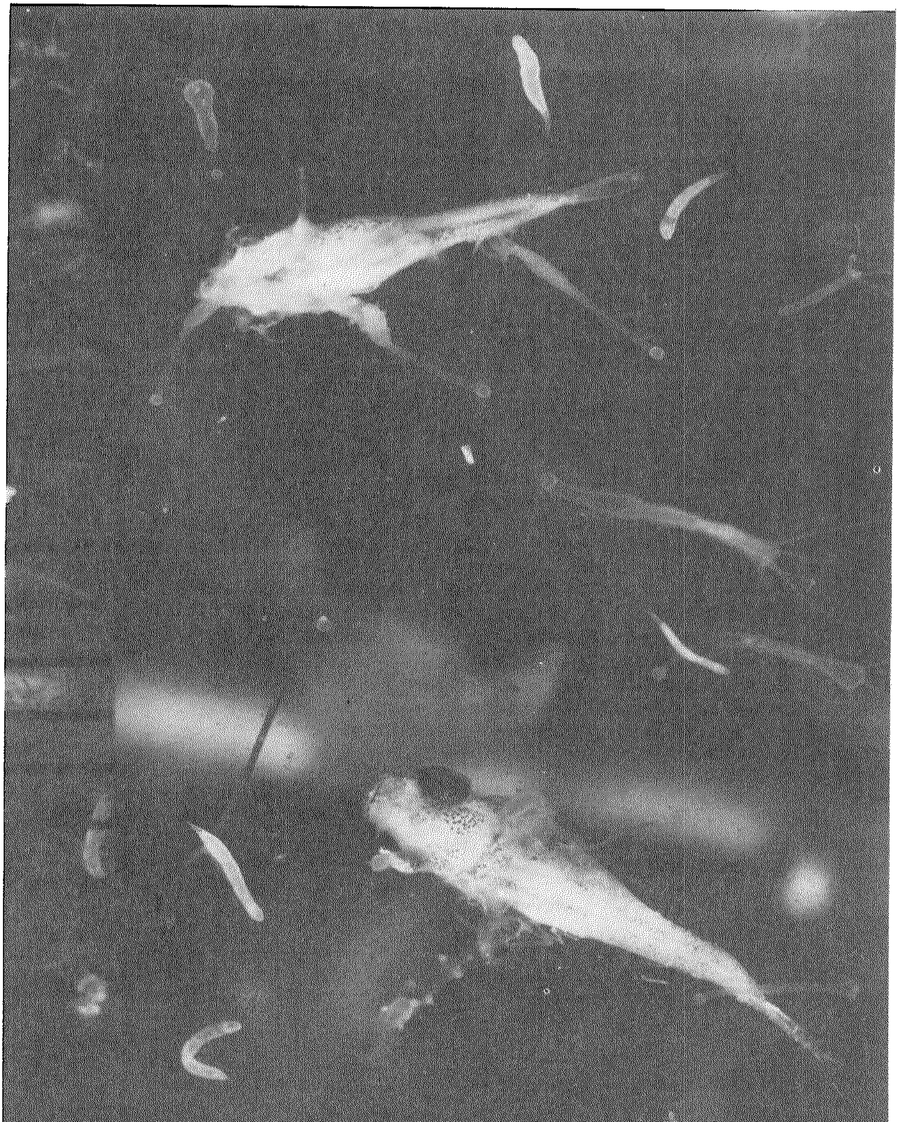

Fig. 2. Fish fry *Tilapia zillii* killed by the hydra *H. americana* (courtesy Max E. Badgley), the attacking hydras in close contact with the victim.

References Cited

Legner, E. F. 1977. Response of *Culex* spp. larvae and their natural predators to two inoculation rates with *Dugesia dorotocephala* (Woodworth) in shallow ponds. Mosquito News 37:435–40.

Lenhoff, H. M. and R. D. Brown. 1970. Mass culture of hydra: an improved method and its application to other aquatic invertebrates. Lab. Anim. 4:139–154.

Lenhoff, H. M. and W. F. Loomis. 1957. Environmental factors controlling respiration in hydra. J. Exper. Zool. 134:171–181.

Loomis, W. F. and H. M. Lenhoff. 1956. Growth and sexual differentiation of hydra in mass culture. J. Exper. Zool. 132: 554–574.

Qureshi, A. H. and E. C. Bay. 1969. Some observations on *Hydra americana* Hyman as a predator of *Culex peus* Speiser mosquito larvae. Mosquito News 29:465–471.

Tsai, S. C. and E. F. Legner. 1977. Exponential growth in culture of the planarian mosquito predator *Dugesia dorotocephala* (Woodworth). Mosquioto News 34: 474–478.

Yu, H. S. and E. F. Legner, 1976. Regulation of aquatic Diptera by planaria. Entomophaga 21: 3–12.

Yu, H. S., E. F. Legner, and R. D. Sjogren. 1974. Mass release effects of *Chlorohydra viridissima* [Coelenterata] on field populations of *Aedes nigromaculis* and *Culex tarsalis* in Kern County, California. Entomophaga 19:409–420.

GENETIC MAPPING OF A LARVAL COLOR MUTANT, *GREENISH LARVA*, WITH THE HELP OF MALE-LINKED TRANSLOCATIONS AND *RUBY-EYE* MARKER IN *CULEX QUINQUEFASCIATUS*

SARALA K. SUBBARAO AND T. ADAK

Malaria Research Centre, 22, Sham Nath Marg, Delhi—110054, India

ABSTRACT. A larval color mutant, *greenish larva*, was isolated from *Culex quinquefasciatus* Say (*fatigans* auct.) from a laboratory colony. Linkage studies with the help of male-linked translocations and *ruby-eye* marker have shown that it is an autosomal recessive mutant on chromosome 3.

INTRODUCTION

In *Culex quinquefasciatus* Say (*fatigans* auct.) there is a striking lack of phenotypic markers which are essential in many genetic studies. A detailed description of most of the available phenotypic markers is given by Laven (1967). Larval color mutants viz., green (*g*)-dominant (Ghelelovitch 1950), melonotic (*mel*)-autosomal recessive and lethal (Laven and Chen 1956), green (*g*) and yellow (*y*)-autosomal recessives on chromosome 2 (Laven 1957), black (*B1*)-dominant and sex-linked (Vande Hey 1964, WHO, Unpublished) and green (*g*), brown (*br*), golden yellow (*go*) and greenish brown (*bg*)-autosomal recessives (Shetty and Chowdaiah 1976) have so far been reported in the *Culex pipiens* complex. Recently green larvae were observed in one of our laboratory colonies, and linkage studies with the help of male-linked translocations and *ruby-eye* (*ru*) marker (Iltis et al. 1965) have shown that this mutant is located on chromosome 3. Since there is a green color larval mutant *green larva* on chromosome 2 described by Laven (1957) this mutant will be referred to as *greenish larva* (*grs*).

MATERIALS AND METHODS

Greenish larva was isolated from a laboratory strain (Pa) De/De (Paris cytoplasm