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Mosquitofish, *Gambusia affinis* (Baird and Girard) Production in Extensive Polyculture Systems[1]

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ABSTRACT

During 1976, mosquitofish, *Gambusia affinis* Baird and Girard, were reared in combination with food and game fishes in 0.1 ha culture ponds at the University of Arkansas at Pine Bluff fisheries research facility. Mosquitofish production was 218 kg/ha, with 1683 fish per kilogram, in ponds that were also stocked with channel catfish, *Ictalurus punctatus* Rafinesque, bigmouth buffalo, *Ictiobus cyprinellus* Valenciennes, grass carp, *Ctenopharyngodon idella* Valenciennes, and silver carp, *Hypophthalmichthys molitrix* Valenciennes. In another similar stocked pond, hybrid sunfish fingerlings depressed mosquitofish yield by 79%. No mosquitofish production was obtained in ponds stocked with 250 largemouth bass, *Micropterus salmoides* Lacepede, fry per hectare, although fathead minnows, *Pimephales promelas* Rafinesque, were added to buffer mosquitofish predation. Total fish yields ranged from 414 to 670 kg/ha for the polyculture systems investigated.

INTRODUCTION

Mosquitofish have long been an important component of mosquito abatement programs through integration of biological, chemical, and physical control technologies (Coykendall, 1975; Meisch and Coombes, 1974; Hoy, et al., 1972). Mosquito population reduction through biocontrol methods is becoming increasingly important due to the growing population, governmental regulations, and to the development of pesticide resistant strains of mosquitoes. Although much has been accomplished, substantial technical knowledge is still lacking on many aspects related to the culture, production, and application of mosquitofish for maximum utilization. During the past several years, information has been gathered on management practices for the mass production of this unique species in Arkansas (Davey and Meisch, 1977). Since 1972, mosquitofish have been employed in Arkansas ricefields as mosquito predators (Meisch and Coombes, 1974). Adult mosquitofish were selected as the best compromise biocontrol fish following extensive aquaria and field tests with eight species (Davey, et al., 1974). Mosquitofish production efforts have met with varying degrees of success, and major problems remain unsolved in several phases of their culture (Davey and Meisch, 1977). Substantial fish losses have occurred in production ponds due to contamination with tadpoles, *Rana catesbeiana* Shaw, and green sunfish, *Lepomis cyanellus* Rafinesque. These animals compete with the mosquitofish for food and space, and the green sunfish may actually prey upon these minnow-size fishes, particularly the immature stages. Additional fish losses are often encountered, especially during harvests, because of aquatic vegetation such as filamentous algae which is common to most small, shallow-water culture ponds.

During 1976, mosquitofish were reared in ponds at the University of Arkansas at Pine Bluff fisheries research facility. Stockings of several species of fishes in combination (polyculture) with the mosquitofish were investigated to effect biocontrol measures as well as to increase total fish production. With mosquitofish being reared for mosquito control, predatory fish stocked to utilize tadpoles and green sunfish, and herbivorous fish added to reduce aquatic vegetation, this experiment was truly a biological investigation. This method of fish production may be called extensive polyculture because of the fish stocking rates and management requirements and because of the species variety.

MATERIALS AND METHODS

Nine 0.1 ha ponds located on the University of Arkansas at Pine Bluff Campus Farm were selected for polyculture fish production studies during the 1976 season. These ponds are contained within a 21-pond fisheries research-complex constructed during the fall of 1975.

All ponds were filled with well water for the first time during March and April, 1976. Alfalfa hay at the rate of two bales per pond was added to provide organic matter for these new ponds and to increase the rate of ferric hydroxide precipitation. Additionally, all ponds received two applications of inorganic fertilizers high in nitrogen and phosphorus content within one month after being filled.

During April, six ponds were stocked with the fish species combinations and rates listed in Table I. Three of these ponds considered to be shallow had a maximum depth of 0.9 m, while three considered to be deep had a maximum depth of 1.5 m. Three more deep ponds were stocked as shown in Table II. Additionally, one of these ponds received one adult male bluegill, *Lepomis macrochirus* Rafinesque, and one adult female green sunfish on 12 May. These fish were stocked in an attempt to produce a crop of hybrid sunfish fingerlings.

Fish in all ponds received a commercial feed ration (25% protein) formulated as sinking pellets. They were fed three times weekly at the rate of 4% of the estimated weight of channel catfish present. Bimonthly adjustments were made in the amounts of feed given based upon a conversion ratio of one pound gain for each two pounds fed. Ponds with mosquitofish stocked at 46 kg/ha received a commercial minnow ration along with the catfish pellets.

Water quality and associated fish activity were observed daily. Water chemistry analyses were conducted bimonthly according to Hach colorimeter analytical procedures. Pond water levels were maintained by periodically pumping to replace evaporation losses; no additional water management was required.

Fish sampling, including stomach analyses, and partial harvesting of some ponds was effected during the study. Complete harvests of all ponds were accomplished during October, 1975.

RESULTS

Mosquitofish production averaged 218 kg/ha in two of the three ponds stocked as shown in Table II. These fish averaged 0.63 g total weight and 39 mm total length each at harvest and averaged 1,683 individuals per kilogram. Sex ratio comparisons at harvest revealed that there were three females for each male mosquitofish in these ponds. In our experiences, females generally were more abundant in pond populations than males. In the third pond, mosquitofish production was substantially reduced; although total production was partially compensated by the production of 68 kg/ha of hybrid sunfish fingerlings. As anticipated, no mosquitofish harvests were obtained from the six ponds stocked as shown in Table I. Largemouth bass production in these ponds was 34 and 29 kg/ha, respectively, for the shallow and deep culture systems. Fish production obtained in the form of buffalo, grass carp, and silver carp averaged 63 kg/ha,

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although stocking rates varied among ponds. Channel catfish yield averaged 375 kg/ha in ponds stocked with 3,150 fish per hectare. Production was 45 kg/ha higher in the shallow than in the deep ponds. Catfish production was 228 kg/ha in ponds stocked with 1,250 fish per hectare. Catfish yield was also reduced in the ponds with hybrid sunfish fingerlings.

Water quality parameters were similar among system treatments. Generally, pH was slightly basic, while total hardness and alkalinity averaged 125 and 220 (ppm), respectively. No stress was placed upon the fishes due to fluctuation of any parameter, including oxygen levels. Additionally, no disease or parasite difficulties were encountered due to environmental or species composition factors with the stocking rates investigated.

DISCUSSION

Polyculture systems of mosquitofish production at UA-PB resulted in higher total fish yields than previous monoculture systems. Production of mosquitofish when cultured alone (monoculture) in ponds has been quite variable, ranging from 63 - 48 kg/ha and net production has been higher in smaller ponds (0.04 - 0.1 ha) than in larger ponds (0.8 - 1.2 ha) Davey and Meisch, 1977). Mosquitofish production averaged 218 kg/ha in two polyculture ponds (UA-PB) in 1976 as compared to an average of 181 kg/ha for seven monoculture ponds in 1974 and 1975 (Davey and Meisch, 1977). An additional 452 kg/ha of catfish, buffalo, silver carp, and grass carp were harvested from these two polyculture ponds for a total fish yield of 670 kg/ha. The pond with hybrid sunfish fingerlings (Table III) produced only 45 kg/ha of mosquitofish (due to sunfish predation) and 369 kg/ha of other species. However, potential sales value of the 68 kg/ha of sunfish approaches that of 173 kg/ha of mosquitofish.

As expected, the effects of largemouth bass predation upon mosquitofish and fathead minnows were drastic. Less than 1 kg/ha of either species remained at harvest in six ponds stocked with one-inch bass fry. Both forage species reproduced throughout the season, but the young were cropped accordingly. The fatheads were stocked and provided with spawning sites in an effort to buffer bass predation upon mosquitofish, in this case however, it appeared that the bass stocking rate was too high for the culture ponds. In experimental ponds at Kelso, Arkansas, channel catfish fingerlings were apparently effective in reducing or eliminating tadpoles and green sunfish from mosquitofish culture ponds. However, 20-25 cm catfish also consumed a portion of the mosquitofish population of these ponds, as indicated by stomach samples.

Polyculture ponds at UA-PB contained no wild fishes or tadpoles at harvest and developed no aquatic vegetation growths during the season. Stocking rates of herbivorous species such as silver carp and grass carp may likely be increased without adverse effect upon mosquitofish production. Other combinations of fishes, of course, may vary depending upon sizes and variety of fishes desired at harvest. Additionally, if cropping of the mosquitofish is employed, then some of the other species may be harvested after 2 or 3 years and recreational fishing could be included as well. Prime consideration must be given to stocking rates of predatory fishes, especially bass and sunfish, which may eliminate mosquitofish in small ponds.

It would be premature to speculate on sales or profit margins associated with mosquitofish production; however, integration of biological and chemical mosquito control agents has been very effective in several areas. The decision for commercial production of these fishes must be dictated by usual business guidelines. However, we believe that it would be desirable for these fish to become more available for use in reducing disease-carrying mosquito populations and thereby alleviating associated problems and discomforts.

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LITERATURE CITED

COYKENDALL, R.L. 1975. Mosquitofish, a beneficial alternative to pesticides: Progress report on its development as a practical tool. Cal-Neva Wildlife Transactions 1975: 122-127.

DAVEY, R.B., M.V. MEISCH, D.L. GRAY, J.M. MARTIN, K.E. SNEED, and F.J. WILLIAMS. 1974. Various fish species as biological control agents for the dark rice field mosquito in Arkansas rice fields. Environ. Entomol. 3(5):823-826.

DAVEY, R.B. and M.V. MEISCH. 1977. Low maintenance produc-Accepted for publication October 1977. Mosquito News. Data submitted for publication.

HOY, J.B., E.E. KAUFFMAN, and A.G. O'BERG. 1972. A large-scale field test of *Gambusia affinis* and chlorpyrifos for moquito control. Mosq. News. 32:161-171.

MEISCH, M.V. and L.E. COOMBES. 1974. Mosquitofish as predators of ricefield mosquito larvae: Preliminary observations under applied field conditions. Ark. Farm Res. J. 23(4):3.

Table I. Combination of fishes stocked in six 0.1 ha production ponds during April, 1976 at UA-PB (three shallow and three deep ponds).

Fish	Number/hectare	Kilograms/hectare
Channel catfish	3,150	81
Bigmouth buffalo	250	90
Largemouth bass (fry)	250	--
Grass carp	100	15
Fathead minnows	--	23
Mosquitofish	--	23

Table II. Combination of fishes stocked in three 0.1 ha production ponds during April, 1976 at UA-PB* (mosquitofish and hybrid ponds).

Fish	Number/hectare	Kilograms/hectare
Channel catfish	1,250	36
Bigmouth buffalo	100	36
Grass carp	50	6
Mosquitofish	--	46
Silver carp	10	1

***In May, a mature bluegill male and a mature green sunfish female were stocked in one of these ponds to attempt production of hybrid sunfish fingerlings.**

Table III. Fish production for polyculture systems at UA-PB during 1976.

Fish	Shallow Ponds[1]	Deep Ponds[1]	Mosquitofish Ponds[2]	Hybrid Pond[3]
Mosquitofish	--	--	218	45
Channel catfish	397	352	286	170
Bigmouth buffalo	167	193	100	62
Grass carp	33	38	50	56
Silver carp	--	--	16	13
Largemouth bass	34	29	--	--
Hybrid sunfish	--	--	--	68
TOTALS Kilograms/hectare	631	612	670	414

[1]Data average of 3 ponds
[2]Data average of 2 ponds.
[3]Data from 1 pond.