SURVEY OF A BRACKISH LAKE ON PULUSUK WITH REGARD TO ITS POTENTIAL FOR FISH CULTURE

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ABSTRACT

Water samples from the lake at Pulusuk were found to have temperatures ranging from 28 to 31°C, and salinities ranging from 0 to 3°/oo. Dissolved oxygen in the surface waters ranged from 4.5 to 7.9 ppm while the water in the loose detrital sediments was very low in oxygen and probably anoxic. One area of the lake is subject to frequent water exchange with the groundwater through a fissure in the limestone bed. This area is kept relatively free of detritus as a result of this exchange. Possibly, species of mullet could be cultivated in this area. Freshwater-acclimated mullet introduced in pens would not interfere with the present fauna which consists of three species of fish, one species of shrimp, one species of gastropod and one species of dragonfly.

INTRODUCTION

The inhabitants of the island of Pulusuk in the central Caroline Islands are traditionally fishermen, and the major source of protein for the island is fish harvested from the sea by trolling and bottomfishing from two-man outrigger canoes. Storms and associated rough seas, however, sometimes make it impossible or hazardous to sail the canoes to the fishing grounds, which are located along Manila reef, north of the island. During those times when fishing from canoes is not possible, the islanders rely on alternate, limited sources of protein, such as fishes trapped from the reef-flat or terrestrial crabs. An extended period without fishing imposes some degree of hardship on the community. If fish could be cultured on the island, even on a small scale, then their problem of fish shortages during periods of adverse weather could be, at least partially, alleviated.

This study was initiated in response to a request from the First Congress of the Federated States of Micronesia that the University of Guam Marine Laboratory carry out a survey of the lake on Pulusuk and make recommendations for its potential use for fish production.

MATERIALS AND METHODS

We left Moen, Truk for Pulusuk October 23, 1981 on board the Truk Queen Number 3 which was chartered specifically for our project. This charter was necessary since the regular field trip ship was in dry dock in Japan. When we arrived at Pulusuk on October 24, permission for us to stay on the island was granted by the Magistrate and Traditional Chief, Mr. Peiong Aimo. Our accomo-

tions on the island were graciously provided by Mr. Aimo and the community. We were also supplied with a two-man outrigger paddle canoe which served as the research vessel for our lake survey.

Specimens of fishes and benthic shrimp in the lake were collected by means of a hand net and a wire trap baited with coconut meat. Snails and plant samples were collected by hand, and one dragonfly larva was collected with a hand net. These samples were preserved in 10% formalin and returned to the Marine Laboratory of the University of Guam.

The depth of the lake was measured by means of a marked, weighted tape at 17 haphazardly selected stations. A diver checked the level of sediment at several points. Dissolved oxygen was measured at the water surface, at the mud surface, and beneath the mud surface with a YSI dissolved oxygen meter and probe. Water salinity was determined with a refractometer, and water temperatures were determined with a submerged maximum/minimum thermometer.

Mullet from the reef-flat at Pulusuk and from the lagoon at Moen were collected with a throw net, preserved in 10% formalin, and returned to the Marine Laboratory of the University of Guam.

RESULTS AND DISCUSSION

The lake on Pulusuk is approximately five hectares in size and is located at the north end of the island as shown in Figure 1. The bottom is covered with a thick layer of fine detrital matter. A channel at the east side of the lake is obviously the site of water exchange with the island freshwater lens system. In this channel there is noticable current, the direction of which is dependent on the tide. We traced the water flow to a fissure in the limestone bedrock at the end of the channel. In the area of the channel there was not

much of the fine detrital material which covers most of the lake bed. Since the lake is shallow, the flow in the channel and the wind are apparently sufficient to keep the water oxygenated above the detrital layer. The lake depth ranged from 1 to 4 meters. The mean depth was 2.6 meters (N = 17, S.D. = 1.00). The depth to the detrital layer was generally less than 2 meters and sometimes as shallow as 0.5 m. Oxygen levels recorded in the lake ranged from 6.9 to 8.1 ppm in the water above the detrital surface and from 0.4 to 4.5 ppm below the detrital surface (Table 1). The water below the detrital surface was very low in oxygen and probably anoxic in most places. Our techniques would cause some oxygenation by insertion of the probe into the detritus. Because of the low oxygen environment in the detrital layer, species introduced to the lake for culture should not stir the bottom deposits. If these deposits were continually disturbed it would probably cause a reduction in the oxygen content of the water.

Temperatures recorded within the lake are also shown in Table 1, and these ranged from 28° to 31°C. There were only small differences in temperature within the water column. The salinity of the lake varied from 0°/$_{oo}$ immediately after a heavy rain to 2.8°/$_{oo}$. We suspect that somewhat higher salinities may be reached after prolonged dry periods. Salinities recorded in different areas of the lake are shown in Table 2.

The fact that the lake is capable of supporting fish and other aquatic animals is evidenced by the large populations of fishes, benthic shrimp and aquatic snails which it contains. The species we found in the lake include three fish species (a gobiid, the poecilliid, Gambusia affinis, and a hemiramphid), one shrimp species, one aquatic snail, and a larval specimen of a species of dragonfly. These organisms are shown in Figure 2. One benthic algal species was common in the lake and formed dense mats on submerged logs

and rocks. This green alga was tentatively identified as a species of Cladophoropsis by Dr. Roy T. Tsuda of the U.O.G. Marine Laboratory.

We were informed by Mr. Basilio Saipweirik that hemiramphids (half-beaks or lihoufanipo) were very abundant in the lake prior to the introduction of the mosquito fish. This introduction occurred in the late 1960's. Our survey indicated that the mosquitofish are now numerous and that only a few half-beaks remain. During our survey we saw only 5 half-beaks, but we were unable to collect any specimens for identification. The residents of Pulusuk were interested in removing the mosquitofish from the lake since these fish were, reportedly, not effective at controlling mosquitoes, and their presence had apparently reduced the population of half-beaks. We could think of no practical way to remove them.

Recommendations for Aquaculture Development

Selection of species

Some of the major considerations for selecting species of fish for cultivation in the lake are as follows:

1) The juvenile fish must be available so that continuous stocking can take place.

2) The lake sediments should not be continuously disturbed by the fish.

3) The fish must be able to tolerate changes in the salinity of the water.

4) The fish must be desirable to the local community as a food fish.

Species of one group of fishes which would satisfy these requirements are those of the mullet family. The local name for these fish is "Araf". Several species of mullets which are found in Micronesia are shown in Figures 3 to 5. We recommend mullet since many of them can survive and grow in either seawater or freshwater. Also, mullet are found in the nearshore areas of

Pulusuk, and therefore juveniles would be available for stocking. We have found that Liza vaigiensis is a species which is hardy, and individuals of this species may be a likely candidate for the culture operation. We suspect that this species occurs at Pulusuk, but we were unable to collect specimens.

Proposed System Design

A pen culture system could be used at the lake. This would mean stocking only a small area of the lake rather than simply releasing the fish unconfined. The lake is simply too big and too deep to be harvested conveniently. Also, the bottom sediments are so deep that it would be impossible to pull a net very far through them.

An ideal location for a pen would be in the vicinity of the channel (Figure 5). In that area the movement of water which results from tidal fluctuations, would help to ensure adequate aeration of the water and would aid in the removal of metabolic wastes. To minimize problems, a low stocking rate should be used at the onset of the project. This density can be gradually increased when the system has been in successful operation for a period of time.

Since the fish will be confined, it will be necessary to feed them. Several potential sources of feed are available on Pulusuk. Especially abundant are breadfruit, which is seasonal, and copra. The breadfruit may need to be boiled and chopped to a size appropriate for the size of fish in the pen. Care should be taken not to overfeed the fish. They should be fed only the amount that they will eat in a short time so uneaten food will not accumulate in the pen. Feeding rates for mullet are usually around 2% of the weight of the fish per day (Chen, 1976). Dried, pelletized food could also be used. These feeds, such as trout chow or chicken feed, might be nutritionally

superior to locally found items, but there would be problems associated with their prolonged storage, regular supply, and cost. The sediments in the lake may also prove satisfactory as feed for the mullets since, in nature, mullet feed primarily on detritus, zooplankton and microalgae (Odum, 1970; Chan and Chua, 1979; De Silva, 1980; and Zismann et al., 1975). Since many factors affect the feeding rate of the fish, the rates should be adjusted to the demands of the particular group of fish being cultured (Hickling, 1971).

Stocking the Pond

The primary source of fry for stocking the pens will probably be the mullet populations found at Pulusuk. The juvenile fish can be caught on the reef flat with a 1/4" or smaller mesh (stretched) cast-net which has a continuous lead chain on its margin. It may be possible to transfer some mullet species directly from the sea to the lake provided that care is taken not to injure the fish during capture or transfer. However, some sizes or species may not be able to tolerate such a sudden transfer and some period of acclimation will be necessary. Many of these aspects will have to be worked out by the individuals involved in the culture operation. Generally, smaller (younger) juveniles seem to have a greater tolerance to sudden salinity changes than larger juveniles.

Fry for stocking the pen could also be obtained from Truk. The fry could be collected from Truk Lagoon, acclimated to freshwater, and shipped live via the field trip ship to Pulusuk. We recommend that the initial stocking of the pen be made in this manner, with preacclimated fry shipped from Moen. This should be supervised by biologists from the U.O.G. Marine Laboratory and from the Department of Marine Resources on Truk.

If available, milkfish fry could also be supplied periodically from Moen, and these could be raised along with the mullet.

ACKNOWLEDGEMENTS

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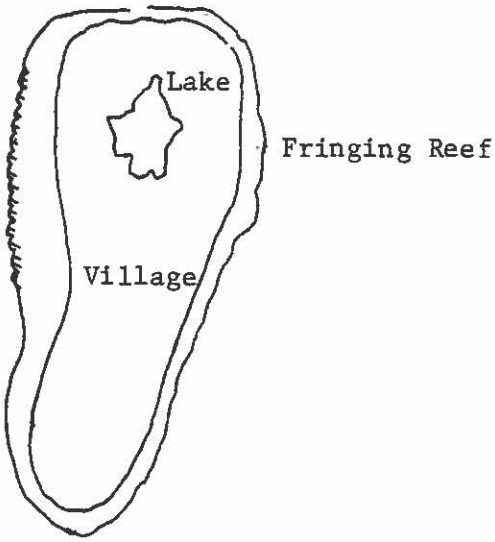
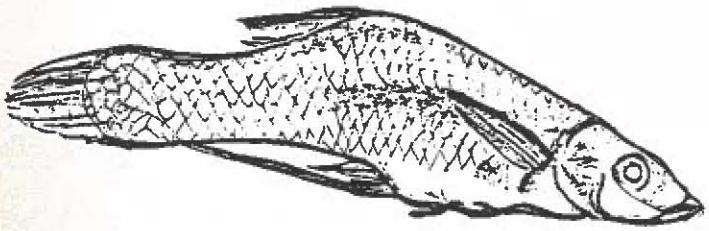
Figure 1. Sketch map of Pulusuk indicating the location of the lake. Scale 1 cm = approximately 500 m.

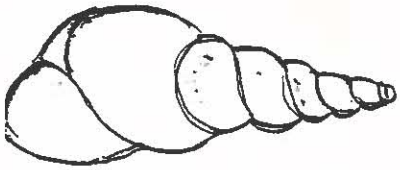


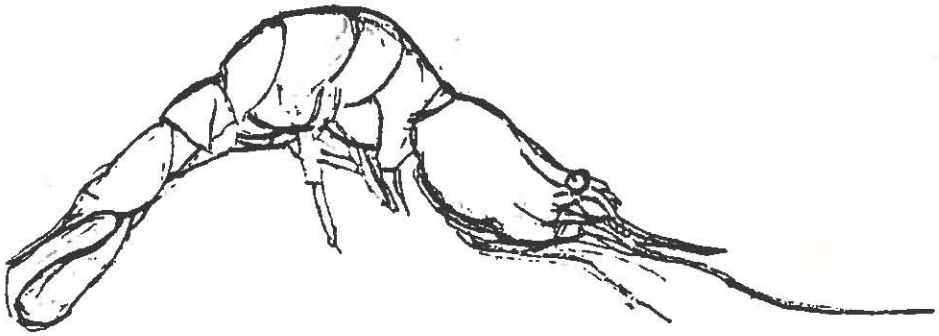
PULUSUK

Eastern Caroline Islands

Figure 2. Fauna of the lake on Pulusuk. From top to bottom: a specimen of a gobiid fish (x 3), specimen of the mosquitofish Gambusia affinis (x 3), two specimens of an aquatic gastropod(x 7), a specimen of a species of shrimp (x 3), a larval specimen of a species of dragonfly (O. odonata) (x 2).







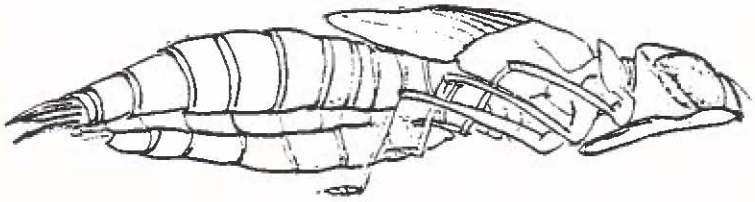


Figure 3. Specimen of a mullet, Crenimugil crenilabis, collected from the reef flat at Pulusuk.

Figure 4. Specimen of a mullet, Chelon engeli, collected from Truk lagoon.

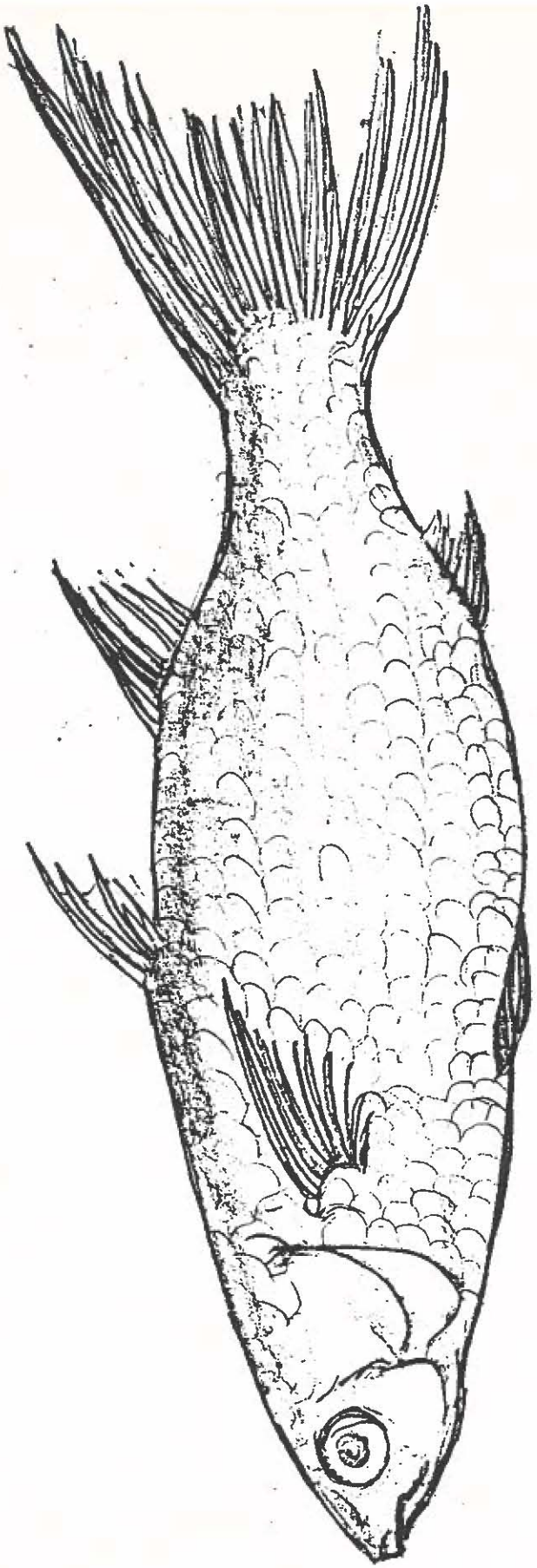


Figure 5. Specimen of a mullet, Liza vaigiensis, collected from Guam. Individuals of this species have proven to be hardy and would be likely candidates for culture at Pulusuk.

Figure 6. The lake at Pulusuk. The arrow indicates the recommended location for a fish pen. This view is from the community swimming area.