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PRELIMINARY OBSERVATIONS OF THE EFFECT OF *EIMERIA FUNDULI* (PROTOZOA: EIMERIIDAE) ON THE GULF KILLIFISH *FUNDULUS GRANDIS* AND ITS POTENTIAL IMPACT ON THE KILLIFISH BAIT INDUSTRY[1]

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ABSTRACT Liver infections of *Eimeria funduli*, a pathogenic coccidium, greatly affected growth of *Fundulus grandis* (Gulf killifish) maintained in an aquaculture facility for 55 days. At termination of the experiment, average weight gained by uninfected killifish was 877.5% compared to 308.0% in diseased fish. There appeared to be no correlation between mortality and disease in this study.

INTRODUCTION

Epizootics of *Eimeria funduli* Duszynski, Solangi, and Overstreet, 1979, a pathogenic hepatic coccidian of killifishes, have occurred in several coastal areas of the northern Gulf of Mexico and probably other areas (Solangi and Overstreet 1980, Fournie and Solangi 1980). Although 80 to 85% of both the liver and pancreatic tissues of heavily infected fish can be replaced by oocysts of *E. funduli* (Solangi and Overstreet 1980; Hawkins, Solangi, and Overstreet 1981), the disease does not appear to cause mortality in affected fish maintained in the laboratory. However, Solangi and Overstreet (1980) suspected that the parasite affected the growth of diseased fish.

The Gulf killifish *Fundulus grandis* is an important member of the salt marsh ecosystem, supports a growing bait industry, and can be reared commercially (McIlwain 1977; Solangi and Overstreet 1980; Tatum et al. 1978). Consequently, the disease could have a considerable impact on the economic potential of Gulf killifish.

This paper reports the effect of *E. funduli* on growth of *F. grandis*, possible impact of the coccidian on the killifish bait industry, and means of preventing the disease in aquaculture facilities.

MATERIALS AND METHODS

Laboratory-reared *Fundulus grandis* were obtained by stripping gravid male and female killifish collected from Halstead Bayou, Ocean Springs, Mississippi. Parasite-free fish were 2 1/2 months old at the beginning of the experiment, and were maintained in the laboratory at a temperature of 25 ± 2°C and salinity of 20 ± 3 ppt. Infected individuals of the grass shimp *Palaemonetes pugio* Holthuis were collected from ponds adjacent to Halstead Bayou.

A group of 50 fish, randomly picked, were fed a single dose of infected grass shrimp to initiate the coccidian infections, whereas, 48 fish constituting a second group were fed Bama® Minnow Chow and they served as controls. Fish in both groups were fed Bama® Minnow Chow throughout the remaining days of the experiment. Diseased and control fish were maintained in separate 3500-liter recirculating tanks containing 15 ppt seawater seeded with unicellular algae to provide supplemental food. Prior to being introduced into culture tanks, all killifish were weighed in grams and their total length measured in millimeters. At the end of the study, all surviving fish from both groups were weighed and measured. Growth was calculated by differences in weight gained and statistical analyses on the growth data were conducted using procedures of Campbell (1967) and of Steel and Torrie (1960).

RESULTS

Infections of *Eimeria funduli* had a considerable impact on growth of *Fundulus grandis* (Table 1). Infected killifish weighed significantly less than their uninfected counterparts. Diseased fish weighed an average of 24.8% more than uninfected fish prior to the experiment; however, by termination of the study (55 days) average weight of control fish exceeded that of parasitized fish by 91.6% (Table 1).

Eimeria funduli infections did not appear to cause mortality in this study. Survival of killifish after the 55-day experiment was 64.0% and 87.5% in control and diseased fish, respectively. However, most deaths occurred during the last 7 days of the study when there was an overnight decrease in water temperature from 26°C to 13°C.

DISCUSSION

In commerical bait-fish operations, about 45 to 52 days are required for killifish to reach marketable size (Tatum and Helton 1977; Tatum et al. 1978). Any factor that increases this grow-out period would reduce profits for bait-fish farmers. Based on data presented in Table 1, *E. funduli* greatly affects the growth of *F. grandis* maintained in an aquaculture facility and, consequently, could increase the grow-out period of killifish. Also, the assumed small stocks of *F. grandis* in panzootic areas reported by Solangi and Overstreet (1980) may be related to coccidian infections. Although, in view of our findings, it is apparent that the parasite could have a significant impact on the economic

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TABLE I.

Average weight (g) and total length (mm) gain of *Fundulus grandis* after 55-day infection of *Eimeria funduli.*

	Control			Diseased		
		Weight	Length[1]		Weight	Length[1]
	Number	Mean ± Standard Error	Mean ± Standard Error	Number	Mean ± Standard Error	Mean ± Standard Error
27 August 1980[2]	50	0.129 ± 0.008	18.66 ± 0.395	48	0.161 ± 0.001	19.58 ± 0.508
22 October 1980[3]	32	1.261 ± 0.261	43.41 ± 2.567	42	0.658 ± 0.023	38.67 ± 0.471
Average gain, %		877.5	132.6		308.0	97.5

[1] Average lengths of control and diseased fish at the beginning and termination of experiments are equal at 95% confidence limit (t-Test).
[2] Average weight of control fish is less than that of diseased fish at 95% confidence limit (t-Test).
[3] Average weight of control fish is greater than that of diseased fish at 95% confidence limit (t-Test).

potential of Gulf killifish, a detailed study on the effect of *E. funduli* on wild populations of killifish is urgently needed.

At present we do not have evidence suggesting a correlation between mortality and disease. Since most deaths in this study occurred during the period when the water temperature dropped abruptly, it appears that temperature shock coupled with undetermined stresses in the culture system could have contributed to the mortality. For the past 3 years we have maintained numerous groups of experimentally and naturally infected killifish in the laboratory for at least 3 months and have not witnessed any mortality. However, even though mortality cannot be ascribed to the parasite per se, heavily infected fish probably have difficulty surviving environmental and nutritional stresses.

To achieve maximum yield of killifish in bait operations, the parasite should be eliminated from the culture system. Although no chemotherapeutic treatment is available currently, isolation of the intermediate host from the culture facility appears to be the only practical alternative available at this time. The grass shrimp and possibly other crustaceans serve as intermediate hosts (Solangi and Overstreet 1980), and have to be eaten to complete the life cycle. Exclusion of the infective intermediate host in pond-culture facilities, the predominant method of killifish rearing, can be a formidable task. On the other hand, closed recirculating systems such as the one developed by Ogle and Solangi at the Gulf Coast Research Laboratory in Mississippi appear to be an attractive alternative to pond rearing. In addition to effectively eliminating the intermediate host and providing good growth, the solar-heated recirculating system of Ogle and Solangi gives the aquaculturist control over many environmental factors not possible in pond culture.

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