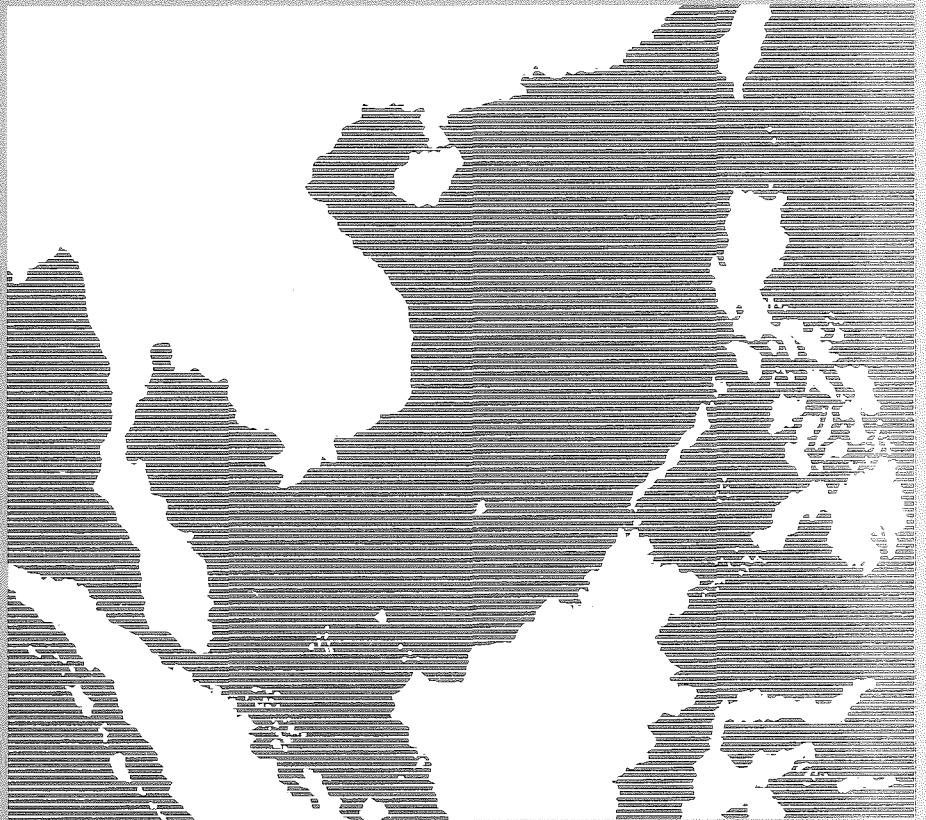


SCS/DEV/73/7  
indo-pacific fisheries council  
SOUTH CHINA SEA FISHERIES  
DEVELOPMENT AND COORDINATING  
PROGRAMME

# THE SOUTH CHINA SEA FISHERIES crustacean resources



UNITED NATIONS DEVELOPMENT PROGRAMME

FOOD AND AGRICULTURE ORGANIZATION  
OF THE UNITED NATIONS

THE CRUSTACEAN RESOURCES AND RELATED FISHERIES  
IN THE COUNTRIES BORDERING THE SOUTH CHINA SEA

by

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This study, prepared on behalf of the South China Sea Programme, was based on field visits in the region from July to September 1973.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

UNITED NATIONS DEVELOPMENT PROGRAMME

Rome, December 1973

THE SOUTH CHINA SEA FISHERIES  
DEVELOPMENT AND COORDINATING PROGRAMME

The South China Sea Fisheries Development and Coordinating Programme (Phase I) was formally conceived by the Indo-Pacific Fisheries Council and its activities have been conducted in close collaboration with that body. The Programme is supported by the UNDP and is being carried out by the FAO Department of Fisheries. This paper, as well as others in a series referred to in SCS/DEV/73/1/Rome, forms the basis for the long-term Phase II programme outlined in that document. The Phase I programme was conducted as an identification project to reflect the wishes and needs of the participating countries for collaborative long-term comprehensive fisheries development.

A.G. Woodland  
Programme Leader

THE CRUSTACEAN RESOURCES AND RELATED FISHERIES  
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SUMMARY

The crustacean resources of the countries in the South China Sea area are of considerable importance, in particular the penaeid shrimp. Production of penaeid shrimp has been steadily increasing during the past few years. By 1971/72 the combined production of the countries covered in this review had almost attained the potential of 290 000 t projected a few years earlier.

Although in all the countries under review considerable effort is under way to improve the collection of statistical data, with some exceptions (e.g. Thailand) there are no research programmes aimed to assess the effect of the fishing pressure on shrimp stocks. Consequently it is difficult to arrive at definite conclusions on the state of the various fisheries. There are indications, however, that in some countries the optimum production of the larger penaeid species has been reached and the fishing effort is being shifted to smaller-sized shrimps.

In only three countries, West Malaysia, Vietnam and Thailand, has growth of the shrimp fisheries been rapid; quite likely growth will continue there in the years to come, although perhaps at a slower rate. In the other countries, East Malaysia (Sabah, Sarawak), Singapore, Philippines and Hong Kong, shrimp production has been more or less static over the past five years (or for the period of time for which data are available) and the prospects for substantial increases of production are slight unless new grounds are located. In the case of Indonesia, any further increase will depend on the discovery of new fishing grounds in deep water and on improvements to the gear employed.

In the majority of the countries covered, production is estimated rather than being based on recorded landings. A sample survey in one country showed that production figures had been overestimated by about 20 percent. Also, shrimp production figures from some important producing countries include considerable quantities of mysids, sergestids, etc., in some cases the proportion being as high as 25-30 percent. This masks the real production

of penaeid shrimp. No doubt these deficiencies will become less acute with the strengthening of the national statistical systems.

Using production figures provided by the national statistical services, and excluding the mysid/sergestid production, the total production of the countries referred to above amounted to 205 000 t by 1971. A future potential in the order of 30.0 to 35.0 x 10<sup>3</sup> t is projected.

The second crustacean resource in importance in the area is crabs, with the most important producing countries being Vietnam and Thailand. Until 1972 crabs and molluscs were grouped together in the Vietnamese statistics; further, the production of Thailand has been considerably overestimated, so the total production can only be inferred. On the basis of available data, provided by FAO or the national statistics of fisheries, it is assumed that the 1971 production was between 30 and 50 000 t, the major part consisting of the swimming crab, Portunus pelagicus. Since the trawling fleet is expanding and operating more in off-shore grounds than previously, a potential in the order of 10.0 to 15.0 x 10<sup>3</sup> t is projected.

Although spiny lobsters are being taken throughout the area, the quantities recorded are small. In 1971 the production recorded was less than 2 000 t, but probably it was higher. It is believed that production of lobsters can be considerably increased if capture methods are improved. Shovel-nosed lobsters (Ibacus, Thenus) are taken by the trawling fleet, and a recent survey conducted off the east coast of Vietnam indicated good concentrations in some areas.

Production of the freshwater prawn, Macrobrachium rosenbergii, in 1972 amounted to about 5 000 t. However, the production for the whole area must have been higher since the quantities landed in Vietnam and other countries have not been reported in the statistics. There was a production of about 30 000 t of freshwater crustaceans from the Philippines in 1969/71; information on the species involved could not be obtained, but it is possible that they were the small-sized prawns Macrobrachium lanceifrons and Caridina gracililostris, mainly utilized by the duck farming industry.

Although shrimp culture is being practised throughout most of the area, the degree of intensity varies from country to country and detailed information on annual production is lacking, except for Thailand. The estimated production in 1972 derived from aquaculture is considered to be in the region of 2 000 t, of which about 1 000 t is produced by Thailand. It is believed that production can be increased by a factor of 10 if improvements to existing practices are applied.

The present study also showed the importance of the molluscan resources of the area. In 1971 the combined production of molluscan species (excluding cephalopods) amounted to more than 350 000 t, equal to or higher than that of crustaceans. If their importance has not been previously recognized it is perhaps due to the fact that the majority of species produced (i.e. cockles, clams, mussels, etc.) are locally consumed instead of being exported, or (in the case of mussels) are being used as food for ducks (e.g. Thailand). Possibilities for further expansion exist, in particular of high value species like oysters.

THE SOUTH CHINA SEA AND  
ADJACENT WATERS

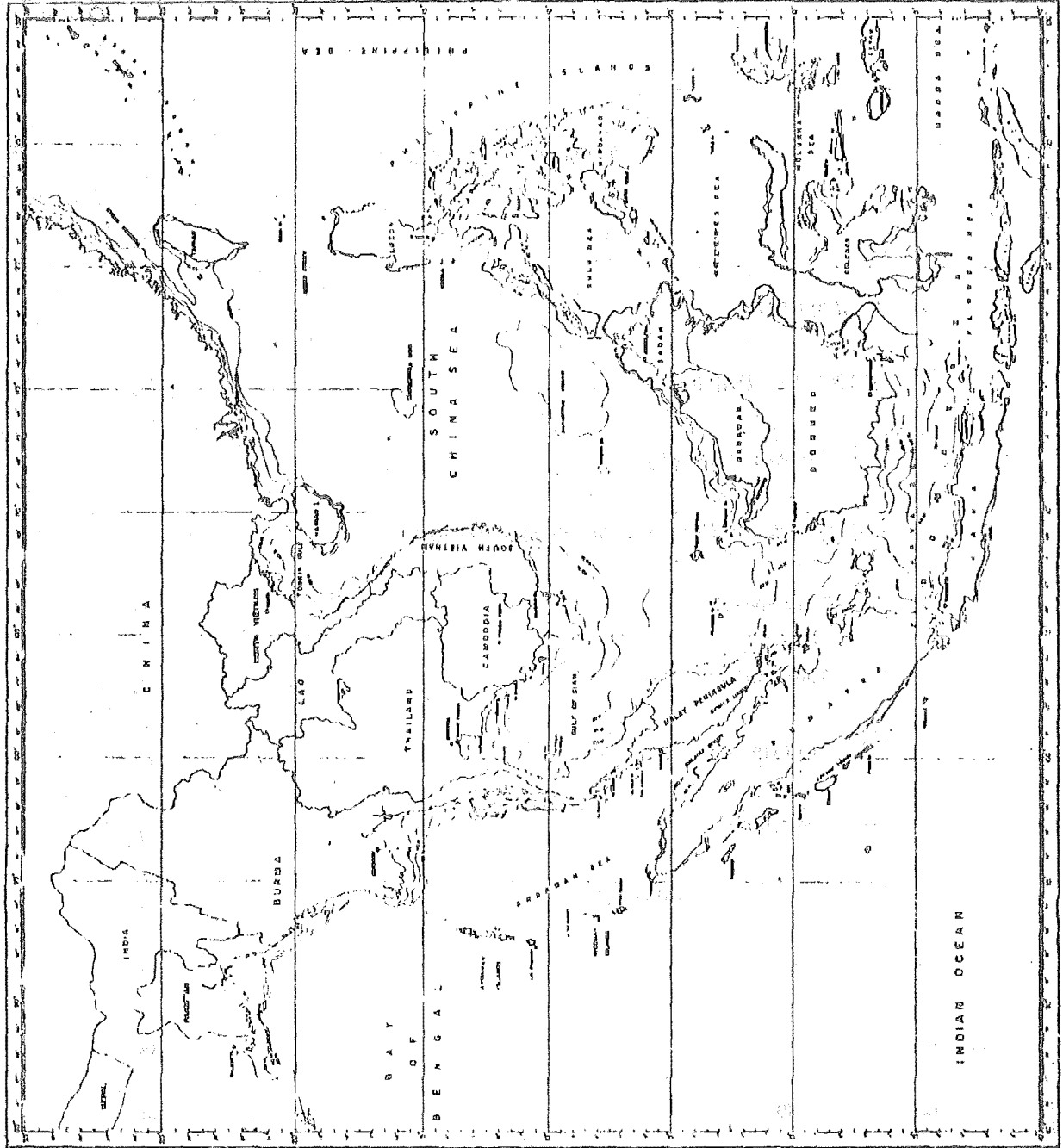


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THE CRUSTACEAN RESOURCES AND RELATED FISHERIES  
IN THE COUNTRIES BORDERING THE SOUTH CHINA SEA

by

M.N. Mistakidis

1. INTRODUCTION

The crustacean resources of the countries in the South China Sea area are of considerable importance (Longhurst, 1971). On the basis of data from the FAO Yearbook of Fishery Statistics, the 1971 shrimp production of the countries covered by the South China Sea Project was about 260 000 t, a quantity which represents more than 25 percent of the world shrimp and prawn production (943 000 t). As indicated in the country reviews, not all the shrimp landed are penaeids or carideans, but they sometimes include a considerable percentage of small-sized shrimp (Acetes, Sergestes) or mysids, utilized for shrimp powder or paste.

To satisfy development and management requirements of the South China Sea Development and Coordination Project, an attempt has been made to compile and evaluate the available national and international information on the crustacean resources and related fisheries in the area covered by the project. In this area there also exist important molluscan fisheries, in particular for mussels and cockles, and considerable activity in crustacean and molluscan aquaculture; information on production and current practices in these activities are included in this report.

While there is considerable published information on the biology of some species (particularly penaeid shrimp) supporting important fisheries in the region, analytical studies of catch rates, fishing effort, species composition in the catches, size distribution, etc. are very limited. When such information and data are available they normally refer to restricted periods of time, and thus their usefulness is limited in assisting predictions on future trends, or in providing an interpretation to short and long-term fluctuations.

The review is based on published information and data, discussions held with authorities concerned in fisheries research or administration, and on personal observations made during travel in the area from 22 July to 7 September, 1973. To obtain information on international fishing activities a brief visit was made to Japan.

2. STATUS BY COUNTRY

2.1 Malaysia (West)

2.1.1 Crustacea

The production of crustacea, particularly penaeid shrimp, is of considerable economic importance in West Malaysia since their export value is 50 percent or more of the total for fishery products. In 1971 the net earnings of foreign exchange from shrimp exports amounted



to M\$ 62.7 million, of the total of M\$ 118.7 million (U.S.\$ 56.5) for all fishery products.

The commercially exploited crustacean resources can be divided into four groups: 1. penaeid shrimp (*Penaeus* spp., *Metapenaeus* spp.), 2. sergestids (small brackish water shrimp, *Acetes* spp.), 3. crabs (*Portunus pelagicus*, *Scylla serrata*), and 4. the giant freshwater prawn (*Macrobrachium rosenbergii*). The following marine landings of these groups were recorded during 1971 (in metric tons): penaeid shrimp 48 470, *Acetes* 5 680, crabs 1 610, and *Macrobrachium* 75. In addition 310 tons of *Macrobrachium* were caught in freshwater.

Shrimp - The expansion of the marine shrimp fishery has been rapid. During a period of 10 years, 1963 to 1972, shrimp production quadrupled, while the percentage in relation to the total marine production increased from 6.6 to 15.2 (Table 1).

Table 1  
Total marine fishery landings, landings of shrimp,  
and percentage of shrimp landings compared to total marine landings,  
West Malaysia, 1963-1974.  
(in tons)

Year Landings	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Marine species	183 636	192 158	198 607	236 607	301 856	339 482	297 840	294 296	317 973	306 379
Shrimp	12 088	13 600	14 792	16 784	24 998	28 757	31 280	40 664	48 469	39 113
% shrimp to total marine landings	6.6	7.1	7.4	7.0	8.3	8.5	10.5	13.8	15.2	12.8

The main shrimp resources of West Malaysia are on the west coast, from the most northern province, Perlis, to the most southern, West Johore. Shrimp production from the east coast is comparatively small, not having surpassed 3 120 tons over a period of seven years (1965-71). This is due to the scarcity of the resource, the small size of fishing communities, the lack of ports and road or rail communications with the west coast, and the extended and unprotected coast exposed to the northeast monsoon.

On the west coast the most important shrimp-producing provinces are Perak, Selangor and Penang, in that order; on the east coast, East Johore. A variety of fishing gear are employed: stakes, seine nets, drift/gillnets, push/scoopnets, bagnets, and trawls. During 1970 and 1971 more than 50 percent of the shrimp landings were made by trawlers. Prior to 1969 landings by seines and bagnets were equal or higher than those by trawl nets.

Shrimp production increased substantially each year of the past decade except in 1972, when landings dropped by approximately 10 000 t (Table 1).

Species composition

Production data are obtained from fishermen, cooperatives and dealers on the weight of shrimp landed and the gear employed. The records do not identify the species of shrimp involved, and it is thus not possible to observe short or long-term fluctuations in abundance

of the important commercial species. Furthermore, there is no regular sampling at the landing ports on size distribution, so no analysis can be made of the possible effects of fishing on the stocks. The Fisheries Division of the Ministry of Agriculture and Fisheries is placing considerable emphasis on improving the collection of statistics. Such data are required to assist in stock assessment, but it will be difficult to collect the information.

According to Lee (1970), who conducted a sampling survey in ten states of West Malaysia, there are 28 species and 6 genera of penaeids caught by commercial gear. The most important genus was Metapenaeus; followed by Parapanaeopsis and Penaeus. Three of the seven species of Metapenaeus (M. lysianassa, M. brevicornis and M. mutatus = M. affinis) were commercially important; Parapanaeopsis coromandelica and P. hardwickii were the most important of that genus, while five others were minor; for Penaeus the most abundant species was P. merguensis, followed by P. indicus. The occurrence of Trachypenaeus, Metapanaeopsis and Solenocera was relatively rare.

Lee (1970) indicated the general distribution of penaeid shrimp in West Malaysian waters and provided an analysis of the distribution by gear types. He reported that all except one of the 28 species recorded were caught by otter trawls, while other gears caught fewer.

Crabs - Crab production increased at a rather slow rate until 1969; after that year production declined.

Table 2  
Landings of crabs, West Malaysia, 1965 to 1972  
(in '000 tons)

Year	1965	1966	1967	1968	1969	1970	1971	1972
Landings	1.5	2.0	2.3	2.2	2.6	2.1	1.6	1.4

Since statistical data do not differentiate between the two species landed it is difficult to assess whether this decrease is associated with one or both of them.

#### 2.1.2 Mollusca

Molluscan shellfish are of relatively minor importance in Malaysian catches with the exception of the cockle (Anadara granosa). The production of cockles amounted to about 28 000 t in 1971, and was obtained from 1 200 ha of coastal mud flats on the west coast, principally in the province of Perak. Two oyster species (Crassostrea rivularis and C. cucullata) occur in some localities of Johore, Melaka (Malacca) and Penang, but production is low.

### 2.2 Malaysia (East)- Sabah and Sarawak

#### 2.2.1 Crustacea

Data on crustacean production were provided by the Fisheries Division at Kuala Lumpur. Shrimp landings in Sarawak during the four years 1968-71 were approximately 2 830, 4 640, 1 430 and 2 320 tons respectively, suggesting a declining production. During the same period total marine landings were almost stationary, the quantities varying between 13 700 to 14 200 tons. No information was available on the species composition of the shrimp catch.

More detailed information was available on shrimp production and the number of vessels engaged in the fishery at Sabah, whose marine fisheries are more important than those of Sarawak. During 1970 and 1971 the total production, including shrimp and freshwater fish (the latter amounting to about 1 000 tons annually) was 26 600 and 27 300 tons respectively. In the same years shrimp landings were 4 360 and 5 400 tons, or approximately 17 and 19 percent of the total landings.

The most productive shrimp fishing grounds are on the east coast, particularly off Sandakan. Landings by trawlers in Sabah are given in Table 3.

Table 3  
Shrimp landings by trawlers, Sabah, 1962-71  
(in tons)

Year	East Coast	West Coast	Total
1962	209	-	209
1963	813	103	916
1964	761	151	912
1965	1 353	306	1 659
1966	2 191	216	2 407
1967	2 982	160	3 142
1968	3 050	226	3 276
1969	2 377	200	2 577
1970	2 638	224	2 862
1971	3 669	136	3 805

The introduction of the otter trawl to Sabah was made as early as 1951, but this gear was not generally adopted for shrimp fishing until the early sixties. From 1961-1965 the number of shrimp trawlers increased from 7 to 135. Since then more vessels have been added to the fleet, as can be observed from Table 4; from 1968 the number stabilized at about 300.

Table 4  
Number of trawlers engaged in shrimp fishing, Sabah, 1965-1971

Region	1965	1966	1967	1968	1969	1970	1971
West Coast	17	16	29	33	30	32	30
Sandakan	108	125	173	268	260	237	242
Tawau	10	11	19	14	22	25	29
Total	135	152	221	315	312	294	304

The largest number of trawlers operated from Sandakan, and landings were greatest at that port (Table 5).

Table 5  
Shrimp landings by trawlers, Sabah, 1967-71  
(in tons)

Region	1967	1968	1969	1970	1971
Brunei Bay (West Coast)	160	226	200	224	136
Sandakan	2 912	2 998	2 294	2 568	3 526
Tawau	<u>70</u>	<u>52</u>	<u>83</u>	<u>70</u>	<u>143</u>
Total	<u>3 142</u>	<u>3 276</u>	<u>2 577</u>	<u>2 862</u>	<u>3 805</u>
Average catch/ vessel/year	(16)	(11)	(8)	(10)	(14)

In the absence of data on the size of the trawlers or of the trawls used (single or double rig, length of head rope), or of fishing times, it is difficult to calculate catch rates. However, the average annual catch per vessel during the period 1967-71 ranged from 8 to 16 tons (highest in 1967, lowest in 1969).

The survey of 118 shrimp trawlers in 1966 showed that about 75 percent of the vessels were from 9-14 m long, and were powered by engines from 4-225 hp (Kong and Keng, 1966).

Shrimp are also caught in Sabah by a variety of other gears; the annual quantities during 1967-71 were estimated to be between 1 200 and 1 600 tons (Table 6).

Table 6  
Shrimp landings in Sabah by trawlers and other fishing gears, 1967-71  
(in tons)

Year	By trawlers	By other gears (estimated)	Total
1967	3 142	1 600	4 742
1968	3 276	1 600	4 876
1969	2 577	1 200	3 777
1970	2 862	1 500	4 362
1971	3 805	1 600	5 405

Species composition - Information is lacking on species composition of shrimp landed in Sarawak. However, Kong and Keng (1968) recorded 22 species from various localities around Sabah; seven of these (Panaeus indicus, P. merguensis, P. monodon, P. semisulcatus, Metapanaeus ensis, M. affinis and M. brevicornis) formed the major part of the catch, and the first two were caught in the greatest quantities.

General considerations - Shrimp production in West Malaysia has increased rapidly during the last five years, except for 1972 when production dropped by almost 20 percent (Table 1).

Surveys were made by two research vessels of the Fisheries Division to assess the demersal fish resources of the shelf bordering both West and East Malaysia. These indicate that the trawl fishery, particularly in the northern part of the Malacca Strait, has probably attained the maximum level of exploitation. The surveys showed, however, that there exists a good potential for the development of trawl fisheries in East Malaysia and on the east coast of West Malaysia (IPFC, 1972). A trawling survey of brief duration conducted by the Fisheries Division on the upper continental slope, north of the Malacca Strait for deep sea shrimp resources, did not produce conclusive results.

Reference was made by individuals in Malaysia during the course of this survey to the "disappearance" or scarcity of shrimp concentrations on the east coast of East Malaysia during a particular period of the year. It was suggested that this phenomenon be investigated, in view of a possible further development of the shrimp fishery. It is likely that the observed seasonal fluctuations are due to the effect of the monsoons. Lee (1970) reported that the peak catches along the east coast of East Malaysia are made during the latter half of the northeast monsoon, and he felt that there was a strong correlation between a production of shrimp and the monsoons. Kong and Keng (1966) reported that in Sabah heavy rain and strong wind result in poor catches, with an improvement in catches at the termination of the monsoon. If the displacement of the shrimp shoals on the east coast of East Malaysia is not pronounced (Kong and Keng observed a displacement of 9-11 m deep after a two-day heavy rain in Sabah), and the weather conditions do not prevent fishing operations, efforts should be made to locate the grounds to which the shrimp concentrations are temporarily displaced.

Well planned exploratory surveys should be conducted in the deep waters off the east and west coasts of West Malaysia, and off Sarawak and Sabah, to ascertain the abundance and density of deep sea crustacean resources. In any case, the existing stocks of marine and estuarine crustaceans require careful evaluation and assessment for management purposes.

The Government is spending considerable effort to intensify the research programme on the experimental culture of Macrobrachium rosenbergii. The new hatchery/laboratory at the Marine Fisheries Research Institute, Glugor, Penang, planned initially for the rearing of M. rosenbergii and later of penaeid shrimp, is almost completed, at the cost of about U.S.\$ 100 000. The hatchery has been designed to produce between 1 - 2 million juveniles for distribution to governmental stations (Bukit Tinggi Fish Breeding Station, near Kuala Lumpur, and the Freshwater Fisheries Research Station (MARDI) at Batu Berendam, Malacca) and to private operators. The Government has also selected 65 acres of land at Gelang Petak, Johore, for the establishment of a Brackishwater Fishculture Station. The total cost of the programme has been estimated at about U.S.\$ 220 000. In view of the great potential for shrimp production in the extended tracts of coastal mangrove areas, this project has been given high priority. The annual harvest of penaeid prawns from the traditional trapping ponds is estimated to be between 250 and 300 tons, from about 350 ha.

The molluscan shellfish industry was not carefully examined during this survey, but since areas suitable for raft culture are apparently limited to West Malaysia, efforts should be made to experiment with other techniques of oyster cultivation. It would appear from the coastal configuration of Sabah that a number of enclosed bays might be suitable for oyster or mussel raft culture. The transport of the final product to West Malaysia will raise a number of problems, but it might be that frozen oysters could be exported to international markets.

The cockle fishery appears to have stabilized at an annual production of about 28 000 tons during the past five years. The prospects for expansion are limited unless new market outlets are found. One of the constraints to their sale in foreign markets is the red colour of the meat, and improvement of its appearance requires processing expertise.

The Government has become aware of the pollution problems, i.e., silting of rivers from tin mining operations; discharge of inorganic materials from rubber, food and canning factories, and textile mills; use of pesticides, etc., and the possible effect of this on fisheries, in particular aquaculture. The responsible authorities are preparing to monitor and control the quality of the water.

## 2.3 Singapore

### 2.3.1 Crustacea

The crustacean production of Singapore is small in comparison with that of other countries in the waters covered by the Project. Prior to 1970 the statistical reports did not differentiate among the groups of crustacea landed, but since that year the data have improved. Presently the information gathered includes landings and value by species, but the amount of fishing effort is not reported. The production of crustacea in 1970, 1971 and 1972 is given in Table 7. During the same years the total fish production (inland, inshore and offshore) varied between 18 300 tons in 1970 and 15 700 tons in 1972. Inland production in 1970, 1971 and 1972 amounted to 866, 917 and 865 tons respectively.

Table 7

Crustacean production, Singapore, 1970-72  
(in tons)

	1970	1971	1972
<b>SHRIMPS</b>			
<u>Penaeus</u> spp. (large)	121	148	218
<u>Penaeus</u> spp. (medium)	789	563	443
<u>Metapenaeus</u> spp. (small)	1 007	590	622
<b>CRABS AND LOBSTERS</b>			
<u>Thenus orientalis</u> shovel-nosed lobster	53	25	188
<u>Panulirus</u> spp. spiny lobster	11	2	126
<u>Scylla serrata</u> mangrove crab	-	12	125
<u>Neptunus pelagicus</u> swimming crab	-	25	215
<b>Total</b>	<b>1 981</b>	<b>1 365</b>	<b>1 937</b>

Although the data available do not cover a long enough period to permit trends in shrimp landings to be observed, it will be noted that there was a considerable increase in the landings of crabs and lobsters in 1972. The mangrove crab is normally caught very close to the coast, but the remaining species in this group occur in deeper waters, and were probably taken by the mechanized fleet which has been extending its operations in offshore waters.

Precise information is lacking on shrimp production from farming activities. In the past there existed large areas of ponds for brackishwater cultivation of shrimp, but the high cost of land, increasingly utilized for industrial development, public housing schemes, reservoirs, etc. caused the traditional culture of shrimps to become uneconomic. The area of shrimp ponds in 1971 was 465 hectares. With an average yield of about 350 kg/ha/year, the production is estimated to be about 160 tons per year.

Species composition - Shrimp are classified according to size but not by species in the landing reports. According to published literature (Tham, 1968, 1968a) the species most commonly found in shrimp catches (not in order of importance) are Penaeus indicus, P. merguensis, P. semisulcatus, Metapenaeus brevicornis, M. ensis, M. burkenroadi, M. lysianassa, Parapenaeopsis tenella, Metapenaeopsis barbata and Trachypenaeus spp. During the northeast monsoon a variety of species belonging to the genus Acetes are caught in considerable quantities in coastal waters. The above shrimp species are also found in the shrimp ponds, and in addition P. monodon occasionally occurs.

General considerations - The existing fishing grounds have been subjected to heavy fishing effort, and it is doubtful whether crustacean production by Singapore will increase unless new grounds are located in the South China Sea, or shrimp culture activities are intensified. Exploratory surveys conducted by the R.V. CHANGI of the Southeast Asian Fisheries Development Centre (SEAFDEC), based at Singapore, have not so far discovered any new shrimp grounds. During the survey cruise No. 4, April-May 1972, when 20 hauls were made within the area bounded by 05°15'-02°45'N and 114°30'-110°45'E (off Sarawak), shrimp comprised only 2.5 percent of the mean catch of 98 kg/h. On two stations the shrimp catches were 4.5 and 5.6 kg/h but in most areas it was only about 1 kg/h. During another survey in April 1973, when 35 hauls were made off the coasts of Sarawak and Sabah in the area of 06°40'-03°28'N and 116°20'-112°40'E, and in depths varying between 32 and 77 m, the total shrimp catch was 22.6 kg (total fishing time 44 h 25 min). In addition, a variety of fish and cephalopods were taken (total weight 8 040 kg), including 100 kg of shovel-nosed lobster.

The Government of Singapore, through the Primary Production Department, is making every effort to increase the intensive culture of high-value species. A multi-purpose hatchery for the mass production of juveniles of Macrobrachium rosenbergii and penaeid shrimps is under construction in the grounds of the present Research Station at Changi Point; eight tanks have been constructed at a cost of Sgp.\$ 85 000, and six more, 6 x 8 x 2 m, will be built. Suitable land for pond culture experiments has been purchased at Tampinic, at a cost of Sgp.\$ 900 000 (U.S.\$ 428 000).

### 2.3.2 Mollusca

The molluscan resources of Singapore are negligible, but attempts to culture oysters (Crassostrea cucullata) and mussels (Mytilus smaragdinus) have recently been initiated.

### 2.4 Indonesia

Although the activities of the South China Sea Fisheries Development and Coordinating Programme cover only part of this country, some information is given on the crustacean and molluscan resources of the entire country.



#### 2.4.1 Crustacea

Shrimp production by Indonesia in 1971 represented 76 percent of the total export value (U.S.\$ 18 million) of seafood. Despite this, and the fact that there has been a shrimp fishery over a long period of years, no reliable landing data are available, except from the joint ventures in the Kalimantan and West Irian regions.

According to Unar (1973) most of the penaeid landings are from the east coast of Sumatra, Kalimantan and Java, the coastal areas facing the Indian Ocean being relatively unproductive. However, the new fishing grounds in the Arafura Sea (West Irian) are considered to be the best in the eastern region of Indonesia.

Shrimp production from marine and estuarine fisheries in recent years has been estimated at 30 000 tons annually (Unar, 1973). According to official records, production in 1971 amounted to 46 797 tons, of a total fishery production of 1 244 555 tons (marine 820 447, freshwater 424 108 tons). It is not known whether the 46 800 tons include sergestids and mysids (locally known as rebon), which form an important part of the production.

According to the information provided by the Department of Fisheries, Djakarta, the shrimp production for 1971 by regional districts was as shown in Table 8.

Table 8

Shrimp production, Indonesia, 1971  
(metric tons)

Sumatra	29 963
Java	2 834
Kalimantan	6 194
Sulawesi	4 885
Nusatenggara (Lesser Sunda Islands)	304
Maluku	2 452
West Irian	165
Total	46 797

Considering that statistical data are incomplete in many provinces, this table shows that Sumatra has considerable shrimp resources. Shrimp landings are unequal along the east coast of Sumatra: in 1971 the majority of the landings (15 910 tons) were made in the province of Riau, in the central part of the island, followed by the province of Sumatra Utara, northwest of Riau (9 040 tons). Smaller quantities were landed at Aceh, at the extreme north tip of the island (1 230 tons); at Jambi, south of the province of Riau (1 085 tons), and at Lampung, at the extreme south tip of Sumatra (1 690 tons). Other landings were made at Sumatra Selatan (800 tons), and at the two provinces in the west coast, Sumatra Barat (155 tons) and Bengkulu (50 tons).

Information on the number of vessels operating and gear used on the east coast shrimp fishery at Sumatra is given by Unar (1973): the number of trawlers in the province of Riau and in the north Sumatra provinces bordering the Malacca Strait increased from 8 in 1966 to 830 by the end of 1971. The majority of these were flat wooden sampan-like trawlers of the 5-20 GT class. Some modern double-rigged trawlers of the 40-100 GT class were also introduced into the fishery, but due to decreased catches about 50 vessels have been transferred to the north coast of Java. Another Japanese-owned fleet of 26 small-sized shrimp trawlers has also transferred its operation to Kotaburu (East Kalimantan), owing to the low catches of about 5 tons (heads-on) per vessel annually. In 1971 seven vessels were still operating in the Jambi area, their total shrimp catch being about 48 tons.

According to Unar (personal communication), the number of vessels operating from the northern point of Sumatra to Jambi (but not necessarily engaged in the shrimp fishery) were as shown in Table 9.

Table 9

Number of fishing vessels operating from the northern point of Sumatra to Jambi, 1970 and 1971

	1970	1971
Sailing vessels	25 771	28 079
Motorized (from outboard to inboard motors, and from 5 to 100 GT)	3 661	3 661
Total	29 432	31 740

During the same years the total marine fishery production of Sumatra was 289 000 and 304 830 tons respectively.

Except for isolated figures on fishing effort, usually provided by foreign companies, details on landings by species or fishing gear are lacking.

According to Unar (personal communication) the majority of the shrimp catches on the east coast of Sumatra are derived from tidal traps, particularly in the Bagan Siapiapi area, (opposite Malacca); trap fishing extends from Pangkalanberandan (approx. Lat. 4°N) to about Point Lumut (approx. 3°30'S). Based on very incomplete information the estimated catch by tidal traps and other fishing methods (bottom gillnets, Danish seines, etc.) is about 50-60 percent of the total, the remaining shrimp production being derived from the trawl fishery.

Information on the exploitation of other crustacean species in Sumatra is lacking. However, there is some production of Macrobrachium rosenbergii, in particular from the Palembang area in southeast Sumatra. During 1973 exports to various markets in Europe, North America, Singapore, Hong Kong and Tokyo amounted to about 1 420 tons. Undoubtedly the overall production of M. rosenbergii must be considerably higher. Various species of spiny lobsters are also found, mainly on the south coast, but no production figures are available.

Species composition - In the absence of detailed information on catches and landings, data on catch by species were also lacking. According to Unar (personal communication) the principal species taken in Sumatra are Penaeus merguensis (Udang kelang), P. indicus, Parapenaopsis subtilis and P. gracillina, Metapenaeus brevicornis (U. badjang), Solenocera subnuda (U. merang), Palaemon spp. (U. batu), Alpheus spp. (U. duri or U. pletok) and Sergestes spp. The latter are taken in huge quantities at Bagan Siapiapi.

Mollusca - The most important and commonly occurring mollusc on the east coast of Sumatra is the edible cockle, Anadara granosa (Kerang darah). Two other species of Anadara occur in various localities of Indonesia, A. inflata (K. bulu) and A. antiquata (K. gelatik), but their geographical distribution is not well known.

With the exception of cockles, which are consumed locally and exported to Singapore, there is very little exploitation of molluscs in Sumatra. The most important area on the east coast is Panipahan. During 1967 the amount of cockles destined to other markets on the island (Bengalis, Dumai, etc.) in fresh or salted condition, amounted to 40 tons.

General considerations - Despite the non-availability of landings, catch rates or fishing effort from the shrimp fisheries in Sumatra, it is believed that shrimp production has become stabilized, particularly after the recent transfer of a number of trawlers to the north coast of Java and east Kalimantan. The Indonesian Department of Fisheries is aware of the desirability of increased data to serve as a basis for management decisions, but owing to the lack of resources these cannot be made available soon.

It is difficult to judge whether the shrimp production of Sumatra will increase. The Department of Fisheries is conducting a shrimp/demersal fish exploratory survey in the Malacca Strait bordering three provinces. The operation is scheduled to last six months, and employs two shrimp trawlers, one of 50 and the other of 150 GRT, both equipped with the Gulf of Mexico shrimp gear. It is also expected that a demersal survey will be conducted jointly by the Marine Fisheries Research Institute, and that a German group will investigate the shrimp resources from Sumatra to the Java Sea, and the southern part of the South China Sea. It appears that some areas of Sumatra have not been properly explored, northwest of Tanjungbalai. Grounds in deep waters might provide new resources. It is also possible that production could increase if the present fleet becomes more efficient, in particular with regard to the gear employed. But if this happened, it might be necessary to decrease the number of small-sized vessels, thus creating socio-economic problems to the coastal fishing communities.

In Sumatra there are great possibilities for the culture of penaeid shrimp in the extensive tidal swamps, and of M. rosenbergii. According to Larimore (1973) in only one area of south Sumatra (Palembang) there exist 100 000 ha of tidal swamps and estuaries suitable for milkfish and penaeid shrimp culture. Technical assistance was recommended to be given by the UNDP/SF Brackishwater Shrimp and Milkfish Culture Research and Development Project at Jepara for aquaculture development in this area. It was also recommended that the production of Macrobrachium be increased through aquaculture, due to the great demand for this commodity in foreign markets. The existing stocks in the Palembang area need to be conserved.

Undoubtedly there exist other resources (crabs and clams) in Sumatra, but their potential is unknown. The east coast of Sumatra does not appear to possess suitable areas for the cultivation of molluscs (in particular oysters) due to the considerable run-off from rivers into the estuaries, but well adapted localities exist in Java and in the Celebes, and the Department of Fisheries is interested in promoting such projects. Some experimental trials will be carried out on oyster culture with C. cucullata in Banten Bay, west of Djakarta. Similar trials were also initiated several years ago near Semarang, East Java, but the results were not promising.

Whatever the prospects for oyster cultivation are, the authorities should consider the hygienic and sanitary aspects involved, particularly if the products are destined for export.

## 2.5 Philippines

### 2.5.1 Crustacea

There is considerable disparity between figures for crustacean production (particularly shrimp) in the FAO Yearbooks of Fishery Statistics and those in Fisheries Statistics of the Philippines 1971, issued by the Bureau of Fisheries, Manila. The two sets of figures for 1967 to 1971 are given in Table 10.

Table 10  
Crustacean production of the Philippines based on  
FAO and Bureau of Fisheries data, 1967-71  
(in metric tons)

	1967	1968	1969	1970	1971
<u>FAO Yearbook of Fishery Statistics</u>					
Shrimps and prawns	24 000	21 500	23 500	21 400	27 900
Misc. marine crabs	3 200	9 200	4 800	5 800	3 800
<u>Fisheries Statistics of the Philippines 1971</u>					
Prawns	-	-	42	11	18
Shrimps	11 700	11 285	10 970	10 380	12 700
Crabs	1 570	4 670	2 180	2 705	1 740

The figures provided by the Bureau of Fisheries are lower probably because they are based on the operations of the "commercial" fishing vessels only, and do not include the production of the "municipal fisheries", or sustenance fishing. In the Philippines vessels under 3 GT in size are under the jurisdiction of the municipalities, and these "municipal fisheries" are treated separately from the so-called "commercial fisheries". The total quantity of fish and invertebrates produced in 1971 was 1 023 095 tons, and the breakdown was as follows: commercial fishing 382 276, fish ponds 97 915 and municipal fisheries and sustenance fishing 542 904 tons. Production by the municipal fisheries and sustenance fishing is therefore substantial. Better landing figures for the municipal fisheries are urgently required.

Production figures suggest that shrimp production had stabilized by 1971. The value of shrimp is high; in 1971 shrimp accounted for about 50 percent of the total value of 40 million pesos of exported fishery products (IPFC, 1972a).

Crab production was mainly Portunus sp. The mangrove crab, Scylla serrata, is also harvested but production figures are not available. Some quantities of spiny lobsters (Palinurus longiceps) are being landed, but no detailed records are available. Lobsters are taken by spearing, and although traps had been tried the results obtained were not promising.

Production of freshwater prawns was about 30 000 tons annually during the period 1969-71 (FAO Yearbook of Fishery Statistics 1971), but detailed information on the species involved was not available from the Bureau of Fisheries. Although the giant freshwater prawn Macrobrachium rosenbergii, occurs in many rivers and their estuaries, particularly in central Luzon and Mindanao, it is doubtful if the above production is based on this species, but instead on the smaller Macrobrachium lanceifrons (hipontagunton), (which is one of the important aquatic resources of Laguna de Bay) and to a lesser extent on Caridina gracililostriis. According to Rasalan, Delmendo and Reyes (1969) the prawns caught in Laguna de Bay are used as food for ducks and as a dried product as human food. It has been reported that in the early sixties the catch from the lake was about 1 t/ha/year, but after a few years there were signs of reduced productivity.

The lack of detailed information on shrimp catches and fishing effort is due to the absence of an organized shrimp fishery. The landings of shrimp (and crab) are by-catches of the trawling fleet. However, information on production by gear is available for 1971 in rounded figures in tons (Table 11).

Table 11  
Production of shrimps, prawns and crabs, by gear,  
in the Philippines, 1971  
(in tons)

	Bagnet	Beach Seine	Purse Seine	Otter Trawl	Total
Shrimps	120	2	6	12 575	12 703
Prawns	-	-	-	18	18
Crabs	3	-	-	1 737	1 740

During the period 1967-71 the number of these gear employed (but not necessarily totally engaged in shrimp fishing) was as shown in Table 12.

The Fisheries Statistics of the Philippines show the fishing grounds used by commercial fishing vessels, and their catches of fish and shrimp. The most important grounds for shrimp are listed in Table 13, with landings of shrimp for 1970 and 1971, and of crabs for 1971.

In an additional 11 fishing grounds shrimp production in 1971 was less than 100 tons each, the quantities varying between 2 and 92 tons; among these is the Lingayen Gulf, where 17 tons of prawns were caught.

Table 12

Number of gears employed in fishing in the commercial fisheries of the Philippines, 1967-71

	Bagnets	Beach Seines	Purse Seines	Otter Trawls
1967	1 002	45	197	593
1968	883	44	202	653
1969	796	41	253	667
1970	858	49	245	653
1971	743	35	265	652

Table 13

Production by commercial fishing vessels of shrimp (1970 and 1971) and crabs (1971) by fishing grounds, in the Philippines (in metric tons)

	Shrimp		Crabs
	1970	1971	1971
Visayan	3 717	4 533	1 134
Sulu Sea (Patawan waters)	2 736	3 579	2
Manila Bay	1 354	1 325	22
San Miguel Bay	1 016	1 131	-
Guimaras Straits	246	410	8
Ragay Gulf	205	341	-
Samar Sea	627	322	-
Tayabas Bay	48	197	2
Capiz Coast	118	163	9
Iloilo Strait	27	140	1
Panay Gulf	38	100	-

Species composition - Good information on species occurring in the catches is lacking, but the following species were reported to be important: Penaeus monodon, P. merguensis, P. semisulcatus, P. latissulcatus and Metapenaeus monoceros. Species of Metapenaeopsis and Trachypenaeus also occur in small quantities. Small catches of Penaeus japonicus have been recorded from some areas; Atya spp. are being taken by push nets in coastal areas.

2.5.2 Mollusca

Production figures of molluscs are not available, although it is known that oysters and mussels are being farmed in Bacoar Bay (Cavite), near Manila and oysters are raised in the Lingayen Gulf (Pangasinan, Luzon) and at Gubat (Sorgoson) southeastern Luzon. The distribution of the mussel (Mytilus smaragdinus) is wide, but the abundance varies from locality to locality. The cultivation of Paphia sp. and Arca sp. is being carried out at Binakayan, Bacoar Bay (Blanco, 1973). The Fisheries Statistics of the Philippines (1971) provide detailed data on the quantity, value and origin of shells by month: capiz (kapis) or window pane oyster (Placuna placenta), mother-of-pearl (Pinctada maxima), snail and troca (? (Trochus sp. ?) (Table 14).

Table 14  
Production of shell products, 1967-71  
 (in metric tons)

	1967	1968	1969	1970	1971
<u>Shells</u> <sup>1/</sup>					
Capiz	2 762	2 315	2 041	520	24 008
Mother-of-pearl	267	303	132	373	211
Snail	10	4	3	8	4
Troca	51	45	24	164	142

1/ Quantity excludes meat parts

The most important localities of capiz production are Negros Occidental, Iloilo, Capiz, Misamis Occidental and Rizal, of troca, Cebu and Manila. The value of exported shells, in raw or finished form, is significant; 1971 it amounted to 4.3 million pesos, or about one fifth of the exported value of shrimp and lobster products.

Oyster and mussel production - Seven species of oysters occur in the Philippines: Crassostrea iredalei, C. malabonensis, C. palmipes, C. lugubrius, C. amasa, C. echinata and C. tuberculata (Carreon, 1969). Of these the first three are the most important (Blanco, 1973).

Information on the cultivated areas and on mussel and oyster production in Bacoar Bay was provided during a brief visit to the Binakayan Oyster Station near Cavite, Manila (Table 15).

Oyster production in Bacoar was not available at Binakayan, but according to the Bureau of Fisheries, Manila, the area devoted to cultivation is about 500 ha and the total oyster production of Bacoar Bay is estimated at about 1.2 million kaings (baskets). The growth rates of cultivated oysters are good. C. iredalei, the most common oyster species, attains commercial size (5 to 6 cm in length) after six months, and 8 to 10 cm in twelve months. Yields of 3 000 to 4 000 kaings per ha/year (about 1 350 to 1 800 kg of oyster meat), are not uncommon. Oysters are sold at 12 pesos per kaing (controlled price) and at 14 to 15 pesos in the free market, but occasionally up to 22 pesos (U.S.\$ 1 = 6.7 pesos). Mussels are sold at about 5 cm in length, usually attained after 4 to 5 months; it is quite possible to obtain 2 to 3 harvests annually.



Table 15

Area under oyster cultivation and production of oysters,  
Bancoor, Kawit and Cavite City, 1972

	Bancoor		Kawit		Cavite City	
	Area (ha)	Quantity (with shell)	Area (ha)	Quantity (with shell)	Area (ha)	Quantity (with shell)
Mussels	122.2	953 160 gall	23.5	183 300 gall	10	78 000 gall
Oysters	-	-	132	132 000 baskets or kaings <sup>1/</sup>	22	22 000 baskets or kaings <sup>1/</sup>

<sup>1/</sup> 1 kaing = 10 gall (with shell) or approximately 1 gall of shucked meat (about 4.5 kg)

The quantities of clams (*Paphia* sp.) harvested during 1972 at Halaan, Bancoor Bay, amounted to 169 000 gallons (with shell), derived from an area of 35.5 ha.

General considerations - Since no shrimp fishery as such exists in the Philippines, and data on catches related to fishing effort are not available, it is difficult to determine probable future production trends. Also, information is lacking on the relative abundance of species in the catches, the extent of presently exploited grounds, the productivity or the seasonal variations in catch. There have been no recent exploratory surveys to locate new grounds. No doubt production will increase somewhat as new areas come under exploitation (although the shelf areas around the numerous islands are not extensive) and through increased fishing effort.

Production will also increase through aquaculture practices, although not in the immediate future, since the stocking of the brackishwater milkfish ponds in which most shrimp are raised is mainly by natural processes, or through the procurement of fry from the wild. According to López (1973) there are about 500 000 ha of mangrove swamps, tidal flats and areas awaiting development. The Estuarine Fisheries Division is making a great effort to improve culture management practices, and plans are under way for the establishment of shrimp hatcheries. A private concern is constructing a hatchery at Batangas, near Manila, and hatcheries are near completion at Tigbanua, Iloilo (under the activities of SEAFDEC) and at Naawan, promoted by the University of Mindanao. The Bureau of Fisheries has also on-going projects in this field of activity, at Ozamis City, Mercedes (Camarines Norte) and at Tolosa, Leyte (López, 1973).

The potential of the spiny lobster is unknown, since no methodical surveys have been carried out.

The prospects for mussel, oyster and pearl culture are promising and the production of the first two can be increased manifold. Blanco (1973) estimates that the potential areas for oyster and mussel culture in Bancoor Bay, Manila Bay, Cebu Island, Northern Leyte and the coasts of Negros and Palawan aggregate to about 100 000 ha. To date there is no

deperation of the edible molluscs destined to internal markets, and any development progress, whether aimed for domestic or foreign markets, will have to include the establishment of cleansing stations.

## 2.6 Hong Kong

### 2.6.1 Crustacea

In spite of the rather limited water areas accessible to the fishing fleet of Hong Kong, its fish production is substantial. In 1972 landings were 121 700 tons, of which about 10 percent consisted of crustacea and about 8 percent of mollusca. The value of crustacean production (U.S.\$ 16.9 million) was about 24 percent of the total value of marine and fresh-water fishery products (U.S.\$ 69.8 million) in 1972.

Fishing operations are pursued principally in the waters of the adjacent continental shelf; in addition a considerable number of vessels operate as far as Hainan Island, approximately 300 miles southwest of Hong Kong. The fishing fleet consisted of 5 612 vessels in 1971, of which 86 percent were mechanized. They provided 92 percent of the marine fish consumed domestically, the balance being met by imports. The number of mechanized shrimp trawlers in the periods 1970-71 were 180 and 233 respectively. In 1971 trawlers contributed 67 percent of the total marine fish production (Nicholls, 1972). Catch and effort data for the crustacean production are lacking.

The principal component of the crustacean production is shrimp, followed by crabs (Scylla and Portunus spp.) and spiny lobsters (Panulirus spp.) (Table 16). Except for shrimp, no data are available over a long enough period of years to draw any conclusions on fluctuations.

Table 16

Landings of crustaceans in Hong Kong, 1971  
(in tons)

Shrimps	11 136
Shrimps (for sauce)	87
Crabs	1 097
Lobsters	169
Total	12 489

All marine fish (except fish sold alive) are required to be sold through the wholesale marketing organization (Fish Marketing Organization) administered by the Department of Agriculture and Fisheries. Catch figures for shrimp caught by local shrimpers and sold through the FMO from 1960 to 1972 are given in Table 17, as are figures for total shrimp catches for the period 1964-72.

It will be observed that with the exception of 1968 and 1969, when production increased slightly, shrimp landings have remained rather static since 1965. The quantities landed are not sufficient to satisfy the local demand, and during 1971 Hong Kong imported considerable quantities of shrimp and unclassified crustacea; some were re-exported (Table 18).

Table 17

Total shrimp landings (1964-1972) and landings of fresh shrimp sold through FMO, 1960-1972 (in metric tons)

Year	Total	FMO
1960		393
1961		414
1962		1 399
1963		915
1964	9 300	547
1965	10 557	621
1966	10 866	1 967
1967	9 728	552
1968	14 053	911
1969	13 038	824
1970	12 402	825
1971	11 136	985
1972	11 843	1 036

Table 18

Trade in shrimp and other crustaceans, Hong Kong, 1971

	Imports	Exports	Re-exports
Shrimps (fresh or chilled)	9 676	4 603	625
Shrimps (Salted or dried)	1 118	53	99
Crustacea (fresh or chilled)	2 021	295	107
Crustacea (salted or dried)	331	66	25

Source: Annual Department Report, 1972

In the absence of catch and effort data and information on the fishing grounds exploited it is difficult to determine the reasons for the slow growth in shrimp production during the past eight years.

Species composition - Information is lacking on the species composition in the crustacean landings in Hong Kong. However, many crustacean species occur in these waters. Most of the shrimp species recorded belong to the genus Penaeus (7), followed by Metapenaeus (5), Parapenaeopsis (2), Metapenaeopsis (2), Trachypenaeus (2), Solenocera (1), Acetes (1), Palaemon (1) and Macrobrachium (2). There are six spiny lobsters belonging to the genus Palinurus; the crabs belong to the genera Portunus (3), Charybdis (3), Scylla (1) and Eriocheir (1). The shovel-nosed lobster Ibacus ciliatus and Thenus orientalis, and species of the lobsterette Nephrops have been recorded.

### 2.6.2 Mollusca

The molluscan production of Hong Kong in 1972 was 10 300 tons (or 7 percent of the total landings), having a value of about U.S.\$ 4.9 million. Less than half were squids, cuttlefish and octopus, the remainder consisting of sea snails, clams, oysters, mussels and abalone.

Production of molluscs in 1960-73 is shown in Table 19.

Table 19  
Landings of molluscs in Hong Kong, 1969-72  
(in '000 tons)

	1969	1970	1971	1972
Squids and cuttlefish (fresh and salted)	4.4	4.3	3.7	4.7
Miscellaneous marine molluscs (fresh and salted)	4.7	5.6	6.1	5.6

Source: FAO Yearbook of Fishery Statistics

Data prior to 1969 are not available on miscellaneous marine molluscs, but records of landings and value of squid and cuttlefish sold through the Fish Marketing Organization are given in Table 20.

Production of sea snails and of clams amounted to 1 460 tons and 910 tons respectively in 1972; there is very little information on the species and areas of exploitation. Some information is available on oyster production, based on two species, Crassostrea gigas, and C. rivularis, the former predominating. The total area of oyster cultivation has been estimated to be about 6 000 acres, with the principal area being at Nam She Wai (Deep Bay).

Data on oyster meat production varied between 240 and 270 tons in the years 1962-65; it dropped to less than 100 tons in 1967, and after reaching 200 tons in 1968 it declined to 106 tons in 1972. Although no special studies have been made, it was stated that the decline was due to the scarcity of workers attending the farms, and to adverse environmental conditions resulting from pollution. The Fisheries Division is presently conducting experimental trials in a new area (Lantau Island). There are no sanitary controls for oysters sold fresh.

Table 20

Landings and value of fresh squid and cuttlefish sold through the  
Hong Kong Fish Marketing Organization, 1960-1972  
(in tons)

Year	Squids		Cuttlefish	
	Tons	H.K.\$ 10 <sup>3</sup>	Tons	H.K.\$ 10 <sup>3</sup>
1960	456	631	812	527
1961	691	1 146	326	463
1962	1 325	1 762	535	684
1963	1 201	1 899	742	879
1964	729	1 688	844	949
1965	955	2 094	420	618
1966	1 768	3 301	458	654
1967	1 134	3 167	583	1 013
1968	1 673	4 378	830	1 471
1969	3 053	6 934	706	1 409
1970	2 696	7 505	677	1 544
1971	1 956	6 401	661	1 663
1972	3 514	8 498	545	1 444

General conditions - It is not possible to state whether crustacean production, in particular of shrimp, will increase in the years to come. Any increase will depend on the discovery of new shrimp grounds, and in improvement of fishing gear.

In addition to fishing surveys on the continental shelf off the coast of south China, aimed to assess stock density and productivity of the region, the Fisheries Research Division has carried out catch-and-effort studies in the commercial trawling fleet, and exploratory fishing in new areas to identify fishery resources. During one exploratory cruise, March 1972, the Division's research vessel, CAPE ST. MARY, caught about 15 kg/h of shrimp at station D7 (117°E, 21°40'N) at a depth below 300 m. In another cruise, September 1972, 4.3 kg/h of shrimp were obtained at station B7 (114°10'E, 20°N), at 300 m depth. In both instances the shrimp species obtained had not been identified.

Some quantities of the shovel-nosed lobster (*Ibacus* spp.) were taken during the cruises made by CAPE ST. MARY during March 1972 to March 1973, using a 93 ft Granton trawl. Quantities from the different transects and stations varied between less than 1 to 35 (in numbers), or less than 0.01 kg to 3.08 kg/h. Generally the density was higher in deeper waters, from 180 to 275 m.

Quantities of squid and cuttlefish were also taken during the exploratory cruises on the north shelf of the South China Sea during the period March 1972 to March 1973. The mean catch rates made by CAPE ST. MARY, in depths of 18 to 275 m, varied from 0.5 to 11.7 kg/h for squid and between 0.01 and 2.9 kg/h for cuttlefish.

Studies have been conducted in the Deep Bay oyster farming industry, and on oyster culture trials on the north coast of Lantau Island. No attempts have been made to rear Macrobrachium or penaeid shrimp. It is considered that the low water temperature during the winter months will slow the growth of cultured shrimp, and might also have adverse effects on survival rates.

The Fisheries Research Division is making considerable effort to increase fish production through the promotion of aquaculture activities, particularly in inland fish culture. Since 1965 the total area of ponds has increased by 64 percent, and by 1972 there were 940 fish farms operated by approximately 500 individual owners, employing over 1 000 skilled workers. Although the freshwater production in 1972 constituted only 2 percent of the marine catch, its value was nearly 8 percent of the total (Hong Kong, 1973).

The principal centre for inland fish culture is the Au Tau Fisheries Research Substation, where common carp, silver carp, big-head and grass carp are artificially propagated, some of the fry produced being utilized for experimental work and the rest being sold to farmers. Fingerling production of big-head (Ctenopharyngodon idella) and silver carp (Hypophthalmichthys molitrix), by August 1973 amounted to 1 156 000 and 523 000 respectively. Since the quantities produced are not sufficient to satisfy the demand, considerable quantities of carp fingerlings are imported annually from provinces of Mainland China and Taiwan; during 1972 about 4.9 and 7.9 million fingerlings were imported respectively. Some of these are re-exported, but lately the number exported has decreased. The most important cultivable species is the grey mullet, mainly Mugil cephalus, the fry being collected from the sea shore. The following quantities were collected: 1970, 19 200 000; 1971, 24 200 000, and 1972, 33 000 000.

A recent development has been marine fish farming at Sokku Wan, Lamma Island. Various marine species, Mylio latus, M. berda, Chrysophrys major and Lutjanus argentimaculatus, are kept in about 200 floating cages by coastal villagers and fishermen. Small-sized fish are either trapped or purchased, and are fed by trash fish. Fish are sold when about 1 lb in weight. Some farms raise Epinephelus spp., but the procurement of seedling is very difficult. No production figures are available.

The expansion of inland fish culture will depend on the availability of land. There are about 500 ha of vacant agricultural land which might be developed eventually by the industry, giving an estimated potential pond area of 1 600 ha. The most suitable area for mariculture development is in the eastern sector of Hong Kong, because of the low level of pollution and higher prevailing salinities (Hong Kong, 1973).

## 2.7 Vietnam, Republic of

### 2.7.1 Crustacea

In spite of the upheaval resulting from military operations in Vietnam, the production of crustaceans, particularly shrimp, has been steadily increasing over the years. Due to the unsettled conditions, the accuracy of statistical data has suffered; production figures (except for exports) should be considered as indicative only of the prevailing trends (Table 21). In 1972 the value of the crustacean and molluscan production was about 17 percent of total fisheries production, the value of shrimp, 13 percent. The number of fishermen, number of fishing boats, processed products and exports are also given in this table.

One of the major difficulties encountered in obtaining a clear picture of the crustacean production of Vietnam was the practice of grouping landings of crabs and molluscs together. After January 1973, however, statistical landing data of crabs and molluscs are given separately. Landings from January to July 1973 of crabs and molluscs were 7 900 and 11 580 tons respectively. Unfortunately there is no breakdown by species.

Table 21

Number of fishermen, number of fishing vessels, catch,  
quantities of processed fishery products, and export of  
fishery products of Vietnam, 1963-72  
(in metric tons)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Fishermen	243 390	245 520	243 500	253 770	270 408	272 300	277 118	317 442	335 690	342 807
Fishing boats	53 750	56 470	58 480	65 150	76 190	77 959	81 955	88 215	91 424	95 062
- motorized	9 220	9 710	12 240	16 770	23 195	29 968	39 000	42 603	48 842	55 247
- non-motorized	44 530	46 760	46 240	48 380	52 995	47 991	42 995	42 612	42 582	39 815
Catch	378 670	398 000	375 000	380 500	410 700	410 000	463 850	517 450	587 500	677 720
- marine fish	299 340	314 000	289 000	287 450	319 500	321 645	355 500	391 765	435 550	501 280
- freshwater	49 900	52 000	57 000	64 710	59 500	51 045	63 670	64 140	71 070	81 770
- shrimps and mysids	17 600			19 160	18 400	24 600	27 500	33 270	45 780	54 250
- crabs and molluscs	7 000	a/	a/	4 500	8 800	9 410	13 370	18 830	19 800	29 725
- squid and cuttlefish	4 830			4 680	4 500	3 300	3 810	9 445	15 300	10 695
Processed products										
- fish sauce <sup>b/</sup>	60	63	57	59	61	59	61	64	70	
- dried fish	18 370	19 410	17 500	16 000	15 000	20 200	20 770	27 980	41 610	
- brine, salted	31 370	32 170	28 100	30 500	35 020	24 830	30 240	34 425	36 730	
- canned fish	235	215	230	205	185	100	20	-	-	
Exports										
- fresh and frozen fish	376	472	233	165	183	-	-	-	204	447 <sup>c/</sup>
- fresh and frozen shrimp	471	339	700	621	432	78	49	26	185	1 728
- fish sauce (litres)	-	-	-	-	180 000	52 000	7 000	65 000	85 500	123 130

a/ Combined figures for crustaceans and molluscs: 1964 = 31 000; 1965 = 29 000

b/ Million litres

c/ Includes frozen squid



Shrimp production is based on a variety of species, including mysids and sergestids (ru8c). The latter are utilized for the production of shrimp powder or paste. Precise information is not available on the quantities of mysids produced; it is believed that their proportion in the quoted landing data is between 20 and 25 percent, but it could be higher. In 1972, of 54 250 tons of "shrimp", about 10 850 tons represent mysids (ru8c) if the factor of 20 percent is applied.

Information on fishing grounds, the number of vessels engaged, fishing gear, etc., is scanty for the crustacean and molluscan fisheries, in particular for the shrimp fisheries. Information provided at the Fisheries Directorate, Saigon, showed that the main shrimping grounds are located on the west coast of Vietnam, from the Cape of Mui Cà Mau to Hà-Tiên, bordering the Republic of Khmer. On the east coast shrimping activities are carried out from Bac-Lieu to Vung-Tàu (Mekong Delta), principally from January to March; further northeastward shrimp fishing takes place from Binh-Tuy to Binh-Dinh, as far north as Quãn-Tri.

Shrimp, mysid and sergestid landings during 1968-72 are shown by province (from south to north) in Table 22.

Table 22  
Production of shrimp (including mysids and sergestids)  
by province, Vietnam, 1968-1972  
(in metric tons)

	1968	1969	1970	1971	1972
Total	24 600	27 500	33 270	45 780	54 250
<u>Province</u>					
An-Xuyên	2 740	3 335	1 035	1 460	4 000
Bac-Lieu	7 900	6 600	10 110	9 140	11 220
Ba-Xuyên	6 330	2 915	2 715	2 515	3 975
Phuoc-Tuy	590	850	1 790	4 425	4 480
Vung-Tàu	920	840	2 235	7 435	5 960
Phu-Yên	565	1 770	5 400	5 000	4 000

The first five provinces listed are located in the vicinity of the Mekong Delta, which is the most productive shrimp area of the country.

According to a survey made in 1972, covering 22 coastal provinces out of 34, 2 419 boats were engaged in shrimp fishing. Data on fishing effort are not available; the total shrimp catch in 1972 (including ru8c) was 34 850 tons. In addition to the above, the shrimp fleet included six steel double-rigged shrimp trawlers (Gulf of Mexico type), two Japanese vessels of 134 GRT (freezers and packers), and four American-owned freezer boats, one of 156 GRT and three of 110 GRT.

At Vũng-Tàu boats fish for both shrimp and fish; those under 20 hp make one-day trips, those between 20 and 50 hp four-day trips, and those above 50 hp 7-10 day trips.

Records were made available of shrimp catches and incidentally-caught fish made by two large vessels, of about 140 gross tons, operating alternatively off the west coast and southeast coast of Vietnam. Originally 40-day trips were made, but as shrimp catches became smaller the length of trips was reduced. From mid-December 1972 to the end of July 1973 both vessels made seven trips each, of 10 to 37 and 17 to 26 days duration. The most frequently fished grounds were near the island of Chuoi (off the southwest coast) and near the Cape of Mũi Cà Mâu, including the island of Hòn Khoai. Shrimp and fish catches made by one vessel varied between 66 and 187 kg/day fishing, and 469 to 1 250 kg/day. The catches of the other vessel were 112 to 408 kg/day of shrimp and 538 to 834 kg/day of fish. The latter vessel spent more fishing time near the island of Chuoi, which appears to have very good shrimp grounds.

Some shrimp farming activities are carried out (almost entirely through trapping-holding-growing operations), particularly in the provinces of Bac-Lieu and An-Xuyen, west of Mekong Delta, but production figures are not available. Likely the production does not exceed 300 tons annually, which is insignificant in comparison to the total marine and brackishwater shrimp catch. It has been reported that yields range from 200 to 600 kg/ha/year, but the latter is unusually high, and perhaps infrequent, since no supplemental feed is applied to the ponds.

About 8 000 tons of crabs were landed during the first seven months of 1973 but the species exploited is not known. The most important species under exploitation is the mangrove crab, Scylla serrata (Cua biển), particularly in the Mekong Delta; the principal centre is the province of Bac-Lieu. Undoubtedly a variety of marine crabs are taken in coastal waters, mainly Portunus.

Shovel-nosed lobsters (Thenus sp., and Ibacus sp.) are caught by the trawl fishery. Spiny lobsters (Panulirus spp.) are also caught, particularly in the provinces of Binh-Dinh and Cam-Ranh and in coastal waters as far south as Vũng-Tàu; production figures are not available. Fishing is by skin-diving.

The giant freshwater prawn (Macrobrachium rosenbergii) appears to be abundant, but production figures are not available. It is sold at comparatively low prices (about U.S.\$ 2.50/kg for large specimens) at the Saigon fish market. The centre of production is the Mekong Delta. Since early 1973 Macrobrachium (Tôm càng) have been exported to Singapore and Bangkok; the mangrove crab, S. serrata is being exported to France.

Species composition - Information on species composition and size distribution of crustaceans landed is scarce. According to information provided at Saigon the most common penaeid shrimp species occurring in the catches were: Penaeus indicus (Tôm bac the), P. merguensis (Tôm bac gân), P. spinulatus (= Metapenaeus spinulatus) (Tôm nghê), P. monodon (Tôm sú), P. semisulcatus (Tôm cõ), P. japonicus, (Tôm sen) and P. longistylus (Tôm bac). The dominant species was P. indicus, followed by P. merguensis, M. spinulatus and P. monodon.

Among the crustaceans collected by the UNDP/SF Fisheries Project (kept at the Off-Shore Fishery Research Institute, Saigon, and identified by Miss B.T. Lang), a great variety of shrimp species were included: Penaeus latisulcatus, Metapenaeus mutatus, M. brevicornis, M. lysianassa, M. intermedius, M. ensis, Metapenaeopsis barbensis ?, M. barbata, M. stridulans, Parapenaeopsis affinis ?, P. hardwickii, P. gracillina ?, P. maxillipedo, P. hungerfordii, Trachypenaeus fulvus, T. pescadorensis, Parapenaeus fiscurus ?, Solenocera subnuda, S. pectinata and S. alticarinata. In the absence of records, no inference can be made as to the general distribution and abundance of these.

Other decapod crustaceans were Palinurus ornatus, Palinudarus trigonus, Squilla oratoria, Bathysquilla crassispinosa, Odontactylus japonicus, Galappa philargius and others.

## 2.7.2 Mollusca

Molluscan production in Vietnam is considerable, approximately 11 500 tons having been landed during the first seven months of 1973. Detailed information on the species exploited is lacking, but it has been reported that mussels (Mytilus sp.), oysters (Crassostrea), clams, cockles (Anadara sp.) and Solen sp. are caught and consumed locally.

The following species of cephalopods appear in the catches: Sepia framea (Muc nang), Loligo formosana (Muc Ong), and Octopus spp. Probably a greater number of cephalopods occur in Vietnamese waters.

General considerations - Shrimp production has increased rapidly during the past three years, even making allowance for the substantial portion of the catch which consists of mysids (Table 21). No doubt such growth rates cannot be maintained for long. Quite likely, with improvements in vessel design and gear, catches from coastal waters will increase further, but in the absence of statistical studies it is not possible to predict future trends. Some disconcerting symptoms of depletion have already been reported. According to Mr. VU HUU Sang, Chief of the Marine Fisheries Exploration Section, Fisheries Directorate, the number of shrimp boats operating in the area from Dao Phu Quoc Island to Hon Khoai Island during 1972 was about 800. In 1973 the number of boats had decreased to less than 200 because of the smaller catches obtained, and also because the species caught were not desirable for export, and thus the profitability of the operations decreased. It is not known whether the decreased catches were caused by annual fluctuations or by over-fishing. Nor is it known whether the boats which ceased fishing in this area transferred to other areas.

It is unfortunate that it was not possible for the vessel HUU NGHI, chartered by the UNDP/SF Offshore Fishery Development Project, to operate on the grounds inside the 20-mile limit during the shrimping/trawling survey conducted from July 1969 to November 1970. However, the operations conducted outside the 20-mile limit, covering the area from Dao Phu Quoc Island (S.W. coast) to Phan-Thiet (S.E. coast), indicated that the best fishing ground of the surveyed area was near Hon Khoai Island, at the extreme south of the Camau Peninsula; the best fishing grounds for red shrimp species were south of Vung-Tau. The best catches of white shrimp (Penaeus merguensis) were made near Palau Obi. In other surveyed areas shrimp appeared to be scattered (Draft Terminal Report, Vietnam project; and Kyokuyo Co. Ltd., 1972).

The other chartered vessel, KYOSHIN MARU, made a survey covering the area south of Hainan Island and off the northeast coast of Vietnam. Although the fishing gear used by this vessel was not suitable for shrimp, some quantities of Penaeus merguensis were taken between latitudes 13° and 15°, in depths below 100 m (Draft Terminal Report, Vietnam project). Some good concentrations of the shovel-nosed lobster (Ibacus ciliatus and Thelus orientalis) were found off the east coast of Vietnam and off Hainan Island near the 200 m depth line (Kyokuyo Co. Ltd., 1972; Figs. 16-9 and 16-10).

In addition there exists a great potential for production of crustaceans, particularly of penaeid shrimp and Macrobrachium rosenbergii (and also of mollusca), through aquaculture. Vietnam has a coastline of about 2 570 km, with some areas (particularly in the Mekong Delta) being very suitable for aquaculture development. Although the Directorate of Fisheries has been providing technical assistance over a long period of years to fresh water fish farms, aquaculture in coastal and brackish waters has not received similar attention. Government fish hatcheries in the various provinces and under the Pacification and Development Programme have been providing fry to fish farmers, either free or for sale. In 1963 the fry production from governmental fish ponds (total area 39 ha) was 1 360 000.

The fry production from government fish hatcheries and from the Pacification and Development Programme (PDP) during the period 1966 to 1972 is given below (Table 23).

Table 23

Production of fish fry by government hatcheries, and the Pacification  
Development Programme, Vietnam, 1966-70  
(in '000 tons)

	1966	1967	1968	1969	1970	1971	1972
Government fish hatcheries (area 42 ha)	2 003	1 352	1 240	667	820	1 186	1 320
PDP (area 6 ha)	-	-	660	232	*	*	*

\*No data

The distribution of fry from the governmental fish hatcheries was as follows (Table 24):

Table 24

Distribution of fish fry from government hatcheries, 1968-72

	1968	1969	1970	1971	1972
Fry distribution (unspecified)	575 000	514 000	-	-	-
Fry sold to farmers	-	-	473 000	586 000	287 700
Free distribution	-	-	44 600	41 200	175 000

The species under culture are Tilapia, Chinese carps, snake-heads, etc. Milkfish are also cultured, mainly in the brackishwater areas from Tuy-Hoa to Cam-Rahn (east coast); mullet are raised at Phan-Rang. The best yields are obtained from the cage culture of Puntius spp. in the vicinity of Châu-Dộc, close to the border of Khmer, where about 5 000 cage units of approximately 20 x 4 - 6 x 2 - 2,5 m exist. Yields up to 10 t/cage/year quoted. Feeding consists of water melons, tomatoes, rice bran, fish, etc.

A turtle (Eretmochelys imbricata) farm exists at Hà-Tiên (near the border of Khmer).

The total area of fish ponds in Vietnam is unknown. Le Van Dang (1973) states that the approximate total area of brackishwater fish ponds is 2 600 ha, but no figures for the total area of freshwater fish ponds are available. According to Mr. Nguyen Van Thuong, Deputy Director of Fisheries, the area of the coastal tidal flats which are considered to be suitable for conversion into fish and shrimp ponds occupies 100 000 to 150 000 ha. In addition there are about one million ha of freshwater flood land, and 100 000 ha of natural lakes. The potential for aquaculture development in the country is therefore great.

## 2.8 Thailand

### 2.8.1 Crustacea

The shrimp fishery of Thailand is one of the most important in South East Asia. In 1972 shrimp production was 89 300 tons; in 1971 the value of exportable shrimp products (726.6 million Baht) ranked first among all species. The introduction of trawling early in the last decade is considered the main contributing factor for the rapid development of this fishery.

The growth of shrimp production over the last 10 years can be observed in Table 25 along with total marine landings and landings of other crustacea and of mollusca. In 1960 the total annual catch of Thailand was approximately 215 000 tons, while in 1972 the estimated catch was about 1.7 million tons, almost an eightfold increase in 13 years. These production figures are only indicative of trends since there is no catch data collection system, and annual catches are estimated by field fishery officers on the basis of day-to-day observations of the fisheries coming under their jurisdiction. The Thai Department of Fisheries has conducted, therefore, a sample survey to find a correction factor for data obtained by this traditional catch survey. The first sample survey, covering the period of one year, was conducted in 1971. This indicated that the total marine fisheries production in 1971 was 1 246 200 tons, including coastal aquaculture products, instead of 1 470 290 tons estimated by the traditional catch survey (Thailand, 1973). It might be reasonable, therefore, to apply a correction factor by reducing the estimated production by 15 or 20 percent (in 1971 it was 18.0 percent) for 1972, and for previous years, to obtain a more accurate figure of production.

Shrimp catch data quoted in the statistics consist not only of penaeid shrimp species but also of mysids (Acetes spp., up to 90 percent, and Sergestes spp.); the proportion of these in the catches fluctuates from year to year. In the Fisheries Record of Thailand 1970 (Fishery Statistics) 13 059 t (1969) and 15 617 t (1970) appear under the heading of "brine-shrimp", which can be assumed to be mysids. Mysids are used for shrimp paste in Vietnam. According to the 1971 sample survey, the total crustacean production (excluding Macrobrachium rosenbergii) was 87 619 t: shrimp, 58 256 t (penaeid 24 037 t, other shrimp, 34 219 t); crabs, 18 876 t (Portunus pelagicus, 15 356 t, Scylla serrata 3 540 t); mysids, 8 870 t, and lobsters, 1 617 t (up to 90 percent consisted of the shovel-nosed lobster, and the rest of the spiny lobster).

Shrimp production derived from aquaculture during 1971 amounted to 911 tons, being 1.3 percent of the total marine shrimp production. The total number of shrimp farms in 1971 was 1 200, having an area of about 9 585 ha. The average yield per unit area was 90 kg/ha (Thailand, 1973).

For statistical purposes the landing places are grouped into four geographical regions or zones, each including a number of provinces. There are three regions in the Gulf of Thailand and one facing the Indian Ocean. The main shrimp resources of Thailand are in the Gulf of Thailand.

Gulf of Thailand: Region 1 - Rayong, Chantaburi and Trad

Region 2 - Phetburi, Samudsongkram, Samudsakorn,  
Samudprakarn, Chacheongsao and Cholburi

Region 3 - Prachuabkirikan, Chumporn, Surasdhani,  
Nakorn-Shridhammaraj, Pattalung, Songkhla,  
Pattani and Naradhivas

Indian Ocean: Region 4 - Ranong, Pangnga, Phuket, Krabi, Trang and Satul

Table 25

Fisheries production of Thailand, 1963-72  
(in '000 tons)

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972
Total catch	418.7	582.5	626.7	732.6	846.6	1 088.9	1 269.9	1 447.7	1 587.1	1 678.9
Freshwater fishes	92.0	78.9	81.7	83.5	81.5	81.1	85.8	96.0	103.2	114.9
Shrimp	23.3	29.5	35.2	45.3	61.7	75.0	76.9	81.6	85.2	89.3
Freshwater prawns	3.4	3.8	4.0	3.5	3.7	4.0	3.9	4.0	2.9	3.7
Miscellaneous marine crabs	9.1	9.2	11.0	13.3	13.3	24.2	14.1	47.9	41.9	56.4
Miscellaneous marine molluscs	72.3	70.1	62.6	102.1	105.6	141.8	139.8	207.9	181.0	161.1

Origin: FAO Yearbook of Fishery Statistics

Table 26

Estimated production of shrimp, other crustacea, and molluscs from various regions of Thailand, 1969-71  
(in tons)

Year	1969				1970				1971			
	1**	2	3	4	1	2	3	4	1	2	3	4
Shrimp	7.2	20.3	26.0	4.9	6.4	22.3	30.3	4.6	5.8	16.7	39.5	5.6
'Brine-shrimp**	3.4	2.4	4.2	3.0	4.8	3.5	3.9	3.3	4.0	4.4	2.0	3.6
Crabs	6.2	3.9	1.8	2.3	6.1	7.1	34.0	0.7	3.5	7.6	29.8	1.0
Lobsters	0.2	1.7	3.0	0.7	0.2	0.9	1.0	0.2	0.1	2.5	0.7	0.3
Molluscs	1.4	134.2	4.1	0.1	2.2	200.0	5.9	0.1	1.8	175.3	3.7	0.1
Squid and cuttlefish	2.4	14.8	5.4	1.9	3.3	25.5	12.5	18.7	7.5	25.1	7.6	10.3

Source: Fisheries Record of Thailand 1970 and 1971

\* Probably mysids

\*\* See text for location of numbered regions

As in neighbouring countries, the exploitation of the shrimp resources in Thailand is based on a variety of fishing gears, i.e., otter, pair and beam trawls, shrimp gill nets, push nets, set bag nets. Useful information on shrimp catches by species and by type of fishing method was obtained during the sample survey conducted in 1971. About 60 percent of the total shrimp catch (excluding mysids) was caught by trawl nets, principally the otter trawl; 13 percent was caught by gill nets, 10 percent by set bag nets and smaller percentages by other gears. Mysids (8 870 tons) were caught by mobile nets (57 percent), followed by push nets (28 percent), and set bag nets. Lobsters (1 617 tons) were caught by otter and pair trawling. Of the exportable shrimp species (24 040 tons), about 42 percent of the catch was made by trawl nets, followed by gill nets (23 percent), set bag nets (16 percent), etc.

There is no information on the number of shrimp trawlers. However, information is available on the total number of otter trawlers operating (including shrimp trawlers), catch per trawler, and catch per trawling hour, for the period 1969-71 (Thailand, 1973) (Table 27).

The total catch of the otter trawl fishery in 1971 was estimated to be 515 600 tons, representing about 40 percent of the marine fisheries production. The catches of fish, crustacea and mollusca were 455 350, 37 360 and 22 890 tons, or 88.3, 7.3 and 4.4 percent respectively.



Table 27

Number of otter trawlers (including shrimp trawlers), by size, Thailand, 1969-1971

Number of otter trawlers	1969	1970	1971
Small (<14 m)	826	685	843
Medium (14-18 m)	906	966	1 056
Large (>18 m)	207	425	502
Total	1 939	2 076	2 401

In 1971, the catch of exportable shrimp species (white, pink, tiger, yellow and jumbo shrimp) by otter trawlers was 9 652 tons, pair and beam trawlers 332 and 199 tons respectively. The majority of the exportable shrimp were caught by medium (47.6 percent) and small-sized (38.3 percent) otter trawlers, the remainder (14 percent) by large-sized vessels. The smaller trawlers appeared to be catching more exportable shrimp per haul than the medium and large boats, as indicated in Table 28.

Table 28

Catch of exportable shrimp per haul, by size of trawler, 1969-71 (in kg)

Size of trawler	1969	1970	1971
Small	6	6	6
Medium	4	4	4
Large	2	2	2

Source: Thailand, 1973

According to the 1971 sample survey, crab production for that year amounted to 18 876 tons, of which approximately 81 percent consisted of the swimming crabs (P. pelagicus) and 19 percent of the mangrove crabs (S. serrata). Such production, however, is markedly below the quantity of 41 900 tons referred to in the FAO Yearbook of Fishery Statistics (see Table 25), or to the statistical table (No. 5) contained in the Fisheries Record of Thailand 1971 (Thailand, 1972). It may be that the production figures for 1970 and 1971 were considerably overestimated, since the 1969 production reported was only 14 100 tons. There is no record in the statistics of other species of crabs being exploited in Thailand but, since a variety of species has been recorded (e.g., Portunus gracilimanus, P. sanguinolentus, Sesarma meinerti), undoubtedly at least small quantities of these are being landed.

During 1971, about 53 percent of P. pelagicus were taken by trawl nets, 32 percent by gill nets and 15 percent by other fishing methods. For S. serrata the majority of the catch (63 percent) was taken by crab traps, 19 percent by gill nets, and 18 percent by other gears.

Species composition - Information is limited on species composition in catches and landings, size distribution of animals, and fishing effort. The difficulties encountered in establishing a data collection system are great when such a great variety of shrimp species is taken, some of which cannot be easily identified by external morphological characters. Nevertheless, such data are indispensable in stock assessment studies.

Several penaeid species support the shrimp fishery. A number of them are destined for export, and the total quantities taken, according to the 1971 sample survey, are given below. No information is provided on the identification of species grouped under the heading "Other shrimps", but they probably consist of small penaeid species of the genera Parapenaeopsis, Metapenaeopsis, Trachypenaeus, etc.

Table 29  
Landings of shrimp by species, Thailand, 1971  
(in metric tons)

Pink shrimp ( <u>Metapenaeus intermedius</u> , <u>M. ensis</u> , <u>Metapenaeus</u> spp.)	10 903
White shrimp ( <u>Penaeus merguensis</u> , <u>P. indicus</u> )	10 641
Tiger shrimp ( <u>P. semisulcatus</u> )	1 677
Yellow shrimp ( <u>P. latisulcatus</u> , <u>P. longistylus</u> )	558
Jumbo shrimp ( <u>P. monodon</u> )	258
Other shrimps	34 219
Total	58 256

The information given above indicates the species composition in catches for the whole country. Data are available on shrimp landings at four major ports on the west coast of Thailand (representing more than 90 percent of the total) from the detailed survey conducted from July 1969 to June 1970 (Sripayat et al., 1971). The percentages of the major species were as shown in Table 30.

Other commercially important penaeid species (P. indicus, P. longistylus, P. plebejus) were also found in the catches, but their representation was very small.

The survey also collected data on catch per unit of effort and average catch/hour's trawling by boats operating from the four major ports. The minimum catch/kg/h trawling ranged from 1.3 (Ranong) to 4.7 (Phuket), the maximum from 4.6 (Ranong) to 16.7 (Satul).

Table 30

Landings of the major species of shrimp in four principal ports, Thailand, expressed in percentages of the shrimp landings

	RANONG	PHUKET	TRANG	SATUL	Average
<u>P. merguensis</u>	39.3	10.6	12.4	12.2	15.2
<u>P. semisulcatus</u>	7.1	15.5	14.0	14.0	14.1
<u>P. monodon</u>	6.1	3.4	4.5	2.7	3.9
<u>P. latisulcatus</u>	1.0	1.7	1.9	1.3	1.7
<u>Metapenaeus spp.</u>	7.5	15.3	19.2	24.0	17.8
Miscellaneous	39.0	53.5	48.0	36.8	47.3

2.8.2 Mollusca

The molluscan production of Thailand is considerable (Table 25). According to the 1971 sample survey the total amount produced (excluding squids, cuttlefish and octopus) was about 293 000 tons live weight (about 20 percent of the total marine production), considerably higher than reported in Table 25. The major component is the sea mussel Mytilus smaragdinus, followed in order by horse mussel (Modiolus spp.), ark shells (Anadara granosa), short-necked clams (Paphia = Venerupis spp.), jack-knife clams (Solen and Pholas (?) spp.), and oysters (Crassostrea commercialis, C. lugubris, C. belcheri). In 1971 the total production of sea mussels was 214 600 tons, or 17 percent of the total. For unidentified reasons, shellfish production, particularly of mussels, dropped markedly in 1972, as indicated in Table 31.

Table 31

Landings of molluscs, Thailand, 1971 and 1972  
(in metric tons)

	1971	1972
Sea mussels	214 593	70 964
Horse mussels	39 139	16 194
Ark shells	12 582	4 137
Short-necked clams	6 406	14 095
Oysters	2 832	4 165
Others	17 246*	7 349
Total	292 798	116 904

Source: Statistics Section, Bangkok

\*Including 4 320 tons of jack-knife clams

Although large quantities of sea mussels are cultured or collected, only about 20 percent are consumed by the local population, the remaining quantities being used as food for ducks. The sea mussel-producing provinces are Choburi, Chacheongsao, Samutprakarn, Samutsakorn and Phetburi, all located around the inner Gulf of Thailand.

The production of squid and cuttlefish in 1971 was almost one seventh of the molluscan bivalves (oysters, mussels, etc.). The value of squid and cuttlefish was 6 percent of the total marine landings, while the value of the bivalve molluscs was 4 percent in 1971. The export of squids and cuttlefish increased from less than 2 000 tons in 1967 to 6 000 tons in 1971. This is one of the most important fisheries, following those for shrimp, Indo-Pacific mackerel (Rastrelliger), and trash fish. The principal species which support the squid and cuttlefish fisheries are Sepia esculenta, S. aculeata, S. omani, S. pharaonis (most common in catches); Loligo edulis, L. formosana, L. duvancelii (most common in catches), Doryteuthis singhalensis and Sepioteuthis lessoniana. Other species may sometimes occur.

According to the FAO Yearbook of Fishery Statistics, squid and cuttlefish production during 1969-72 was as follows (Table 32).

Table 32  
Production of squid and cuttlefish, Thailand, 1969-1972  
(in '000 tons)

1969	1970	1971	1972
24.5	59.9	50.6	65.2

The 1971 sample survey, however, indicated a production of 36 780 tons (squid 23 528 and cuttlefish 13 253 tons), which is considerably less than the amount given above. In addition there was a production of 740 tons of octopus. In this instance the correction factor is 28 percent, and not 18 percent as applied earlier. According to the same survey, about 91 and 98 percent of the squid and cuttlefish catches were made by otter and pair trawls, the remaining quantities being taken by the traditional fishing gears, i.e., cast nets, bamboo stake traps and hand lines (Thailand, 1973).

General considerations - Even allowing for the inclusion of mysid production in the shrimp landing data, and the possibility that such production has substantially increased during the past few years, there has been an almost twofold increase in shrimp production in seven years (Table 25). In the absence of special studies on the shrimp fisheries of Thailand, in particular the monitoring catch rates and fishing effort, it is precarious to predict the amount of expansion still possible.

Although there is no evidence available to show a general decline in shrimp catch rates in contrast to the marked decline shown for demersal fish stocks by recent resources surveys (IPFC, 1972b), a decrease in the quantities of exportable shrimp species has been reported from 1968 to 1970 (Thailand 1973). There has been an upward trend in landings of pink shrimp (Metapenaeus spp.) since 1970, but the production of the remaining species supporting the export trade has remained almost stationary, at least based on trawling operations: the catch per haul of exportable species made by trawlers has fluctuated very little during the 1969-71 period (Thailand, 1973).

The shrimp trawling surveys conducted by the Marine Fisheries Laboratory vessels MV PRAMONG 4 and 5 in the Gulf of Thailand and in the Andaman Sea (Indian Ocean) indicated that the maximum total shrimp catch in kg/h varied seasonally from 12.1 to 56.7 kg/h (four areas in the Gulf of Thailand, during 1968-69), and between 5.5 and 53.1 kg/h (two areas in the Andaman Sea, during 1969) (Tarnbuppa et al., 1971).

The future of the shrimp fishery appears to be promising. In addition, the Department of Fisheries is supporting the development of shrimp farming, either through the improvement of existing practices or through the expansion of the marine fresh/brackishwater shrimp hatching and rearing programmes at governmental research stations.

Shrimp production derived from farming during 1971 amounted to 911 tons, the average yield from 1 200 farms being 90 kg/ha. This is considerably lower than the yield of 150 kg/ha/year for 1972, referred to in the Country Statement - Thailand (IPFG, 1972b).

Useful information on shrimp farming in Thailand was collected during a survey conducted in February and May 1973, by the Department of Fisheries, Bangkok, and Provincial Fishery Officers (Sakurai, 1973). The number of shrimp farms operating in 1972 was 1 154, having an area of 56 602 rai (or 9 056 ha) distributed in 14 out of 22 coastal provinces. The majority (943 farms having an area of 7 310 ha) were located in the provinces of Samutsakorn, Samutsonghram, Bangkok and Samutprakarn, all close to Bangkok. The province having the next largest number of farms (172 with an area of about 670 ha) was Chantaburi, close to the border of Khmer. In the remaining provinces the number of shrimp farms totalled fewer than 30.

The size of farms (including the surrounding dike, but not the water surface area, an estimated 92 percent of the total) ranged from less than 10 to 1 000 rai (1.6 to 160 ha); about 70 percent of the farms were from 20 to 99 rai (3.2 to 15.8 ha), with an average of 7.8 ha.

The total production derived from farming practices in 1972 was estimated to be 985 tons of shrimp, the majority consisting of white shrimp, *Penaeus merguensis* (51.8 percent), and pink shrimp, *Metapenaeus monoceros* (44.5 percent). In addition, about 459 tons of fish were produced during the same period. Whereas the national production average was about 17.4 kg/rai (109 kg/ha), the productivity from the 285 farms sampled varied from less than 4 to 100 kg/rai (25 to 625 kg/ha). The survey indicated that in about 60 percent of the farms the yield was less than 19 kg/rai (119 kg/ha), while in only 11 percent the productivity was over 40 kg/rai (250 kg/ha). The productivity varied according to the size of pond area, being lower in large-sized ponds. Yields varied from locality to locality as a result of conditions in water supply, availability of seed, predation, etc.

The potential area suitable for shrimp culture has been estimated to be about 100 000 ha. On the assumption that only half of this area can be developed, and that the national average yield would increase to 220 kg/ha from the current 110 kg/ha, the estimated future shrimp production through aquaculture could be in the range of 9 000 to 10 000 tons annually.

### 3. RESOURCE POTENTIAL OF THE AREA

The crustacean resources of the South China Sea area (in particular penaeid shrimps) are considerable. The FAO Yearbook of Fishery Statistics gives shrimp production of the countries under review as about 260 000 tons in 1971, a quantity representing more than 25 percent of the world shrimp and prawn production (943 000 tons) for that year. These statistics, however, probably include some mysids and other crustaceans, and the true production of shrimps and prawns in the region may be somewhat smaller.

Less than a decade ago the production of these countries was about 130 000 tons, about half the 1971 total. Thus, during the span of a few years the production almost reached the estimated full potential of 290 000 t (Longhurst, 1971). The figures in Table 33 give the best available estimate of landings, based on discussions with the fishery officers in the countries concerned.

The rapid growth in shrimp production could be related to some extent to the improvement in the collection of national statistics, but it is also a consequence of the mechanization of small fishing craft and the use of larger and better equipped vessels, nationally- or internationally-owned, which have made it possible to fish on grounds not previously exploited.

Table 33

Comparison of projected and actual shrimp production in  
the South China Sea area  
(tons x 10<sup>3</sup>)

	After Longhurst (1971)		National statistics		National statistics
	Present <sup>c/</sup>	Potential	1971		1972
	Shrimp		Shrimp	Mysids, etc.	Shrimp
Malaya (Malaysia W.)	3.4	5.0	-	-	-
Sarawak	?	1.0	48.5	5.7	39.1
Sabah	3.0	4.0	2.3		(2.3) <sup>a/</sup>
Singapore	0.8	10.0	5.4		(5.4) <sup>a/</sup>
Indonesia (Sumatra only)	2.5	100.0	1.3		1.3
Philippines	20.3	50.0	-		-
Hong Kong/Macao (Hong Kong only)	14.3	20.0	30.0		(30.0) <sup>a/</sup>
Vietnam	50.0	50.0	12.7		(12.7) <sup>a/</sup>
Thailand	35.2	50.0	-		-
Total	129.5	290.0	11.1	9.1	54.2 <sup>b/</sup>
			58.3	8.9	58.3 <sup>a/</sup>
			206.3	23.7	215.1

<sup>a/</sup> Unavailable for 1972; figure for 1971 used

<sup>b/</sup> Shrimp and mysids

<sup>c/</sup> Most figures for late sixties

In all countries considerable effort is being made to improve the statistical data. But, except in Thailand, there are no research programmes aimed to assess the effect of the fishing pressure on shrimp stocks, and it is consequently difficult to arrive at definite conclusions on the state of the various fisheries. There are indications, however, that in some countries the optimum production of the large penaeid species has been reached, and that the fishing effort is being shifted to smaller-sized shrimps.

In three countries, West Malaysia, Vietnam and Thailand, the growth of the shrimp fisheries has been rapid. The trend will probably continue in the future, although perhaps at a slower rate. In the other countries, East Malaysia (Sabah and Sarawak), Singapore, Philippines and Hong Kong, shrimp production has been more or less static over the past five years (the period for which data are available) and the prospects for substantial increases in production are slight unless new grounds are located. In the case of Indonesia (Sumatra), any further increase will mainly depend on the discovery of new fishing grounds in the deep waters of the Malacca Strait (northwest part of Sumatra), and on improvements to the traditional gear employed.

On the basis of the data given in the FAO Yearbook of Fisheries Statistics, the combined production of the countries referred to above has almost attained the projected potential of 290 000 tons within a few years after the fishery began on a substantial scale (1965/72). From production figures provided by the national statistical services, total production by 1971 amounted to about 205 000 tons, and by 1972 an estimated 215 000 tons. A potential in the order of 30.0 to 35.0 x 10<sup>3</sup> tons is estimated on the basis of available production figures.

Shrimp production figures are not available from Burma, Khmer and China. For China Longhurst (1971) referred to Ivanov's suggestion that about 100 000 tons of shrimp are being taken annually prior to 1964 from the Yellow Sea, and on the basis of this a potential of 150 000 tons was projected. When production figures from these countries become available, it will be necessary to review the projected potential for the area.

Crabs are the second most important crustacean resource in the area, with the principal producing countries being Vietnam and Thailand. Until 1972 landings of crabs and molluscs in Vietnam were grouped together (Table 21); and the production of Thailand had been considerably overestimated, so that the total production can only be inferred. On the basis of data provided by FAO or the national statistics, the 1971/72 production is between 30 to 50 000 tons. The major part consists of the swimming crab (Portunus pelagicus), followed by the mangrove crab (Scylla serrata), and then other species.

The exploitation of the crab resources (Table 34) is mainly in the coastal zones. The recent expansion of the trawling fleet and the introduction of larger vessels will encourage operations on offshore grounds, and it is expected that the production of swimming crabs (Portunus spp.) will increase. A potential in the order of 10 to 15 x 10<sup>3</sup> tons is projected.

Spiny lobsters are being taken throughout the area, but the quantities landed are small. Probably landings are not properly identified in the national statistics. In 1971 the total production amounted to less than 2 000 tons, but probably it was higher. It is believed that landings can be considerably increased if capture methods are improved. Shovel-nosed lobsters (Ibacus, Thenus) are taken by the trawling fleet, and the recent survey conducted off the east coast of Vietnam indicated good concentrations in some areas.

The annual production of the freshwater crustacean Macrobrachium rosenbergii in 1972 amounted to about 5 000 tons. The production for the whole area must be higher since the quantities landed in Vietnam and other countries are not reported. About 30 000 tons of freshwater crustaceans were reported from the Philippines (1969/71), but information on the species involved could not be obtained. It is quite possible that the production is based on small prawns (Macrobrachium lanceifrons and Caridina gracillirostris) mainly utilized by the duck farming industry.

Table 34

Crab production by South China Sea countries (1971-1972)  
(in '000 tons)

Country	National statistics			FAO statistics	
	1971	1972	1973	1971	1972
W. Malaysia	1.6	1.4	-	1.6	1.4
Sarawak	-	-	-	0.1	0.1
Sabah	-	-	-	5.2	5.4
Singapore	-	0.3	-	-	0.3
Indonesia	-	-	-	-	-
Philippines	1.7	-	-	3.8	5.9
Hong Kong	1.1	-	-	-	-
Vietnam	(19.8)*	(29.7)*	8.0 <sup>+</sup>	-	-
Thailand	18.9 <sup>1/</sup>	-	-	41.9 <sup>2/</sup>	56.4 <sup>2/</sup>
Total	23.3	1.7	8.0	52.6	69.5

- \* Combined production of crabs and molluscs
- + Production during first seven months of year
- <sup>1/</sup>From sample survey
- <sup>2/</sup>Estimated production

Shrimp culture is practised almost throughout the area, the degree of intensity ranging from country to country. Detailed information on production is lacking, except for Thailand. The reported annual production through aquaculture is about 2 000 tons, of which about 1 000 tons was produced by Thailand in 1972. It is believed that production is actually higher, and that it can be further increased by the factor of 10 if improvements to existing practices are applied.

The molluscan resources of the area are also important. In 1971 the combined production of molluscan species, excluding cephalopods, amounted to more than 350 000 tons, being almost equal to or higher than that of crustaceans. The majority of species produced (cockles, clams, mussels, etc.) are locally consumed or, in the case of mussels, are used as food for ducks (e.g. in Thailand). Possibilities exist for expansion, in particular of high-value species like oysters. Projects aimed to increase production of oysters or other edible molluscan species should consider the hygienic and sanitary requirements of buyers, particularly if the products are destined for export.

One of the major difficulties encountered during the present review was the lack of reliable data on landings, species composition and size distribution of catches, and studies to assess the effects of the fishing effort on stocks. Although considerable effort is being taken by the authorities to improve the collection of statistical data, technical assistance is desirable to assist in the establishment of research programmes which will provide the basic data required in stock assessment.



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