EFFECT OF SELECTED SODIUM CHLORIDE CONCENTRATIONS FOR MINIMIZING MORTALITY OF MOSQUITOFISH *GAMBUSIA AFFINIS* IN HOLDING TANKS

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The mosquitofish, *Gambusia affinis* (Baird and Girard) is native to the Atlantic seaboard of the United States and tributary drainages of the Gulf of Mexico. The mosquitofish has assumed a global range since the early 1900's because of its efficiency as a biocontrol agent against mosquito larvae.

Considerable research has been conducted on the general effectiveness of the mosquitofish as a control agent. Current research is needed on the techniques for mass production and handling of mosquitofish. Reynolds (1975) investigated the feasibility of intensive *Gambusia* culture in cages. Intensive pond production of *Gambusia* was investigated by Challet and Rohe (1974). Newton et al. (1977) reported production rates of *Gambusia* in extensive catfish polyculture systems. Relatively little research has been reported on techniques for reduction of mortality during holding and transportation of *Gambusia*. Davey and Meisch (1977) noted that holding mosquitofish during transportation was a major problem in the application of mosquitofish for mosquito control.

The addition of salt during holding and transfer has been shown to increase survival of fish other than *Gambusia*. Lewis (1971) noted that the addition of 0.35% salt (NaCl), by weight, increased survival of golden shiners *Notemigonus crysoleucas* (Mitchell) during holding and transportation. The addition of 0.9% salt increased the survival rate of bigmouth and black buffalo *Ictiobus cyprinellus* (Valenciennes) and *Ictiobus niger* (Rafinesque) fry and fingerlings held in captivity by Hollander and Avault (1975).

The objectives of this study were to determine the effect of various salt concentrations on survival during harvest, transportation, and holding of *Gambusia*. Delayed fish mortality due to handling while seining and transporting has been attributed to two concurrent factors: 1) stress during handling alters the acid-base balance of the blood, decreasing the capability of the blood to carry oxygen; and 2) stress increases the demand for oxygen resulting in greater water passage over the gills which erodes the protective mucus covering facilitating water entry into the blood plasma, thereby disrupting ionic balance. The addition of salt to freshwater reduces both of these adverse reactions (Collins and Hulsey 1963, Lewis 1971).

Gambusia were cultured in 0.1 ha ponds located at the University of Arkansas Agriculture Research Center, Pine Bluff, Arkansas during the summer of 1980. Adult *Gambusia* were collected using a 37 m × 4.8 mm Raschel mesh type seine and transferred into a 570 liter live hauling tank aerated with bottled oxygen. The fish were then delivered to the laboratory and placed in holding tanks (1330 liter) which had a fresh pond water exchange rate of 13.4 times per hour.

Gambusia were stocked in twelve, 380 liter tanks at the rate of 0.25 kg liter and aerated with atmospheric oxygen. The treatments consisted of 4 tanks with a 0.2% salt solution by weight, 4 with a 0.5% salt solution, and 4 with a 1.0% salt solution. The fish were held in these treatment tanks over a 3-day period. Each 24 hours, mortality was recorded separately for both sexes. At the conclusion of this period, the remaining fish were counted and added to the mortalities to determine the number of mosquitofish/kg.

In a second series of tests, twenty-four, 114 liter tanks were filled with 38 liters of water and aerated with atmospheric oxygen. Treatments consisted of 6 tanks with no salt treatment and 6 each with 0.2%, 0.5% and 0.1% salt by weight. The tanks were stocked at a rate of 65 g/liter per tank. Mortality was recorded daily and expressed as a percentage of the total. Five subsamples weighing 0.45 kg were counted to determine the number of fish/kg.

In seining of the fish, it was noted that mature male mosquitofish (gonopodium hooks present) ranging in size from 18–23 mm in length were caught between the links of mesh whereas females and immature males of the same size class passed through the mesh. It was also observed that when the fish were transferred from the seine many larger males (23 mm or greater) were held on the side of the net by their gonopodium. These fish could be removed from the net by vigorous shaking. In nearly every seine haul after shaking the net, dismembered gonopodium could be found. Samples of fish shaken from the net and

placed into holding tanks yielded high mortality rates (>95%) within 24 hours.

There were significant differences in mortality among the 3 salt treatments in the first experimental series (Table 1). Mortality for the 3-day period ranged from 8.2% in the 0.2% salt treatment to 47.1% for the 1.0% salt treatment. All mortality rates were highest on the first day and decreased significantly over the next 2 days. Males suffered an average of 86% of the actual mortality on the first day for all treatments. After the first day of containment, there was no significant difference in mortality rate between sexes.

In the second series of tanks there were also significant differences in fish mortality rates among the salt treatments with the higher mortality occurring in the no salt (control) treatment (19.5%), followed by 14.1% mortality in the 1.0% salt treatment (Table 2). There was no significant difference between the 0.2% and the 0.5% salt treatments (7.5% and 7.7%). The highest mortality was again recorded after the first 24 hr period and decreased thereafter. Mortality was also significantly higher for males during the first 24 hr of this trial. The higher first day mortality rate of the males was likely due to physical damage to the gonopodium of males during seining and transporting.

Mortality significantly decreased in the 0.2% and 0.5% salt treatments in the first 24 hr period, and nearly ceased after 48 hr. The cessation of mortality after 48 hr is consistent with findings by other investigators (Miles et al. 1974, Collins and Hulsey 1963) who attributed the mortality decrease to normalization of osmotic balance.

In summary, handling and holding produces stress that results in substantial mortality of mosquitofish. The addition of 0.2% to 0.5% salt by weight to the water during holding and transportation facilitates maintenance of osmotic homeostasis and usually increases fish survival by stabilizing mortality within 48 hr.

Table 1. Mean daily mortality of mosquitofish maintained in holding tanks at three salt concentrations at the Agricultural Research Center at the University of Arkansas at Pine Bluff, Arkansas, 1980.

	Percent mortality rates		
Day	0.2% salt by weight	0.5% salt by weight	1.0% salt by weight
1	4.8_a[1]	11.0_a	24.4_a
2	2.2_b	5.9_b	13.5_b
3	1.2_c	3.1_c	9.2_c
Totals	8.2_I[2]	20.0_{II}	47.1_{III}

[1] Treatment means followed by different letters are significantly different at the 0.05 level.

[2] Total means followed by different Roman numerals are significantly different at the 0.05 level.

Table 2. Mean daily mortality rates for mosquitofish held in holding tanks with no salt treatment and at three salt concentrations at the Agricultural Research Center at the University of Arkansas at Pine Bluff, Arkansas, 1980.

	Percent mortality rates			
Day	No salt	0.2% salt by weight	0.5% salt by weight	1.0% salt by weight
1	8.2_a[1]	4.5_a	4.8_a	7.0_a
2	6.0_b	2.0_b	1.7_b	3.0_b
3	5.3_b	1.0_c	1.2_b	4.1_b
Totals	19.5_I[2]	7.5_{II}	7.7_{II}	14.1_{III}

[1] Treatment means followed by different letters are significantly different at the 0.05 level.

[2] Treatment means followed by different Roman numerals are significantly different at the 0.05 level.

References Cited

Challet, G. L. and D. L. Rohe. 1974. A pilot program for the intensive culture of *Gambusia affinis* (Baird and Girard) and *Tilapia zillii* (Geravis), Part 1. Description of facilities. Bull. Soc. Vec. Ecol. 1:38–40.

Collins, J. L. and A. H. Hulsey. 1963. Hauling mortality of threadfin shad reduced with MS-222 and salt. Prog. Fish-Cult. 25:105.

Davey, R. B. and M. V. Meisch. 1977. Low maintenance production studies of mos-

quitofish (*Gambusia affinis*) in Arkansas. Mosq. News 37:760–763.
Hollander, E. E. and J. W. Avault, Jr. 1975. Effects of salinity on survival of buffalo fish eggs through yearlings. Prog. Fish-Cult. 37:47–50.
Lewis, S. D. 1971. The effect of salt solutions on osmotic changes associated with surface damage to the golden shiner, *Notemigonus crysoleucas*. Abstr., Part B, Sci. Eng. 31:6346.
Miles, H. M., S. M. Loehner, D. T. Michairch and S. L. Salivar. 1974. Physiological responses of hatchery reared muskelunge (*Exox masquinongy*) to handling. Trans. Am. Fish. Soc. 103:336–342.
Newton, S. H., A. J. Merkowsky, A. J. Handcock and M. V. Meisch. 1977. Mosquitofish, *Gambusia affinis* (Baird and Girard) production in extensive polyculture systems. Proc. Ark. Acad. Sci. 31:77–78.
Reynolds, G. T. 1975. Pilot program for the intensive culture of *Gambusia affinis* (Baird and Girard) and *Tilapia zillii* (Gervais). Proc. N. J. Mosq. Exterm. Assoc. 129–137.

BOOK REVIEW

CONSOLIDATED INDEX FOR THE UPDATED NANOGEN INDEX, PESTICIDES AND CHEMICAL POLLUTANTS. Published by Nanogens International, P.O. Box 487, Freedom, CA 95019, 160 pp.

This index of chemicals must be used in conjunction with a formerly published index called the Nanogen Index published in 1975 and updated in 1980. Data are made available on about 4900 chemical substances. It is difficult to understand why substances like steer manure, rabbit manure and rice hulls are included in an index of this nature. Granted they may be considered as pollutants under extraordinary circumstances, but this hardly justifies inclusion in an index such as this. Even more difficult to understand is why sucrose (sugar), and Sucrets® (4-hexylresorcinal) are considered as a pesticide or chemical pollutant.

The beginning section is devoted to recently introduced control chemicals. This is presented in tabular form with a code designation, common name (when available) chemical name (empirical formula), structural formula, other names and uses. This section could be improved by indicating the basic manufacturer's name and address for anyone wishing to obtain samples for testing or research. A short section on experimental control chemicals is included which also does not indicate the basic manufacturer.

Entomologists may find the section on insect attractants and disruptants of interest (semiochemicals) primarily for calling attention to these substances. The data are presented in tabular form and an insect code as well as a common name, and sometimes the scientific name are presented. In this table the reader is confronted with two code systems, the insect code, and the nanogen code for the chemical substance.

One page of the index is devoted to nanogen code changes which lists the original code, page number, new code and the chemical involved.

Two pages are devoted to corrections and duplications to be expunged from the nanogen index.

The remainder of the index is divided into an alphanumerical index and an alphabetical index, both of which are confusing if a reader wants to follow through on a given compound. In the alphanumerical index code names assigned by several entities form the basis for indexing. For example a compound may be listed by a company code designation, the U.S.D.A. code designation, the World Health Organization (OMS) code designation, and perhaps others. ENT-15949 and OMS-194 turns out to be the insecticide aldrin.

The alphabetical index is a conglomeration of common names, chemical names, trade names and miscellaneous items, with very little meaning or help in trying to locate information on a specific substance. The most useful feature of this index, and the alphanumerical index is the reference to nanogen index page number which serves as a basis of orientation for the myriad of names applied to some chemical substances.—Lawrence L. Lewallen, California Dept. of Health Services, Vector Biology & Control Branch, 5545 East Shields Avenue, Fresno, CA 93727.