SPC/Fisheries 9/WP.27
21 January, 1977
ORIGINAL : ENGLISH

SOUTH PACIFIC COMMISSION

NINTH REGIONAL TECHNICAL MEETING ON FISHERIES
(Noumea, New Caledonia, 24 -28 January L977)

ATOLL AQUACULTURE - CULTURE OF MILKFISH, *CHANOS CHANOS* (FORSKÅL), IN THE GILBERT ISLANDS FOR PRODUCTION OF LIVE BAITFISH AND AS A MEANS OF INCREASING THE SUPPLY OF PROTEIN-RICH FOOD

by

V. Gopalakrishnan
UNDP/FAO Project, Tarawa,
Gilbert Islands

SUMMARY

The first series of observations made on the culture of milkfish, *Chanos chanos*, in a new pilot experimental fish farm in Tarawa, Gilbert Islands, are described. The typical environmental conditions and the harsh climatic and soil characteristics had been thought to be factors against the development of large-scale aquaculture in atolls, but favourable data regarding abundance of fish seed in the lagoons and the availability of inter-tidal flats and mangrove areas suitable for the construction of fish ponds prompted the initiation of the feasibility programme. Data obtained on the food and feeding habits, and growth of milkfish in experimental ponds have been presented. Production rates of 212 kg/ha/12 weeks and 305, 334, 457 and 415 kg/ha/20 weeks have been obtained in the preliminary studies, without fertilization and supplementary feeding. Different types of locally available feeds have also been under trial and highly satisfactory production rates - up to 2,300 kg/ha/yr with average of 2,200 kg/ha/yr - have been obtained. As regards the culture of milkfish for use as bait for pole-and-line fishing, the stocking rates achieved so far are for juveniles 75,000 /ha and for fry 1,00,000 /ha. In general, fry reared in the ponds attained bait size in 8-10 weeks' time and the maximum production rate obtained so far in this type of operations is 2,826 kg/ha/yr. Stock management practices involving simultaneous stocking of fish of different age and size groups and stocking at intervals of about 4-5 weeks have been tried and the latter appears to have yielded better results for the culture of bait size milkfish. The results obtained so far indicate appreciable scope for the development of aquaculture in the Gilbert Islands for producing live bait fish to support a pole-and line tuna fishing enterprise and also for producing food fish.

SPC/Fisheries 9/WP.27
18 January 1977
ORIGINAL : ENGLISH

SOUTH PACIFIC COMMISSION

NINTH REGIONAL TECHNICAL MEETING ON FISHERIES
(Noumea, New Caledonia, 24 - 28 January 1977)

ATOLL AQUACULTURE - CULTURE OF MILKFISH, *CHANOS CHANOS* (FORSKÅL), IN THE GILBERT ISLANDS FOR PRODUCTION OF LIVE BAITFISH AND AS A MEANS OF INCREASING THE SUPPLY OF PROTEIN-RICH FOOD

by

V. Gopalakrishnan
UNDP/FAO Project, Tarawa,
Gilbert Islands

I. INTRODUCTION

1. The Gilbert Islands have a total land area of approximately 684 km^2 and they lie scattered over about 5 million km^2 of the Pacific Ocean. Currently the export of copra and phosphates are the main sources of revenue, but the latter item is expected to be depleted completely by 1978, which condition is bound to have a serious impact on the economy of the country. It is therefore anticipated that the primary developmental aim during the years to come will be to exploit the marine resources. Till now, fisheries activities in general have been exclusively based on subsistence level operations. Past attempts to survey and harvest the marine resources from the vast ocean area have been only marginal and in the nature of preliminary exploratory programmes. As a means of identifying the economic viability of a tuna fishery, the Government formed a Fisheries Survey Unit, and under an agreement with an American tuna company began a joint tuna survey, primarily in the area of the central Gilberts. The first observations indicated that although large stocks of tuna existed in the areas surveyed, the supply of suitable bait for pole-and-line skipjack fishing was limited. It was expected that this joint survey was to be extended in order to investigate further bait availability and tuna stocks in other areas. Unfortunately, the survey was abruptly halted when the three survey vessels were lost during the hurricane in October 1972. It is felt, however, that the first results cannot be considered to be conclusive due to the limited grounds surveyed. Thus, in addition to the normal interest in augmenting the tempo for exploitation of the marine resources, a matter of serious concern to the authorities is the production of sufficient quantities of baitfish which may help in the establishment of a tuna fishing industry. A well-programmed survey of the baitfish resources in the Gilbert Islands is a pre-requisite to the development of an export-oriented fishing industry. Comprehensive biological information leading to determination of the maximum sustainable yields of baitfish as well as tunas have to be collected to determine the size of the fishing fleet that the resources can support. The culture of baitfish to form an auxiliary industry is perhaps one major solution to this situation.

2. Realising the urgent need for making a critical study of the problem of developing fish culture in the Islands, both for augmenting food supply and producing live bait, a UNDP/FAO aquaculture project was initiated in 1974 to investigate the feasibility of taking up fish culture in the lagoons, with special reference to milkfish (*Chanos chanos* Forskål) farming and to undertake pilot studies in suitable areas.

3. Limited culture of milkfish (locally known as 'baneawa') has been practised in the Gilbert Islands by private individuals in isolated and non-drainable ponds, adopting traditional and empirical methods. Such fish culture has been totally as a subsistence fishery and not for any any cash market. No special techniques have been reported, and the main effort has been to collect the fry from the lagoons as and when necessary and introduce them into the ponds. No further management practices have been prevalent, except occasional feeding with mashed coconut, and the fish harvested mainly for family consumption. Such limited culture of milkfish has suffered a serious setback since the introduction of *Tilapia mossambica* Peters into the Islands about twelve years ago. *Tilapia* is not liked by the Islanders as a food fish and they complain that since this unwelcome introduction,the growth of milkfish in the ponds has been adversely affected.

II. PILOT EXPERIMENTAL FISH FARM IN TARAWA

4. Tarawa Atoll, on which is located the administrative capital of the Gilbert Islands, was chosen for conducting the initial feasibility studies, and a reconnaissance survey of the lagoon indicated several areas suitable for the establishment of a pilot experimental fish farm. Detailed observations were then made at four regions,and on the basis of data gathered on the tidal amplitude, topography, fish seed availability, etc., it was finally decided that the pilot farm may be located at Ambo, Tarawa.

5. The pilot farm, which was constructed during a period of about eight months, has a total area of 8 ha., comprising nine experimental ponds of varying sizes. The largest pond is about 3.5 ha. in area and is connected to the lagoon through an independent sluice gate. The other eight ponds have been constructed in the adjacent mangrove swamp and each of them is connected to the lagoon through a feeder canal provided with sluice gates. The observations presented in this working paper were obtained from five of the ponds.

III. CLIMATIC CONDITIONS

6. The Gilbert Islands have maritime equatorial climate with normal temperatures between 29 and 32°C and extremes at 22 and 36°C. The mean annual temperature is 26.7°C. The trade winds blow throughout the year, mostly as easterlies with occasional westerly gales during the period October to February. The average annual rainfall is about 127 cm on the islands close to the Equator, rising to 305 cm in the north. However, drought conditions are known to prevail, sometimes lasting up to three years. In general, the wettest season is during December to April and the driest during July to October. The mean temperature of the lagoon and ocean waters is in the neighbourhood of 31°C.

IV. SOIL CONDITIONS

7. The atoll soil consists of unconsolidated calcareous debris resting on solid foundations. The lagoon shore is generally a low sandy flat, but the intertidal reef areas may have deposits of 'reef mud' having organic matter in varying concentrations. In a typical mangrove area used for the construction of the experimental ponds, the top 20 cm was found to be coral mud rich in organic matter and changing gradually to sand and organic matter below. The atoll soil formed of calcium and magnesium carbonate is, in general, in the slightly alkaline range.

V. TIDAL FLUCTUATIONS

8. The general principles of successful milkfish culture call for suitable tidal range in the area in order to maintain reasonable depths of water and afford draining facilities. It is also necessary to ascertain that clean unpolluted water is available in the inflow channels. The tidal range data for the area in which the pilot farm is located, during the different months of 1975, are given below:

Month	Spring Tide		Neap tide	
	Min.LWL,	Max.HWL	Max.LWL	Min.HWL
January	- 0.3 m	2.2 m	0.7 m	1.2 m
February	- 0.3 m	2.2 m	0.7 m	1.2 m
March	- 0.3 m	2.1 m	0.7 m	1.1 m
April	- 0.2 m	2.1 m	0.7 m	1.2 m
May	0.0 m	2.0 m	0.7 m	1.2 m
June	0.1 m	1.9 m	0.7 m	1.2 m
July	0.0 m	1.9 m	0.7 m	1.2 m
August	- 0.2 m	2.1 m	0.8 m	1.1 m
September	- 0.3 m	2.2 m	0.8 m	1.1 m
October	- 0.3 m	2.2 m	0.7 m	1.2 m
November	- 0.1 m	2.2 m	0.7 m	1.2 m
December	- 0.1 m	2.1 m	0.7 m	1.2 m

The tidal ranges observed have been found to be adequate for the proper management of the ponds.

VI. SALINITY AND TEMPERATURE CONDITIONS

9. Salinity as a single factor plays a dominant role in the management practices for aquaculture in the atolls. The existence of Ghyben-Herzberg water lens in many of the Pacific atolls makes the question of salinity control complex. In order to mitigate the adverse effects of greatly changing salinity patterns in the fish ponds, the tidal water exchanges have been carefully manipulated, thus avoiding extreme conditions over long periods. The ranges of salinity and temperature observed in the experimental ponds are summarised in the table below:

Month (1975)	Salinity range (ppt)	Temperature range (^{o}C)
January	4.8 - 30.5	26.9 - 36.0
February	2.2 - 33.7	25.4 - 30.6
March	21.2 - 29.8	28.0 - 32.8
April	2.8 - 29.2	27.8 - 36.0
May	8.8 - 30.5	29.0 - 33.2

Month (1975)	Salinity range (ppt)	Temperature range (°C)
June	18.0 - 29.2	27.8 - 31.5
July	23.3 - 33.7	29.6 - 34.2
August	16.7 - 41.6	27.4 - 30.8
September	16.7 - 31.8	28.8 - 35.4
October	33.7 - 40.3	27.2 - 30.8
November	33.7 - 41.6	28.6 - 33.4
December	35.1 - 41.6	27.0 - 31.1

It is somewhat difficult to maintain the salinity of pond water within the favourable range under conditions of freshwater scarcity and absence of drainage system to divert rain water away from the ponds. The general conditions in Tarawa Atoll do not provide a reliable supply of fresh water, but it has been observed that by careful and judicious management of the sluice gates, this problem can be solved to a great extent.

VII. COLLECTION OF SEED

10. Fish seed survey centres were established at four centres in the Tarawa Lagoon, taking into consideration accessibility during different tidal phases, nature of banks and bottom, current and wave patterns, etc. Pits in the inter-tidal region, specially in mangrove areas, were also surveyed using rectangular bag-type nets. The mouth regions of the bights at the stations mentioned above provided favourable tidal currents for the operation of fry collection nets. All the four stations were found to be good for the collection of milkfish fry in large numbers. Milkfish fry are found in the Tarawa Lagoon practically throughout the year, but the seasons of peak availability are December - January and June - July. While this general survey was conducted to observe the fish seed resources of the Tarawa Lagoon, the entire fry requirement for the experiments conducted in the pilot farm came into the feeder canal on their own. The abundance of milkfish seed will be observed from the five calculated averages during one season only.

June - July 1975

Catch/net/hr/2 men

Selected days in serial (spring tide phase)	
1	42,000 fry
2	38,000 "
3	34,000 "
4	50,000 "
5	48,000 "

VIII. FOOD AND FEEDING HABITS

11. For the first set of experiments, fertilization and supplementary feeding practices were not adopted. This was with a view to determine the maximum production rates that could be obtained from the initial growth of pasture in the ponds and subsequent influx of tidal water at intervals. The interchange of water between the ponds and lagoon resulting in recoupment of nutrients and food organisms, and dilution of waste products in the pond water, required careful manipulation of the sluice gates during particular tidal phases.

12. It is known that good growth of pasture is the most important pre-requisite for successful milkfish culture. However, the possibility that milkfish is a plankton feeder has been considered by different workers. During the present investigations it was observed that although the milkfish generally consumed the benthic pasture, whenever plankton was available in appreciable quantities the fish fed profusely on the plankters. This was confirmed by stomach content analyses also. Such feeding behaviour is particularly interesting in situations like those in atoll lagoons, both technically and due to the high cost of imported fertilizers. Further, chemical fertilizers may produce certain problems in ponds constructed in atolls, relating to absorption of the nutrients rapidly by the soil, necessitating adoption of further techniques to get the substances released back into the pond water. The food of *Chanos chanos* in the open sea is considered to be benthic microscopic vegetable organisms together with foraminiferans, molluscs, and dead copepods, and in the estuaries - different types of algae and diatoms, lamellibranchs, fish eggs, etc.

IV. GROWTH AND PRODUCTION RATES

13. The growth and estimated production rates during the first set of experimental observations were: (All estimates are averages) -

Stocking rate (/ha)	Period (weeks)	Length (mm)	Weight (g)	Estimated production
1,500	12	251	200	212 kg/ha/12 weeks
1,500	20	255	185	305 kg/ha/20 weeks
2,000	20	206	91)	
	12	186	87)	334 kg/ha/20 weeks
	8	124	27)	
	4	77	5)	
3,000	20	258	163)	
	12	188	87)	457 kg/ha/20 weeks
	8	125	28)	
3,000	20	248	168)	
	12	237	140)	415 kg/ha/20 weeks
	8	122	26)	

14. A feeding programme was initiated subsequently, but the average production rates indicated above, obtained without fertilization or supplementary feeding, are considered to be very good.

15. The supplementary feeds used for the second set of experiments were imported pellets, damaged flour, damaged locally made biscuits and grated coconut. Two methods of feeding, viz. by 'broadcasting' and using floating feed trays were tried. The milkfish readily respond to feeding in floating trays provided with fine-mesh netting on the bottom. By using different combinations of the feeds, production rates up to 2,300 kg/ha/yr have been obtained, with an average of 2,200 kg/ha/yr.

16. As regards the culture of milkfish for use as bait for pole-and-line fishing, trials to determine the highest density stocking rates have been in progress in three ponds. The stocking levels achieved so far are: juveniles - 75,000/ha and fry - 1,000,000/ha.

These experiments were also aimed at determining the benefits of fertilization and supplementary feeding. The maximum rate of production so far obtained in this regard is 2,826 kg/ha/yr. The fry reared in the ponds attained bait size of 7 to 10 cm length in 8-10 weeks time. The best stocking strategy so far worked out involves stock manipulation programmes using at least three different length groups and stocking them at intervals of about 4-5 weeks. Further work in this direction is in progress.

17. The observations so far made clearly indicate that the atolls of the Gilbert Islands present considerable scope for the development of multi-purpose aquaculture, with milkfish as the most important candidate.
