

# MORTALITY OF FRESH WATER AND TROPICAL FISH FRY BY CYCLOPOID COPEPODS

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## INTRODUCTION

Observations of attacks of cyclopoid copepods on larval fish have been described infrequently in the literature. Davis (1959) found dead fish fry from Lake Erie with *Cyclops bicuspidatus* and *Mesocyclops edax* attached. He found that a laboratory culture of *Mesocyclops edax* equivalent to a population density of 500 copepods per liter could damage the fins of young rockbass, *Ambloplites rupestris*. Fryer (1953) observed *Cyclops viridis* attacking a recently hatched fish. In the same account, he reported that an aquarist witnessed attacks by *Cyclops* sp. on newly hatched tropical fish fry and attributed the deaths of two dozen young to this cause. Oliva and Sládeček (1950) reported the death of a 2-cm long axolotl larva following attacks by *Cyclops strenuus* and *Cyclops vicinus*. Spandl (1926) states that cyclopoid copepods may attack and injure small fish, and that death possibly results from infection after the attack. Innes (1955) saw cyclopoids attached to young fishes.

The present paper describes experiments designed to confirm the observations of Davis and to test the effect of population density of cyclopoids and of various sizes of fish fry on predation rates. These experiments constitute the initial phase of a longer research program which will be an attempt to evaluate the role of cyclopoids as natural predators of young fish.

## MATERIALS AND METHODS

Adult and copepodid stages of *Cyclops vernalis*, *C. bicuspidatus*, and *Mesocyclops leuckarti*, were collected near the Fisheries pier or in open water of Hatchery Bay, Put-in-Bay, Ohio. Copepods were usually collected on the day they were used to start experiments, but, in some instances when cyclopoids were impossible to obtain in quantity, cultured *C. vernalis* were used. Differences between the behavior of freshly caught animals and that of those maintained in laboratory cultures were not noted.

Fish eggs and fry were collected from nests in a small farm pond in Beaver County, Pennsylvania, and in Terwilliger's Pond, South Bass Island, Ohio. Bluegill fry, *Lepomis macrochirus*, were obtained from the nest area in the tanks at the Toledo Aquarium. Zebra eggs and fry of *Brachydanio rerio* (Hamilton-Buchanan), the fry of the gourami, *Trichogaster trichopterus*, and the eggs and fry of a cichlid, *Cichlasoma nigrofasciatum*, were obtained by breeding these fish in thermostatically controlled aquaria.

Experiments were set up in finger bowls of 200-ml capacity, one and two liter finger bowls, one and two liter battery jars, or ten gallon aquaria. A control and a test group was used for each experiment. There were no copepods in control aquaria. Fry in test groups were subjected to cyclopoid concentrations equivalent to and ranging from 10 to 500 individuals per liter. Most of the experiments were run within the 20 to 100 copepods per liter range, which is the order of magnitude of the population density found in many freshwater lakes and ponds. Morgan (1958) in his extensive studies of the plankton of 11 one-acre ponds, however, found as many as 247.5 *C. bicuspidatus*, *Eucyclops agilis* and *Mesocyclops* sp. per liter in one of the ponds on April 30, 1955.

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A count of the fry in each aquarium was made daily. Direct observation of the test group was maintained much of the time to verify that death of the fry was actually due to cyclopoid attacks.

## RESULTS

Mortality of all species one and two days after hatching was from 25 to 50 percent in the aquaria containing *C. vernalis*, *C. bicuspidatus* and *Mesocyclops leuckarti*. That in the control groups which contained no cyclopoids was from 1 to 5 percent. Table 1 represents a summary of 49 experiments showing the mortality of fry after three days with cyclopoid copepods. In all experiments grouped together, there was a distinct difference in survival between those containers having cyclops and those without. The 50 percent mortality in the sunfish control group probably indicates inadequate numbers of fry. Table 2

TABLE 1

*A summary of 49 experiments showing mortality of various species of fry after three-days exposure to cyclopoid copepods in concentrations below 200 individuals per liter*

Type of fry	Cyclops per liter	Number of fry	Mortality	% loss
Gourami	0	51	1	2.0
Gourami	6.6-125	81	25	30.9
Sunfish	0	14	7	50.0
Sunfish	25-150	28	24	85.7
Cichlid	0	73	13	17.8
Cichlid	3.2-186	124	96	77.4
Zebra	0	47	5	10.6
Zebra	10-169	44	33	75.0
Rock bass (?)	0	24	3	12.5
Rock bass (?)	20-50	21	6	28.6

TABLE 2

*Summary of 24 experiments showing mortality of bluegill fry after five days exposure to various concentrations of Cyclops vernalis and Cyclops bicuspidatus*

Cyclops per liter	Number of fry	Mortality	% loss
0	69	7	10.2
10-50	30	24	80.0
51-100	19	18	94.7
101-150	32	32	100.0

shows that as the number of cyclopoids increased, deaths of fry also increased over a period of five days. Four experiments were devised involving 27 control fry, 28 test fry and 200 or more cyclops per liter. Mortality in the test group was 46.4 percent, and no deaths in the control group after one day. By the second day there had been a 60.7 percent loss of test fry compared to a 7.5 percent loss in the control.

It was found that many of the fry that were 8 mm or more in length could avoid or survive damage from cyclopoids in concentrations equivalent to 1000 per liter. The size at which fry can withstand attacks probably varies with each species, activity or motility of the fry being perhaps of prime importance to survival.

The method by which a larval fish is destroyed by a cyclopoid is essentially that

described by Davis (1959). In many cases copepods were observed attached to and apparently chewing on the tail, head, body or yolk sac region of fry. If the yolk sac were the initial point of attack, it would usually rupture only a few minutes after the attachment of the copepod. Some of the yolk would flow out and coagulate. Death of the fry followed almost immediately. If the tail were attacked, mortality of the fry would appear to depend on the persistence of the cyclopoid and the amount of tissue devoured. If a cyclopoid attacked the head region, death of the fry was generally noted within two or three minutes.

#### CONCLUSIONS

These experiments indicate that mortality and predation of fry increase as the concentration of the cyclopoids increases. It is suggested from these experiments that certain cyclopoid copepods may be one biologic factor in reducing or lowering some fresh water fish populations. Overpopulation of fish would occur within a very short time if not for a multitude of physical, chemical and ecological factors.

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