OPERATIONAL AND SCIENTIFIC NOTES

LOW MAINTENANCE PRODUCTION STUDIES OF MOSQUITOFISH, *GAMBUSIA AFFINIS* IN ARKANSAS[1]

RONALD B. DAVEY AND M. V. MEISCH

Dept. of Entomology, University of Arkansas, Fayetteville, AR 72701

Among reports on the use of mosquitofish, *Gambusia affinis* (Baird and Girard), as predators of mosquitoes in rice fields 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 areas other than Arkansas has been reported by Challet and Rohe (1974), Challet et al. (1974), and Reynolds (1975). This is a report on a preliminary study conducted to ascertain fish production in ponds with a minimum of management. Subsequent intensive studies will doubtlessly include cost analysis systems of such a program.

Studies were conducted in 2 similar 1.2 ha ponds located near DeValls Bluff, Prairie Co., Arkansas during the summer of 1974. In 1975 a 0.8 ha pond located near Lonoke in Lonoke Co. was used. Four additional ponds (2 of 0.1 ha and 2 of 0.04 ha) were made available by the U. S. Dept. of Interior Federal Fish Farming Exp. Stn. at Kelso, Desha Co., AR. All were minnow production ponds typical of the area, being either square or rectangular in configuration with soil bottoms. The average water depth was ca 1.0 m with no slope at the sides, and each pond was filled from well water, and could be drained from a movable standpipe of ca 0.3 m in diameter.

Prior to stocking, all ponds were drained and all fish were removed to assure pure stocking of mosquitofish. Removal of vegetation was also attempted. Since well water was used to flood ponds there was no possibility of introducing other fishes prior to stocking mosquitofish.

In 1974 the 1.2 ha ponds were stocked during the last week in May and fish were harvested 6 wks later. Brood stock was obtained from natural populations near Tillar, Desha Co., AR. One pond was stocked with ca 4.5 kg while the other was stocked with ca 45.4 kg of mosquitofish. Fish were fed daily except on weekends and rainy days. A ration of Prime Quality® Fish Food Meal supplemented with Prime Quality® Pro-A-Catfish Pellets was used. The daily amount of feed was 3.0% of the total estimated poundage in the pond and was increased as the fish reproduced. The feed was broadcast by hand over the water surface.

In 1975 all ponds were stocked during the first week in May. Brood stock was obtained from a pond located on the Fish Farming Exp. Stn. The ponds were stocked with the following number of kg of fish: 0.8 ha at 61.2; 0.10 ha at 11.3; and 0.04 ha at 4.5. Fish in the 0.8 ha pond were harvested 10 weeks after stocking as was one of the 0.04 ha ponds. Fish in the remaining ponds were harvested twice during the study period thus allowing additional production. The 0.1 ha ponds were seined after 10 weeks and again after 17 weeks, while the remaining 0.04 ha pond was seined after 14 and 17 weeks. The fish were fed in the manner described above with 2 exceptions. The Prime Quality® Pro-A-Catfish Pellet supplement was not included. Fish in the 0.1 and 0.04 ha ponds were fed a predetermined amount of feed rather than a percentage of the estimated poundage in the pond. Fish in each of the 0.1 ha ponds were fed 454.0 g of feed, and the fish in each of the 0.04 ha ponds were fed 227.0 g of the food.

Exact records were not taken; however, the ratio of females to males was ca 1:1, but there were always more females than males. There were no cases where females were observed to be more abundant than 4:1 over males.

Before fish were harvested drainpipes were screened with 3.0 mm mesh screen and ponds were drained to a very low level and seined several times. This assured that all of the fish in each pond were harvested and weighed to obtain production records. The only fish which were not harvested were so small that they passed through the seine and were considered insignificant in the total poundage obtained. Fish were harvested using 3.0 mm mesh nylon seines, either 15.2 or 30.4 m long. Fish were weighed at the harvest site by placing 907.0 g of water in an 11.0 liter capacity plastic bucket and obtaining its weight, then placing fish in the bucket and weighing them and subtracting the weight of the water and bucket. Total poundages were recorded from each pond. Random samples were also taken to ascertain the average weight and length of fish in particu-

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lar ponds. Water temperatures were recorded during the study period. Temperatures taken at the water surface and at 1.0 m varied very little and ranged from 68° F. in May to 90° F. in August. The mean temperature throughout the period was ca 80° F.

The 1.2 ha pond stocked at 4.5 yielded a 17.7-fold increase (80.3 kg) in production (Table 1). While this was the largest increase in production of all systems tested, it produced the smallest number of kg of fish/ha. The other 1.2 ha pond produced 139.7 kg of fish, an ca 3.1-fold increase; however, the kg/ha rate was 78.6 which is substantially more than the other 1.2 ha pond. From these data, it can be inferred that the 1.2 ha pond stocked at 4.5 kg was simply stocked too lightly to achieve maximum production in the interval of 6 weeks.

Immediately upon harvesting, a sample of 181 gravid females obtained from the 1.2 ha pond stocked at 4.5 kg produced an average fish size of 3.3 gm and 58.0 mm. These were the largest fish obtained in any pond. These fish averaged over twice the weight and were 13.4 mm longer than those fish reported by Challet et al. 1974. The mean length of the fish was at the upper limit for the size reported by Sholdt et al. 1972.

The 0.8 ha pond yielded 139.7 kg of fish after 10 weeks. This represented an ca 2.3-fold increase over stocking. In addition to mosquitofish, this pond had many large green sunfish, *Lepomis cyanella* Rafinesque, as well as many tadpoles. We have no explanation as to how the pond was contaminated with the green sunfish.

Fish obtained from the 0.1 ha ponds, which were harvested twice over the test period, produced ca 4.0 and 2.5-fold overall increases. After 10 weeks one of the 0.1 ha ponds produced 14.1 kg of fish while the other 0.1 ha pond produced 12.2 kg. When these ponds were reharvested after 17 weeks, they produced an additional 14.5 and 40.9 kg of fish, respectively. The dramatic increase in the one pond was surprising and we have no explanation as to why one pond increased while the other remained constant. The increase above the stocking rate on a kg/ha basis was strikingly more than the larger ponds (Table 1). The smaller 0.04 ha ponds again produced large yields of fish on the basis of kg/ha above the stocking rate at 240.0 for the pond harvested twice and 192.5 for the pond which was harvested once.

Representative samples were taken from one of the 0.04 ha ponds immediately after harvesting fish. This produced gravid females which averaged 1.5 g and 56.0 mm. Although these fish were smaller than those taken from the 1.2 ha ponds, they are more indicative of the normal size of mosquitofish in this area (Davey unpublished data).

From these results it appears that smaller ponds yield more fish in kg of fish/ha; therefore, it would appear to be more advantageous to produce fish in several small ponds rather than one large pond. In going from a 0.8 ha pond to a 0.1 ha pond the minimum amount of increase observed was 74.9 kg of fish/ha. This increase would seem to warrant the extra work involved in harvesting several small ponds rather than one large pond.

There are, however, several points which make production in large ponds more feasible. The increased poundage observed in the 1.2 ha pond stocked at 4.5 kg (80.3 kg) proves that phenomenal increases can be obtained in a short period even at a low stocking rate. Also, while the other 1.2 and 0.8 ha ponds did not show as dramatic an increase over stocking, total production was large. This would be an

Table 1. Mosquitofish produced from various size ponds at different stocking rates and harvest intervals.

Surface hectares stocked	Kg brood stock introduced	Total Kg harvested	Kg/Ha increase over stocking rate	No. /wks. following stocking
1.2	4.5	80.3	63.2	6
1.2	45.4	139.7	78.6	6
0.8	61.2	139.7	98.1	10
0.1	11.3	53.1	418.0	*
0.1	11.3	28.6	173.0	*
0.4	4.5	14.1	240.0	**
0.4	4.5	12.2	192.5	10

* Fish harvested after 10 and 17 wks.
** Fish harvested after 14 and 17 wks.

advantage if many fish were needed to stock a large amount of rice acreage. Another advantage is that the amount of manpower would be substantially reduced in harvesting one large pond as opposed to many small ponds. Finally, it would be much more economical to build one large pond than to establish several small ponds. More research is needed to establish the optimum pond size necessary to gain maximum production.

Increased production appears to be afforded by cropping or harvesting fish in ponds several times over the season. In those ponds which were harvested twice the fish yield in kg/ha was usually higher. Periodic fish harvesting of ponds will reduce possible cannibalism and also prevent fish from reaching carrying capacity and thus reducing production. This would be especially true of small ponds.

There were basically 4 major problems encountered in harvesting fish from production ponds. First, the "buildup" of aquatic algae, *Pithothora* spp, in the production ponds made the harvesting process extremely difficult or even impossible. When seined in this situation, many of the fish were entrapped in the vegetation and injured or killed. The second problem was in keeping ponds free of tadpoles. Precise records were not maintained, but in some instances seines were half filled with tadpoles. The tadpoles likely reduced fish production by competing for space. They also were a problem when sorting fish. A third problem involved other fish species, mainly green sunfish which competed for space and food, and in some cases preyed upon mosquitofish. As with tadpoles they were a problem in fish sorting. The thrashing activities of the other fish injured some mosquitofish, thus causing death. Finally, problems arose in handling and transporting mosquitofish after they were harvested from production ponds. It was necessary to screen vat agitators with 3.0 mm mesh screen wire. This prevented fish from being entrapped and mangled in the agitators. In several instances attempts were made to obtain mosquitofish from local minnow producers. The producers collected large stocks of fish, which were subsequently lost because agitators were not screened. Even though these producers had expertise in handling other fish species, techniques for mosquitofish were lacking. It was also observed that fish were injured during harvest when seines were coated with tar substances. For this reason, only uncoated nylon seines were acceptable.

Ultimately, mosquito abatement districts rather than private minnow producers are concerned with stocks of fish necessary to achieve biological control. This investigation has given an indication as to stocking rate, pond size, and necessary time to achieve production with a minimum of management. It has also brought to light problems which may be encountered if such an operation is undertaken.

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PSOROPHORA HORRIDA IN MICHIGAN[1]

ZAIM, M., H. D. NEWSON AND G. D. DENNIS

Department of Entomology, Michigan State University
E. Lansing, MI 48824

Two females of *Psorophora horrida* (Dyar & Knab), a new record for Michigan, were collected on August 8 and 31, 1977 in a beech (*Fagus* sp.)-maple (*Acer* sp.) climax forest in East Lansing (T. 3N., R. 1W., sec. 6), during human biting collections.

Ps. horrida is a woodland mosquito. Its immature stages are found in temporary shaded pools following heavy and prolonged rains. Its distribution in the United States is primarily in the Southeast (Carpenter and LaCasse 1955). It is known to occur from Nebraska and Minnesota south to the Gulf states and east to Pennsylvania (Siverly 1972).

Siverly (1972) reported the occurrence of this species in small numbers in most of the counties in the southern third of Indiana. Parsons et al. (1972), in their revised list of the mosquitoes of Ohio, recorded this species as a rare mosquito in that state. This report extends the northward distribution of this species.

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A TECHNIQUE FOR THE COLLECTION OF ENGORGED TABANIDAE[1]

R. H. ROBERTS[2]

Bioenvironmental Insect Control Laboratory, Agr. Res. Serv., USDA, Stoneville, Mississippi 38776

In the laboratory biological studies of the immature stages of Tabanidae are conducted most efficiently with larvae that have hatched from eggs obtained from identified engorged adults. The usual method is to collect the adults with a hand net at the moment they finish feeding on the bait animal in the field. However, there are several drawbacks to this procedure: (1) the time and labor required to remain with a tethered bait animal during the 2-6 hr or more needed to obtain an adequate number of engorged females; (2) the necessity of changing work schedules in order to collect species at periods of the day that are outside the normal period, for example, at sunrise or sunset; (3) the danger of accidents due to such activities of the bait animal such as kicking; (4) the loss of specimens that escape the net or that feed on areas not easily accessible to collection with a hand net such as the upper inside areas of the hindlegs; and (5) the possibility of dislodging specimens prior to engorgement.

The technique that was devised was as follows: The bait animal was placed in a 12 × 12 × 8-ft screened building (Fig. 1) constructed of eleven 4 × 8-ft and one 4 × 4-ft diagonally braced 2 × 4-inch frames covered with 4-mesh hardware cloth. These frames were bolted together, three to a side. The single opening into the building was located in one corner and was 4 × 4 ft. The top half of the 4 × 8-ft space was closed with the 4 × 4-ft screened frame. The top of the building was covered with a 14 × 18-mesh screen nailed to 2 × 4 lumber on 30-inch centers.

In operation, a haltered bait animal was tied to a cleat in one of the corners away from the door opening. Tabanids that approached the building from any direction flew around the structure and eventually entered. Also, after several test trials, a shiny black ball (9 inches in diameter) was hung in the opening to facilitate the entrance of tabanids into the building.

[1]In cooperation with the Delta Branch of the Mississippi Agricultural and Forestry Experiment Station, Stoneville, MS 38776.

[2]Present address: Insects Affecting Man Research Laboratory, Agricultural Research Service, USDA, Gainesville, Florida 32604.