



AQUACULTURE IN TAIWAN

Condensed and edited by Dr. R. S. V. Pullin (ICLARM) from the paper entitled, "Status of Aquaculture in Taiwan," by Yen Pin Li and Po-Wei Yuan. 1979. Council for Agricultural Planning and Development, Taipei, originally prepared for the U.S.-Taiwan Joint Workshop on Fish Health, 23-25 July 1979 in Seattle, Washington. Photographs by Dr. Pullin.

Introduction

IN 1978, Taiwan had a population of about 17 million. Per capita annual consumption of fish was about 35 kg. Aquaculture contributed 18.6% of the total fish supply of 884,900 t. Table 1 shows the expansion of aquaculture over the last decade. Most of the farms are family businesses of between 0.1 and 2.0 ha, but there are some large companies farming eels and shrimps. Table 2 lists the major species cultured in Taiwan. Apart from milkfish, grey mullet and eels, nearly all the fish seed required is produced by commercial hatcheries.

Freshwater Ponds

Polyculture operations are widespread and are normally based on Chinese grass and common carps. Additional species, such as fresh-

water clams (*Corbicula spp.*), grey mullet, tilapias (including *Sarotherodon niloticus*, *S. mossambicus*, *S. aureus* and hybrids), snakehead, freshwater acclimatized sea perch and estuarine sea bass, are also selectively used in polyculture. The usual annual yield from carp polyculture is 3-6 t/ha.

Integrated farming systems, such as chicken-fish, duck-fish and pig-fish, are also practiced. Annual production can reach 6 t/ha, using animal waste fertilization alone, and 10 t/ha, with supplemental feeding. The fish species used are *S. niloticus* and the hybrids, *S. mossambicus* × *S. niloticus* and *S. aureus* × *S. niloticus*, which have been responsible for the development of multiple harvesting techniques and monosex culture.

Eel culture is found mainly in the Ilan, Lukang, Yunlin and Pingtung areas. The main species is *Anguilla japonica*, with small scale culture of

the local species *Anguilla marmorata*. Over 90% of the 1978 production was exported live or part-processed to Japan where it supplied over one-third of the total consumption of eels. Eel culture uses intensive feeding methods and aeration to give an average annual yield of about 10 t/ha. The growout period from glass eels (6,000/kg) to market size (4-5/kg) is about 350 d. Fluctuations in the supply of the wild caught seed and disease outbreaks are the major problems faced by the industry.

Macrobrachium culture is expanding in Taiwan, using mainly a Malaysian strain of *M. rosenberghii* in preference to the native strain. This is cultured in former carp and tilapia ponds with seed from commercial hatcheries. Aerated ponds have yielded over 2 t/ha of 25 to 40 g prawns after 6 mo growout.



Above. Sorting tilapia broodstock at a farm near Lukang.

Right. Feeding time at an eel farm in Pingtung county. Photos p. 10, 11 by R.S.V. Pullin.



Brackishwater Ponds

Milkfish (*Chanos chanos*) has been cultured for over 300 yr and it remains the most important species. The pond soil is fertilized to encourage benthic-algal production and multiple size stocking and harvesting are practiced. Annual production fluctuates with the supply of fry which are all wild caught.

Polyculture is commonly practiced, using various stocking ratios of milkfish, *Penaeus monodon*, *Metapenaeus ensis*, *Scylla serrata* and *Gracilaria confervoides*. Culture of shrimp, particularly *Penaeus monodon*, is undergoing a rapid expansion because of the increased demand, high market price and the success of hatchery techniques giving mass production of seed. There is a trend towards increased stocking of shrimps, to make them the main crop from former milkfish ponds by deepening the ponds and installing aeration equipment. Also, new farms using intensive culture methods and formulated feeds are rapidly increasing in number. Mangrove crabs (*Scylla*

serrata) are usually stocked at about 500-1,000/ha in polyculture and fed trash fish, fish offal and crushed molluscs. The growout period is 3-6 mo. Berried female crabs command a high market price for use in crab monoculture.

Gracilaria growth is encouraged by the nutrient-rich water in polyculture systems. It has been cultured in Taiwan for about 6 yr, giving annual yields of about 10-12 t/ha. The annual production varies with demand and market price. The algae are harvested at 10-d intervals in the growing season (June to December) and are washed, sundried and sold with a moisture content of 20%. Inorganic or organic fertilizer is used where *Gracilaria* is the main crop.

Mariculture

Oysters (*Crassostrea gigas*) are cultured along the west coast by off-bottom methods: bamboo poles in tidal areas; ropes between poles or suspended from fixed frames in shallow sublittoral areas; ropes suspended from rafts in sheltered waters exceeding 3m depth and buoyed floating long lines in more exposed, deeper waters. The growout period is 6-12 mo, giving a shell length of 6-7 cm. The entire 1978 production was marketed within Taiwan.

The culture of clams (*Meretrix* spp.) started in 1925 and has spread to many west coast tidal areas. Natural

spat (0.5 mm) are collected with sieves and sold to seed growers who operate clam nurseries in converted milkfish ponds. The seed is sold for growout at 800-1,000 clams per kilogram and raised by farmers to market size (2-3 cm shell length). Industrial pollution has recently become a major threat to both oyster and clam culture; it has ruined some formerly productive areas.

Research and development is proceeding with other high value marine species, such as the small abalone (*Haliotis diversicolor supertexta*) for which induced spawning and larval rearing techniques have been developed. Commercial abalone hatcheries are in operation. Marine finfish have received little attention but cage cul-

Table 1. Aquaculture production in Taiwan for 1968 and 1978 with the areas used in 1978. (Source: Taiwan Fisheries Bureau 1969, 1979).

Culture type	Production, 1968		Production, 1978		Area used, 1978	
	t	% of total	t	% of total	ha	% of total
Freshwater ponds	12,077	21.3	71,538	43.5	15,841	27.2
Brackishwater ponds	24,058	42.5	50,317	30.7	18,665	32.1
Mariculture	15,553	27.5	32,795	19.9	15,317	26.3
Others (rice-fish culture and other impoundments)	4,899	8.7	9,741	5.9	8,377	14.4
Total	56,587		164,391		58,200	

ture of sea bream (*Chrysophrys major*) has begun on a small scale and research is in progress to ensure seed supply from captive broodstock.

Other Methods

Rice-fish culture has declined in recent years due to the indiscriminate use of pesticides. Rotation of rice and fish crops is still practiced in some areas, however, where the water supply is insufficient for year-round aquaculture. Fish yields from all rice field aquaculture operations are normally very low as the irrigation of crops is given priority over the needs of aquaculture when the water supply is limited.

Freshwater cage culture in reservoirs has recently been recognized as an efficient means of increasing production. Yields of 4-6 t/100 m³ have been obtained after 4-5 mo growout with intensive supplemental feeding.

The Future

It seems unlikely that the area used for aquaculture in Taiwan can be significantly expanded because of competition for land and water use with other activities, government regulations and the increasing problem of industrial pollution. The future development of aquaculture will therefore depend on intensification of present operations. This will require a continued research and development program directed towards ensuring seed supply, and high unit area production.

Table 2. The species used for aquaculture in Taiwan, with production figures for 1978 where known (Source: Taiwan Fisheries Bureau 1979).

	Common name	Scientific name	Production (t)
<i>Finfish</i>	Milkfish	<i>Chanos chanos</i>	30,153
	Tilapias	<i>Sarotherodon</i> spp. and hybrids	27,518
	Silver carp and Bighead carp	<i>Hypophthalmichthys molitrix</i> } <i>Aristichthys nobilis</i> }	10,031
	Grass carp	<i>Ctenopharyngodon idella</i>	6,980
	Common carp	<i>Cyprinus carpio</i>	3,260
	Crucian carp	<i>Carassius carassius</i>	2,419
	Eel	<i>Anguilla japonica</i>	2,128
	Grey mullet	<i>Mugil cephalus</i>	1,960
	Black carp	<i>Mylopharyngodon piceus</i>	
	Mud carp	<i>Cirrhina molitorella</i>	
	Estuarine sea bass	<i>Lates calcarifer</i>	
	Sea perch	<i>Lateolabrax japonicus</i>	
	Catfishes	<i>Clarias</i> spp. <i>Parasilurus asotus</i> <i>Pangasius</i> spp.	
	Snakehead	<i>Ophicephalus</i> spp.	
	Rainbow trout	<i>Salmo gairdneri</i>	
Ayu	<i>Plecoglossus altivelis</i>		
Mud skipper	<i>Boleophthalmus chinensis</i>		
Sea bream	<i>Chrysophrys major</i>		
<i>Molluscs</i>	Pacific oyster	<i>Crassostrea gigas</i>	17,944
	Hard clams	<i>Meretrix</i> spp.	
	Short-necked clams	<i>Comphina veneriformis</i> }	15,093
	Corbiculas	<i>Corbicula</i> spp.	5,914
	Purple clam	<i>Soletellina diphos</i>	
	Cockle	<i>Anadara granosa</i>	
Small abalone	<i>Haliotis diversicolor</i>		
<i>Crustaceans</i>	Grass shrimp	<i>Penaeus monodon</i>	1,556
	Sand shrimp	<i>Metapenaeus ensis</i>	693
	Mangrove crab	<i>Scylla serrata</i>	445
	Kuruma shrimp	<i>Penaeus japonicus</i>	
	Red-tailed shrimp	<i>Penaeus penicillatus</i>	
	Giant freshwater prawn	<i>Macrobrachium rosenberghii</i>	
<i>Reptiles</i>	Soft-shelled turtle	<i>Trionyx sinensis</i>	281
<i>Algae</i>	Gracilaria	<i>Gracilaria confervoides</i>	11,901
	Nori	<i>Porphyra</i> spp.	15
	Nori	<i>Monostroma</i> spp.	
	Gracilaria	<i>Gracilaria</i> spp.	