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Mosquitofish Production in Monoculture and Polyculture Ponds

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General Notes

Nomenclature for the taxa reported below follow Crum and Anderson (1981). Collectors' initials are in parentheses following the county or counties the specimens were collected from.

Amblystegium riparium (Hedw.) BSG. Garland (JEM).
Anomodon minor (Hedw.) Furnr. Arkansas (EBW).
Aulacomnium heterostichum (Hedw.) BSG. Poinsett and St. Francis (EBW).
Bartramia pomiformis Hedw. Crittenden (EBW).
Bruchia flexuosa (Sw. ex Schwaegr.) C. M. Miller (EBW).
Bryum argenteum Hedw. Pulaski (EBW).
Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Scherb. Hempstead (EBW).
Ceratodon purpureus (Hedw.) Brid. Stone and Washington (SLT).
Diphyscium foliosum (Hedw.) Mohr. Sharp (SLT).
Ditrichum pallidum (Hedw.) Hampe. Chicot, Clark, Crittenden, Howard, Marion, and Sevier (EBW).
Fissidens bushii (Card. & Ther.) Card & Ther. Garland (JEM).
Funaria hygrometrica Hedw. Chicot, Crittenden, Hempstead, Lincoln, Polk, and Sebastian (EBW).
Funaria flavicans Mx. Howard and Lincoln (EBW).
Leptobryum pyriforme (Hedw.) Wils. Garland (JEM).
Orthotrichum strangulatum P.-Beauv. Garland (JEM).
Pilonotis longiseta (Mx.) Britt. Pulaski (EBW).
Physcomitrium pyriforme (Hedw.) Hampe. Columbia, Howard, Lincoln, Logan, Mississippi, and Polk (EBW).
Plagiothecium cavifolium (Brid.) Iwats. Garland (JEM).

Two new state records are also represented. *Sphagnum macrophyllum* Bernh. ex Bird. was collected by Dr. P. L. Redfearn et al. in Hempstead County. In North America this species is found in aquatic habitats in Newfoundland, Nova Scotia, New York to Florida and west to Texas, including Tennessee. *Venturiella sinensis* (Vent. ex Rabh.) C. M. var. *angustaannulata* Griff. & Sharp was collected in Stone County by the senior author. The location represents the taxon's most eastern distribution in North America. The species has been recorded from only three other locations in North America, Texas (Bartram, 1934) and Oklahoma (Inkenberry, 1960; Redfearn, 1970).

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MOSQUITOFISH PRODUCTION IN MONOCULTURE AND POLYCULTURE PONDS*

Mosquitofish (*Gambusia affinis*, Baird and Girard) are playing an increasingly important role in mosquito-control programs across the nation, due to increasing costs of insecticides, public pressure over environmental damage by insecticides, and the need for continuous mosquito control near populated areas. Among reports on the use of mosquitofish as predators of ricefield mosquitoes are those of Horsfall, 1942; Fowler, 1964; Craven and Steelman, 1968; and Meisch and Coombes, 1974. Large numbers of mosquitofish will be necessary to achieve adequate control over wide areas (Hoy and Reed, 1970; Hoy et al., 1971, 1972; Davey et al., 1974). The intensive culture of mosquitofish in California has been reported by Challet and Rohe, 1974; Challet et al., 1974; and Reynolds, 1975.

Since 1972, mosquitofish have been tested as biological control agents against the dark ricefield mosquito (*Psorophora columbiae*, Dyar and Knab) in Arkansas (Meisch and Coombes, 1974). Mosquitofish readily adjust to the temperature extremes and reduced dissolved oxygen levels of ricefield water. It has been proved that mosquitofish are the most desirable fish for ricefields and also that they are effective predators of floodwater mosquitoes (Davey et al., 1976). However the major problem confronting use of mosquitofish as biological control agents has been obtaining adequate supplies for seeding ricefields, ditches, pools, and ponds.

Because few commercial fish farms produce mosquitofish, most mosquito-control agencies must produce their own. Commercially produced mosquitofish are extremely expensive, costing as much as $88 per kg. By contrast, considerable mosquitofish production occurs in commercial baitminnow ponds where they are considered a pest fish because they compete directly with minnows for food and space. These mosquitofish are presently being wasted. Additionally, they are difficult to separate from minnows during harvest and also present problems in holding tanks. Mosquitofish may be reared and harvested from catfish-production ponds with fewer problems than when reared with minnows (Newton et al., 1977). Thus, they could be a desirable secondary income fish for catfish producers.

In 1976, a cooperative program was initiated by fisheries biologists at the University of Arkansas at Pine Bluff and by entomologists at the University of Arkansas at Fayetteville. This project was aimed at developing and evaluating management techniques for producing mosquitofish.

From 1976 through 1978, mosquitofish were reared in polyculture systems under pond conditions with channel catfish (*Ictalurus punctatus*, Rafinesque). Channel catfish fingerlings were stocked into three 0.1-ha ponds at 2470 fish/ha and fed at the rate of 22.45 kg/ha and fed a floating minnow meal. All ponds were completely harvested at the end of each year.

During 1979 and 1980, mosquitofish were produced in polyculture with catfish, bigmouth buffalo (*Ictiobus cyprinellus*, Valenciennes) and grass carp (*Ctenopharyngodon idella*, Valenciennes). Buffalo and grass carp were stocked at the rate of 247 and 30 fish/ha, respectively. Catfish fingerlings were again stocked at the rate of 2470 fish/ha and fed a sinking pelleted feed daily. However, in 1979-80 as well as in subsequent years, mosquitofish were not fed separately. At the end of the 1979 growing season the mosquitofish were harvested, while the catfish were sampled but remained in the ponds. At this time, catfish averaged 0.45 kg in weight. Mosquitofish were restocked the following spring (1980) at the rate of 22.45 kg/ha. During 1980, catfish were fed a sinking pelleted feed only three days a week.

During the 1981 growing season, mosquitofish were reared in both polyculture and monoculture ponds. Catfish fingerlings were stocked at 4940 fish/ha and fed a floating pelleted ration five days a week. Mosquitofish were not fed separately.

Mosquitofish reared under monoculture conditions were fed a floating minnow meal five days a week, an amount approximately equal to three percent of their weight. Monoculture ponds were fertilized (12-24-12) at the rate of 48 kg/ha twice early in the season to initiate and maintain algal blooms.

In 1982, mosquitofish were cultured with catfish fingerlings stocked at both 7410 and 14,820 fish/ha. Mosquitofish were also produced in monoculture ponds stocked at the rate of 22.45 kg/ha. All other conditions were similar to those of the 1981 experiment.

Mosquitofish were harvested according to a standardized schedule during all culture years. Each year mosquitofish were stocked at the rate of 22.45 kg/ha. The first harvest was 60 days after initial stocking, using a 6.2-mm mesh seine. Subsequent harvests continued every 30 days thereafter until the final harvest. Total periodic harvests averaged four per season prior to a final fall harvest.

Production of mosquitofish during the 1976-78 culture seasons averaged 225 kg/ha with supplemental feeding (Table). In 1979, mosquitofish (reared without separate feeding) production decreased significantly to 147 kg/ha. Production of catfish is reported in the Table. Catfish stocking rates were the same (2470 fish/ha) during both these periods. However, in 1980 when catfish (average weight of 0.45 kg) were fed a significantly greater amount of feed than in previous years, mosquitofish yields were 350 kg/ha as compared to 1979. Harvested buffalo and grass carp yields are also reported in the Table.

Table. Net production (Yields) by fish species during 1976-82 at UAPB.

Year	Culture condition	Mosquitofish (kg/ha)	Feed fed mosquitofish (kg)	Catfish (kg/ha)	Feed fed catfish (kg)	Buffalo (kg/ha)	Grass carp (kg/ha)
1976-78	Polyculture	1/ 225 b	87	465 (2470 fish/ha)	744	---	---
1979	Polyculture	147 a	---	1757* (2470 fish/ha)	747	385* (247 fish/ha)	90* (30 fish/ha)
1980	Polyculture	350 c	---	---	1614	---	---
1981	Polyculture	112 a	---	968 (4940 fish/ha)	969	164 (247 fish/ha)	9 (30 fish/ha)
1981	Monoculture	427 d	520	---	---	---	---
1982**	Polyculture	222 b	---	1557 (7410 fish/ha)	2298	---	57 (30 fish/ha)
	Polyculture	255 b	---	2042 (14,820 fish/ha)	3879	---	54 (30 fish/ha)
1982	Monoculture	473 d	496	---	---	---	---

1/ Means followed by different letters are significantly different at the 95% level.

* Total production for two years (1979-80).

** In 1982, there were 2 catfish stocking rates for polyculture production.

General Notes

In 1981 mosquitofish production in polyculture ponds decreased to an average of 112 kg/ha (Table), although catfish fingerling stocking rates had doubled (from 2470 fish/ha in 1976-78 and 1979 to 4940 fish/ha). Monoculture yields under intensive management averaged 427 kg/ha.

During 1982, mosquitofish production in polyculture ponds was 222 and 255 kg/ha at catfish stocking rates of 7410 and 14,820 fingerlings per ha, respectively (Table). Intensive management of monoculture gambusia ponds in 1982 yielded 473 kg/ha.

Duncan's multiple range analyses revealed no significant differences in production of nonfed mosquitofish at catfish fingerling stocking rates of either 2470 or 4940 fish/ha (Table). However, there was a significant difference in production rates between fed and nonfed mosquitofish at catfish stocking rate of 2470/ha. There were no significant differences among fed mosquitofish with channel catfish stocked at a rate of 2470 fish/ha and nonfed mosquitofish at catfish stocking rates of 7410 and 14,820 fish/ha (Table). There were no significant differences in mosquitofish production among monoculture ponds for all years, and monoculture yields of mosquitofish are significantly greater than polyculture yields (Table).

Mosquitofish production in catfish ponds (without feeding) appeared to be related to catfish feed input. A comparison of correlation coefficients indicates that when catfish fingerlings are stocked at low rates (2470 or 4940 fish/ha) with correspondingly low feed inputs, mosquitofish production will be low. Higher feed inputs, resulting from increased stocking rates of catfish and correspondingly greater poundages, increase mosquitofish yields. However, this trend holds true only with catfish fingerling stocking rates up to 7410 fish per ha. Doubling the catfish stocking rate to 14,820 fingerlings/ha increases mosquitofish production, but not proportionally. Generally, mosquitofish production may be increased by supplemental feeding when catfish stocking rates are low. Mosquitofish production through monoculture resulted in the highest yields per hectare.

For the present, polyculture production of mosquitofish as a secondary crop associated with catfish appears to be the best approach. Market demands are isolated and varied, although the demand is present in states with organized mosquito-abatement programs. Fish are generally requested during early to midsummer when mosquito-control efforts are initiated. Development of mosquito-abatement district stocking programs is needed as part of the overall effort to optimize mosquitofish usage.

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