

# ***Bionomics of the Shrimp Fishery in the Inshore Waters of Qatar***

by

**K. Sivasubramaniam and Mohamed Amin Ibrahim,**  
Marine Science Department,  
Faculty of Science.  
University of Qatar

## **ABSTRACT**

The shrimp fishery in Qatar is carried out by artisanal crafts, operating from Doha and Al Khor on the East coast. The fishing is restricted to the 2-6 Fm depth range and *Penaeus semisulcatus* forms about 95 % of the shrimp catch. The main fishing season is from July to December and the catch rates vary between 40 and 4 kg/boat/trip, with averages of 16 kg/boat/trip in Doha and 27 kg/boat/trip at Al Khor. Annual production during the period March 1980 - February 1981 was about 76,000 kg. The size range entering the fishery is 10 - 44mm in Carapace-length and the females tend to grow faster than males. Average growth rates for males and females of the species was estimated as 1.8 and 2.0mm in Carapace-length, per month, respectively.

There are two spawnings annually; one at the beginning of spring and the other around the end of autumn. The monthly rate of total instantaneous mortality was estimated to vary between 0.30 and 0.49.

The present scheme of operation of the crafts gave an annual profit of 40 to 50,000 Q. Riyals/craft during 1980/81. The sharply increasing market price, with the decreasing monthly production, provides viability to the operation, even when the catch rate declines from 40 kg to 6 kg.

In view of the prevailing rate of exploitation on the small stock of shrimp, management measures, such as the enforcement of the closed season and introduction of regulations to prohibit fishery in juvenile grounds, to restrict the use of mesh sizes below specified minimum and diversion of fishing effort of shrimp crafts, into other profitable fishing operations, are discussed. Entry into commercial shrimp trawling in and around the presently fished area, should be done cautiously and after preliminary investigations. The need for a fishery extension service unit and a fishery statistical unit is emphasised.

### **Introduction**

Commercial scale shrimp fishery in the north-western part of the Arabian Gulf, which started around 1959, reached a peak at the end of the 60's and then began to decline through the 70's. In Qatar, the commercial scale shrimp fishery started much later (in 1968) and had a rather short life by being suspended in 1979. The artisanal shrimp fishery on the other hand, which was not significant prior to 1959, began to improve and expand rapidly with the development of the commercial fishery and still continues to exist in all the Arabian States, as well as in Iran.

The general characteristic of the shrimps to spend the first half of their life in shallow inshore waters within the reach of artisanal crafts, as well as the fact that artisanal fisheries are generally much less capital-intensive investment, contribute to the sustenance of the artisanal fishery for shrimps and also place them in a more advantageous position as a competitor to the commercial scale operation in an interactive fishery of this type.

Biological and other related studies on the shrimps in the Gulf have been underway since 1969 (Boerema, 1969; Enomoto, 1971; IOFC, 1970, 1977, 1978; Gulland, 1972; Al-Attar et al 1974; Badawi, 1975; Ellis, 1975; Price and Jones, 1975; Hull, 1978; Van Zalinge et al 1978, 1979, 1980; Price, 1979; Mohamed et al, 1980 and Venema, 1980) and have been intensified in very recent years. However, the main shrimp stock along the Iranian coast and the north-west Arabian coast have been heavily fished before their status could be assessed and management measures introduced. Hardly any attempt has been made to study the shrimp stock(s) in the Qatar waters, though it has been considered to be relatively small.

Presently, the shrimps in Qatar waters are fished entirely by the artisanal fishery. Larger shrimp trawlers, which belong to the defunct Qatar National Fishing Company, which were operating mainly off Bahrain and Saudi Arabia, fished in Qatar waters in 1978 when catch rates in the former areas declined. It is very likely that the recently set-up New Qatar National Fishing Company (solely local) will soon begin commercial scale shrimp fishery in the Qatar waters.

Considering the history of the shrimp fishery in the north-western part of the Gulf, it is extremely important and urgent to investigate the biology and stock size, before the yield is increased beyond the present level and if suitable management measures are to be introduced in good time.

The present study was instigated by that urgent need and represents only the first step in that direction. Any encroachment into the economic aspects of the existing fishery is purely to contribute information, influencing the consideration of management measures.

#### **Source of Data**

In Qatar, the artisanal shrimp fishery is conducted from two fishing centres, one situated in Doha and the other at Al Khor (Fig. 1). Therefore, the sampling of the landings was carried out once a week at Al Khor and twice a week in Doha to estimate effort, catch and catch composition, between March 1980 and February 1981. The shrimps, fish, crabs, lobsters and cuttlefish are landed in separate baskets and the respective quantities were estimated from the numbers of baskets of each variety unloaded and by random checking of the weights of contents of each type of basket used. Species composition of finfish is determined by eye estimation of their proportion in each basket and the species identification made from samples purchased. At Al Khor, as the number of shrimp trawling crafts (dhows) is small, the landings of all the boats were recorded on the sampling day. However, in Doha between 30 — 100 % of the landings were observed on any sampling day. In addition, the characteristics of the gear was examined on randomly selected crafts in Doha and Al Khor and trash fish collected from the deck and from trawl nets at their arrival in port, before being cleaned.

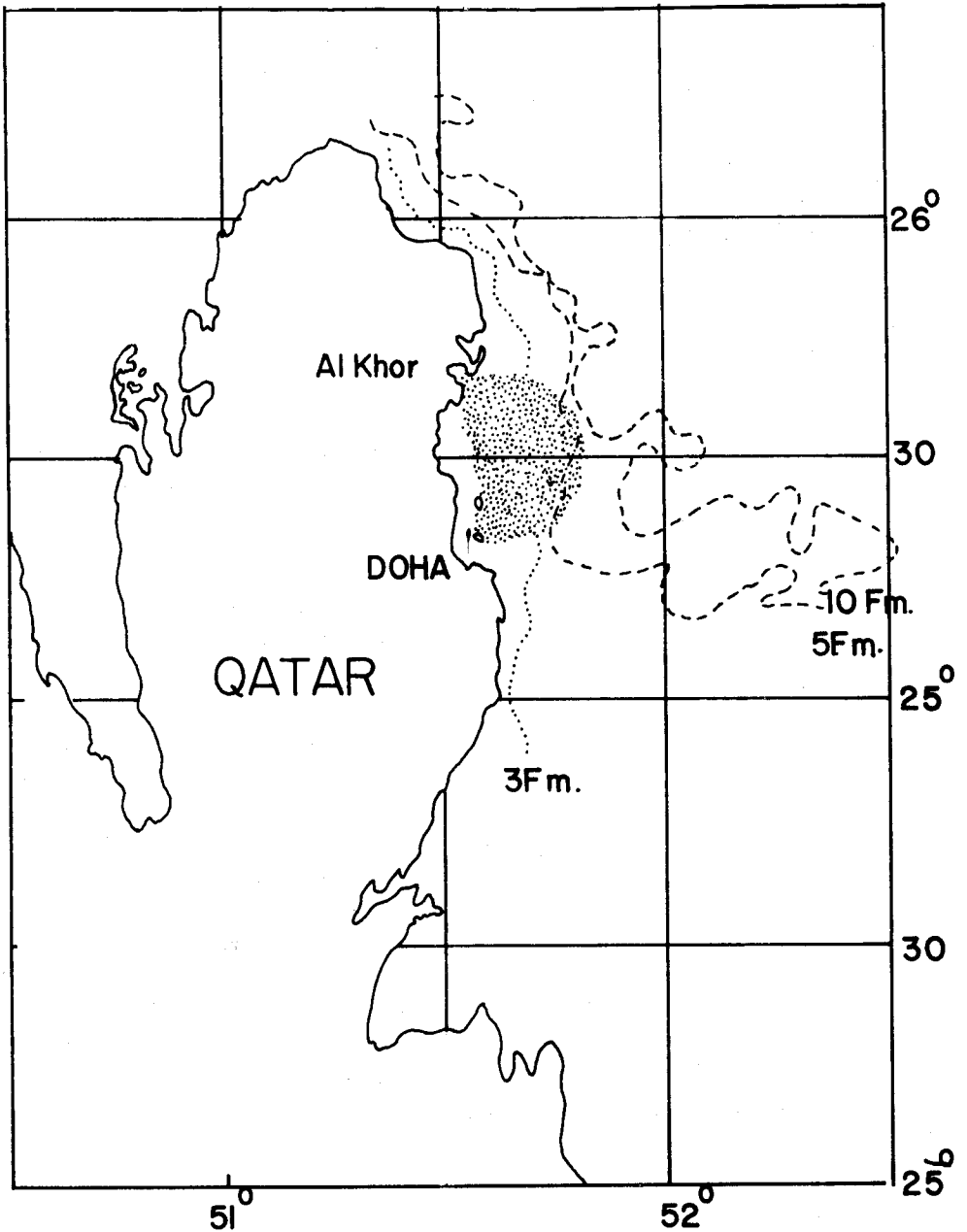


Fig. 1. Inshore shrimp fishing ground in Qatar waters.

By interviewing the fishermen on board of their crafts, information was collected regarding.

- the craft,
- area of operation,
- composition of crew,
- operational procedure and
- fishing time etc.

The duration of time out of port and the sailing time were almost constant at each port. The gear used is generally of a standard type. Irrespective of fishing time, all fish and shell fish landings by artisanal crafts in Qatar, are in the early hours of the morning, to be in time to retail the catch in the fish market. At Al Khor, shrimp fishing is from dusk to dawn; hence, estimation of the number of crafts fishing on any sampling day and sampling of their landings were carried out at the same time. The Doha shrimp fleet fish from dawn to dusk and, hence, the number of crafts actually fishing had to be checked in the evening, when they returned to port, but the sampling of the landings had to be carried out on the following morning during the unloading.

Random samples of 2 - 3 kg of shrimps from each fishing centre were taken at least once a month for the following measurements :

- total length (in mm)
- Carapace length (base of eye stalk to hind border of carapace close to middorsal, in mm)
- total weight (in g)
- tail weight (in g)

These measurements were carried out, according to sex in order to determine the sex ratio and differences in length frequency distribution and length-weight relationships between males and females.

These samples were purchased at the time of landing. When this was not possible, the transporting vehicle was followed to the market and samples purchased before any possible mixing of the catches, from the two centres or with shrimps from Iran and Oman, occurred.

### **Fishing Grounds**

The artisanal fishery for shrimps is conducted in the 2-6 Fm depth belt, extending between Doha and Al Khor. The Doha fishermen operate mainly near the two islands Safliya and Aliya, close to Doha. At the beginning of the season, when

young shrimps are predominant, the fishery is conducted closer to the island in about 2-3 Fm depth. Gradually, the fishery shifts north-easternly into waters of about 5 - 6 Fm depth. Very early in the season, or the beginning of the year, Al Khor shrimpers operate near either side of the entrance to the Khor (Bay) and then gradually shift to deeper waters, mainly north of the area fished by the Doha fleet.

In the area where the inshore shrimp fishing is conducted, the bottom is mainly sandy and it is muddy-sand in the adjacent deeper water (Purser, 1973). The bottom gradient is moderate in the vicinity of the shrimp grounds, while it tends to be relatively more steep in the adjacent area north of it and much less steep in the adjacent area south of it (Purser, 1973).

The involution of the coastline between Al Khor and Doha also presents a wide belt of 0 - 3 Fm depth in that area (Fig. 1). Occurance of ground water seepage and sweet water springs in this locality is not clearly known. Patches of sea grass (*Halodule* sp.) in the waters around the two small islands have been observed and a certain quantity of this weed appeared frequently in the hauls made by the shrimp trawls.

#### **Fishing Crafts, Gear and Operation**

In Doha, the shrimp trawling dhows generally do not carry out any other type of fishing activities. Hence, they are layed up during the lean and closed seasons and the crew, mainly Iranians, engage themselves otherwise during these periods or return home. A preliminary survey revealed, that about 25 traditional crafts carry shrimp trawls in Doha. However, this fleet has now been reduced to about 16 crafts. They range mainly from 7 - 10 m in overall length and are powered with inboard engines of 20 - 30 hp. A few others are of 10 - 12m and of less than 7m L.O.A. Those of less than 7m in length are primarily inshore gillnetters, which conduct shrimp trawling in the very shallow parts of the ground close to the islands, in waters of less than 3 Fm depth and at the beginning of the year when the shrimp fishing season commences. It was very rare that the entire fleet operated on any particular day and the average number of crafts operating per day decreased gradually towards the end of the season (Table 1).

Table 1

Fishing season, number of crafts operating, crew/boat and duration of trip for the Doha and Al Khor shrimp trawling fleet

Season	Average number of boats/day		Average number of crew/boat		Average duration of trip	
	Doha	Al Khor	Doha	Al Khor	Doha	Al Khor
March 1980	0	4*	0	3	0	12th (night)
April 1980	11	2*	2	3	12th (day)	12th (night)
May 1980	0	3*	0	3	0	12th (night)
June 1980	0	0	0	0	0	0
July 1980	13	0	2	0	12th (day)	0
August 1980	11	0	2	0	12th (day)	0
September 1980	10	8	2	3	12th (day)	12th (night)
October 1980	9	6	2	3	12th (day)	12th (night)
November 1980	8	6	2	3	12th (day)	12th (night)
December 1980	4	6	2	3	12th (day)	12th (night)
January 1981	0	2*	0	3	0	12th (night)
February 1981	0	4*	0	3	0	12th (night)

\* : Includes crafts conducting combined drifnetting and shrimp trawling.

At Al Khor, the fishing dhows are primarily off-shore driftnetters for large pelagics. A few carry out only shrimp trawling, when the shrimp catches are good or they carry out shrimp trawling on their way to and from the off-shore driftnetting, as a combined fishery, when shrimp catches are poor. Among these dhows, there is a periodic shifting from gillnetting to shrimp trawling, depending on

the relative value of the shrimp and kingmackerel catches. Hence, the number of dhows trawling for shrimp varies slightly with each day and the general level of effort is evident from the average number of crafts operating per day during each month (Table 1). These shrimp trawling crafts usually are larger in size than those at Doha, with 10 - 12m L.O.A. and 50 - 70 hp inboard engines.

The shrimp trawls used by traditional crafts are basically the Gulf of Mexico type with almost the same mesh size in all parts of the net. Although the majority of the nets have 1¼" (32mm) mesh size, a few of the nets examined at Al Khor had 1" (25mm) mesh size at the cod end and 1¼" mesh size in other parts.

The headline is about 6.5m with a few floats and the foot rope, carrying a chain, is about 7m. The otter-boards are approximately 100 cm (length) × 45 cm (height) and made up of two wooden planks with reinforced strips of iron traversing across the boards and around the free margin. In addition, it also has a T frame shoe. The warps of 20mm polyethylene ropes are about 45m long and are tied to the transverse beam which is 4½ - 5m long. The gear is manually operated by a crew of two in the dhows in Doha and three in those at Al Khor. The towing speed of the net was estimated to be 1.2 to 1.5 knots (Kristjohnsson, 1978).

Al Khor shrimpers leave port around 5 p.m. and return at 5 a.m. If trawling is near the entrance to the Bay, the sailing time is about ½ hour, but to the main shrimp fishing area, the sailing time is about 1½ hours. From Doha, the shrimp dhows leave around 4 a.m. and return between 4.30 and 5.30 p.m.; their sailing time to the grounds varies between 1½ to 2 hours. The towing time varies generally between 1.5 - 2.0 hours per haul and an average of four hauls are made during each trip.

The period between 1st February and 30th June has been declared as closed season. The main shrimp fishing season in Doha is from July to December, but one or two boats may go out sporadically during the first half of the year to check concentration of shrimps in the ground. However, during April 1980, the operation was steady and production significant.

At Al Khor, the main fishing season is from September to December, but some dhows carry out trawling, solely or combined with driftnetting, from January to May. From June to the end of August, all fishing activities at Al Khor were halted, except for inshore gillnetting and occasional handlining, as the crew returned to their home states for Ramadan and summer holidays.



## Catch Composition

The community in the shrimp grounds is of a highly mixed composition. About 21 varieties (Families) of finfishes and 4 varieties of shellfishes were commonly caught in the trawl. Some difference in the percentage species composition was observed from the annual totals for the two fishing centres (Fig. 2), but it is difficult to comment on this. Almost all species of finfish caught were juveniles or young ones of demersal fish species, except flatfishes (Soleidae and Bothidae), and were generally in the size range of 6 - 20cm. Only two species of the finfishes were found to be totally unmarketable in Qatar; the others, even though small in size, were marketable because of their limited quantities.

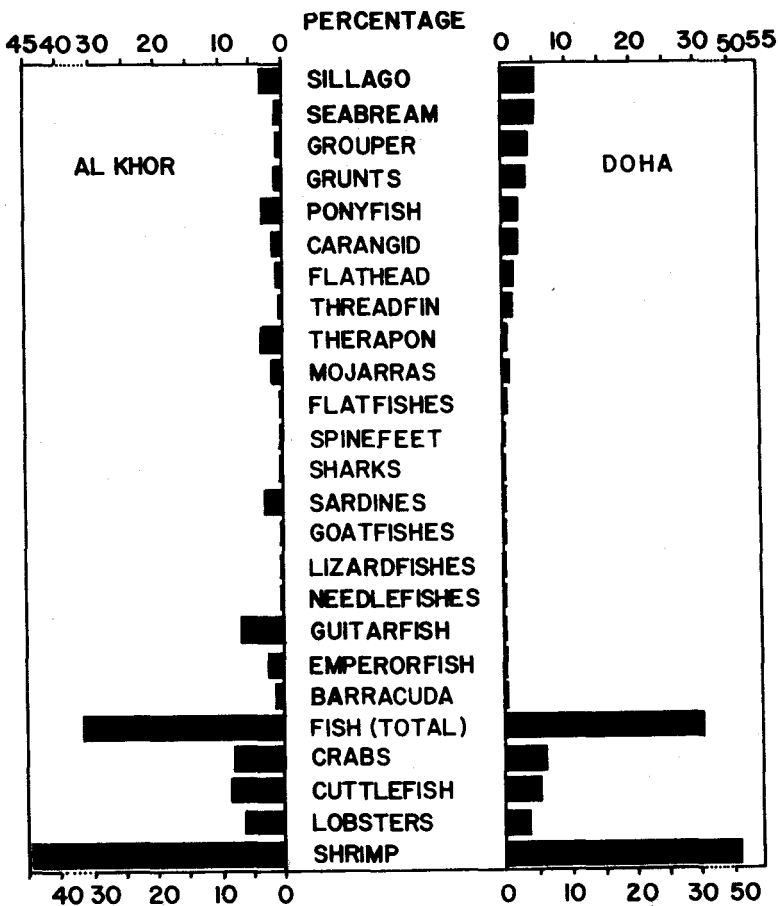


Fig. 2. Percentage composition of the shrimp trawl catches by the fleet at Doha and Al Khor, 1980.

The following shellfish varieties enter the shrimp fishery in the inshore waters of Qatar and these are marketable irrespective of the size ranges entering the fishery :

- shrimps (*Penaeus semisulcatus* de Haan, *Metapenaeus elegans* de Man, *Metapenaeus stebbingi* Nobili, *Metapenaeopsis stridulans* (Alcock) and *Alpheus* sp.)
- slipper lobster (*Thenus orientalis* (Lund))
- cuttlefish (Sepioidea).

Crabs (*Portunus pelagicus*) are landed only if they are of marketable size. *P. semisulcatus* was identified as the main species of shrimp in the catches made with relatively very small quantities of *M. elegans* occurring almost always. This *Metapenaeus* species was extremely negligible at Al Khor, but it was about 12 % in terms of number of individuals or 5 % of the weight in the shrimp samples taken from the Doha landings. Other species of shrimp mentioned above were extremely poor in quantity and frequency of their occurrence in the landings.

Both at Al Khor and Doha, the finfish represented 32 % of the catch and the shrimps 51 % and 44 % respectively (Fig. 2). These proportions were seasonally variable, with higher proportions of finfish at the beginning and the end of the shrimp fishing season.

### Catch Rates and Production

The size range of the crafts, characteristics of the trawl gear and duration of each trip at each centre varied within extremely narrow ranges. In view of this consistency and the difficulty in determining the exact duration of the tows per trip, it was considered that each trip is a suitable unit of effort and the catch/boat/trip was taken as the catch per unit effort or the catch rate. The mean catch rate for each month and that for the season as a whole, were determined from the landings which were sampled during each calendar month and over the entire fishing season in a 12-months period, respectively.

Although a large number of crafts from Doha were engaged in shrimp trawling during April, the catch rates were extremely poor. The best catch rates were realised in July 1980 when the proper fishing season started and then it steadily declined until the end of the season in December 1980 (Fig. 3a). At Al Khor, the monthly mean catch rates showed peaks in April and October, but that of April was higher and most equal to the peak in July for the Doha fleet (Fig. 3b). The shrimp fishery at Al Khor was not operational during July and August, when the Doha fleet was experiencing their best catch rates. The catch rate in January of the following year (1981) was the lowest for the Al Khor fleet and it improved in February, but the fishery was not continued into March/April although this period in 1980 yielded the best mean catch rate.

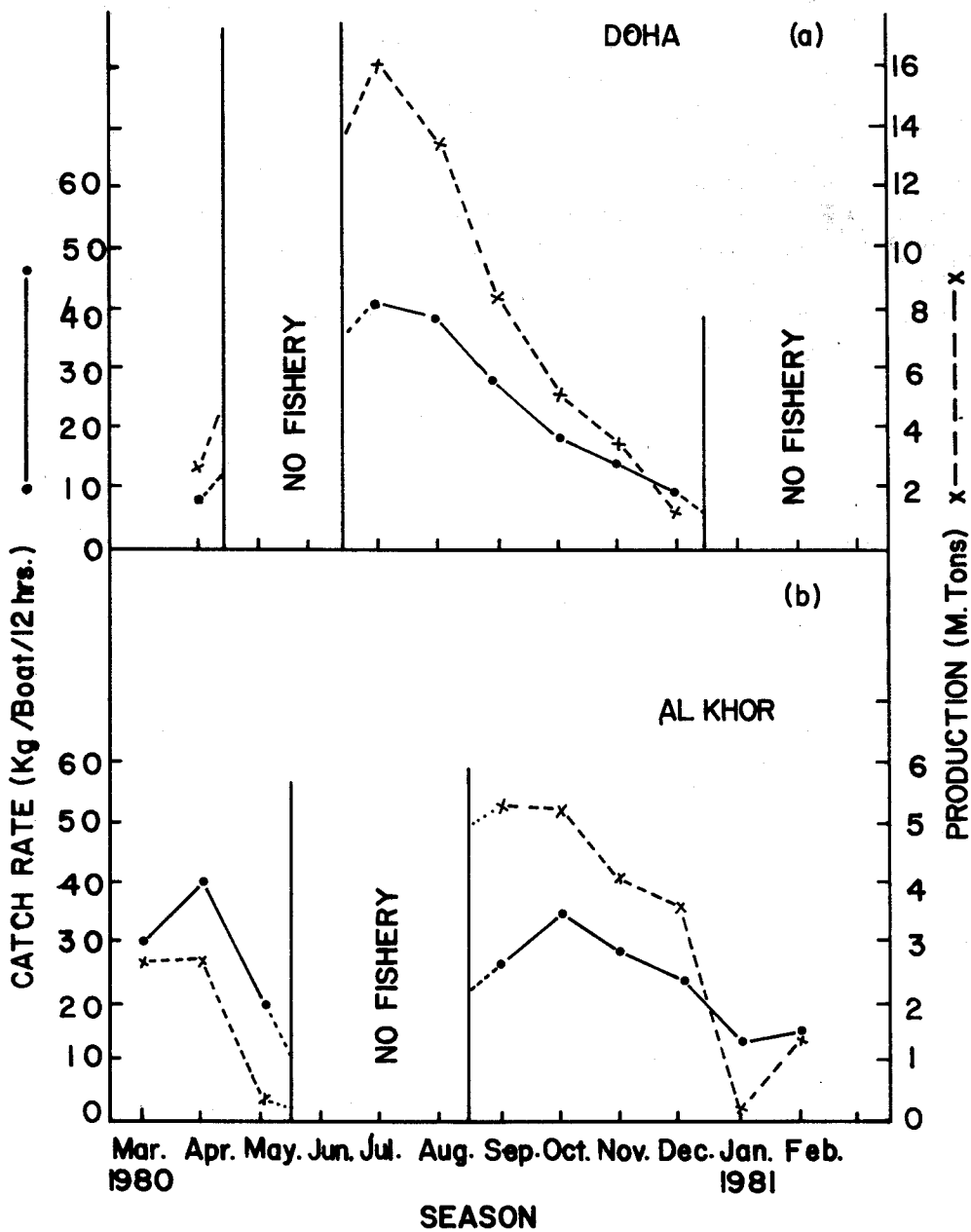


Fig. 3. Seasonal variation in catch rates and production of shrimp, at Doha and Al Khor (1980/81).

A higher mean catch for the season was observed in the Al Khor fishery, compared to that of the Doha fleet, but a student's 't' test indicated that the difference was insignificant. The frequency distribution of the catch rates (Fig. 4a and 4b) showed a high degree of variability for the fleets from both fishing centres but their ranges were almost the same. However, the distribution for the Doha fleet was highly skewed, which reduced the validity of the 't' test. The variation between months was much greater than the variation within any month of the fishing season.

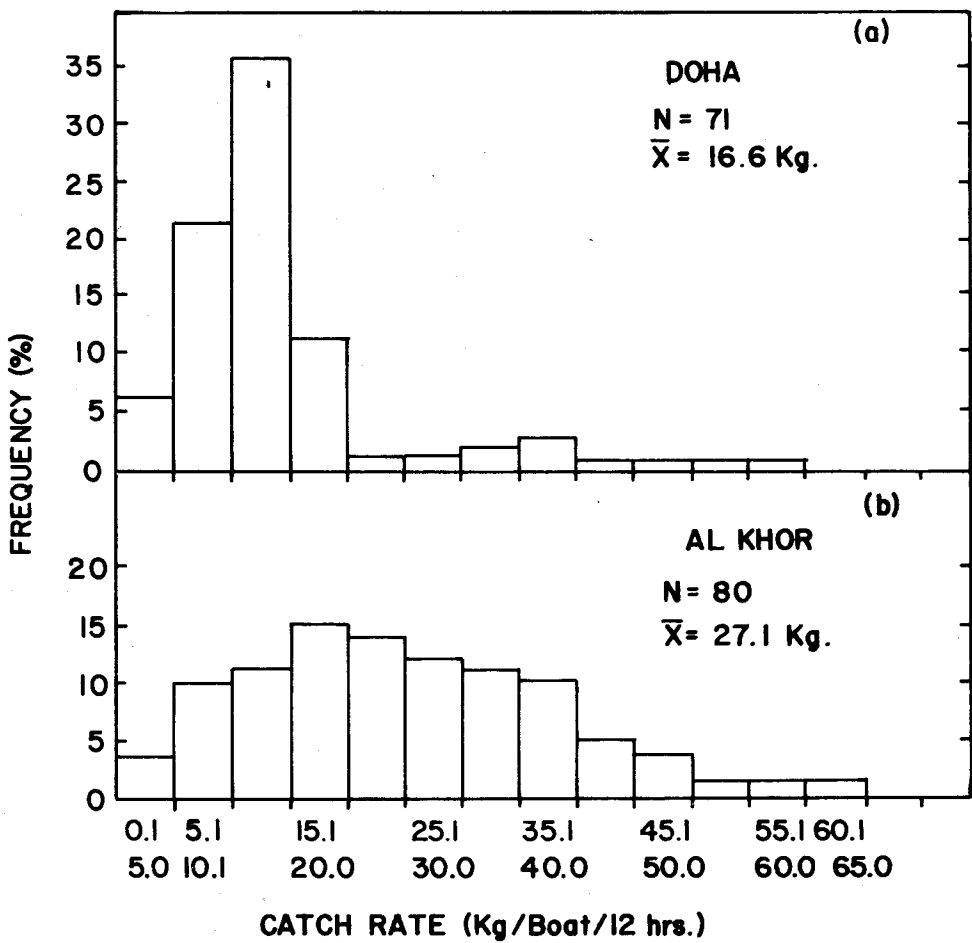


Fig. 4. Frequency distribution of shrimp catch-rates, at Doha and Al Khor (1980/81).

The two fleets were operating from bases which are placed at the two extremities of the fishing ground. It was not possible to ascertain the degree of overlapping of the fishing grounds, covered by the two fleets. The higher mean catch rate for Al Khor may have been partly due to the relatively better operational range of their crafts, higher power of the engines, difference in distribution of shrimp by day and by night, any difference in the shrimp distribution pattern in the northern and southern halves of the ground, as indicated by the seasonal variation and partly due to other reasons.

The monthly production of shrimps from the two fishing centres, based on the sampling conducted, are shown in Figures 3a +b. For the period of 12 months (March 1980 - February 1981), the production of shrimps from the inshore waters of Qatar was estimated to be 75'975 kg. The production by the Doha fleet, with 7 months of fishing, was estimated to be 50'315 kg and that by the Al Khor fleet, with 9 months of fishing, was 25,660 kg. As some consumers (local and expatriate) preferred to buy shrimps directly at landing points, the quantity retailed through the Doha market may not represent the actual production.

### Size Composition

The size composition of the shrimp *Penaeus semisulcatus* entering the fishery, ranged from 10mm - 44mm in carapace length (base of eye stalk to mid dorsal end of carapace). The carapace length frequency distribution of the samples of the various months in which the fishery was conducted, showed polymodal tendencies, particularly in the case of Doha samples. However, it is possible that this may have been partly due to the small size of the samples. Samples from Al Khor were taken only from September 1980 and the mean size of the shrimps was observed to be slightly smaller than that from Doha. Hence, carapace length frequency distributions were determined separately for the two fishing centres (Figs. 5 - 8). The modal size for males and females tends to be the same in the early stages but when the carapace length exceeds 16 - 18mm, the modal size of the female advances faster than that of the male. Though polymodal, there appears to be only a single peak mode for each sex, indicating that the fishery is primarily exploiting the recruitment from a single spawning season and during the main fishing season, the size range of this group varied from 22 to 32mm in the case of males and 26 to 36mm in females.

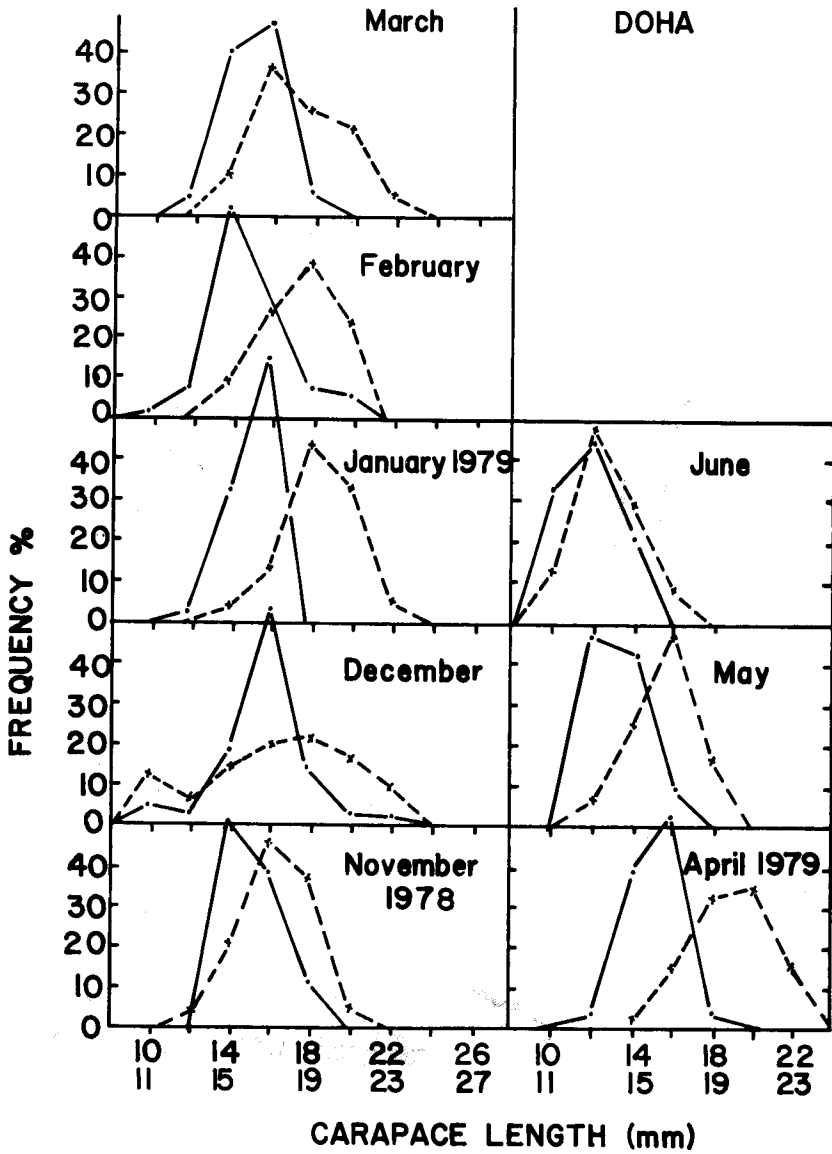


Fig. 5. Carapace-length frequency distributions for shrimp landed in Doha, between Nov. 1978 and June 1979.

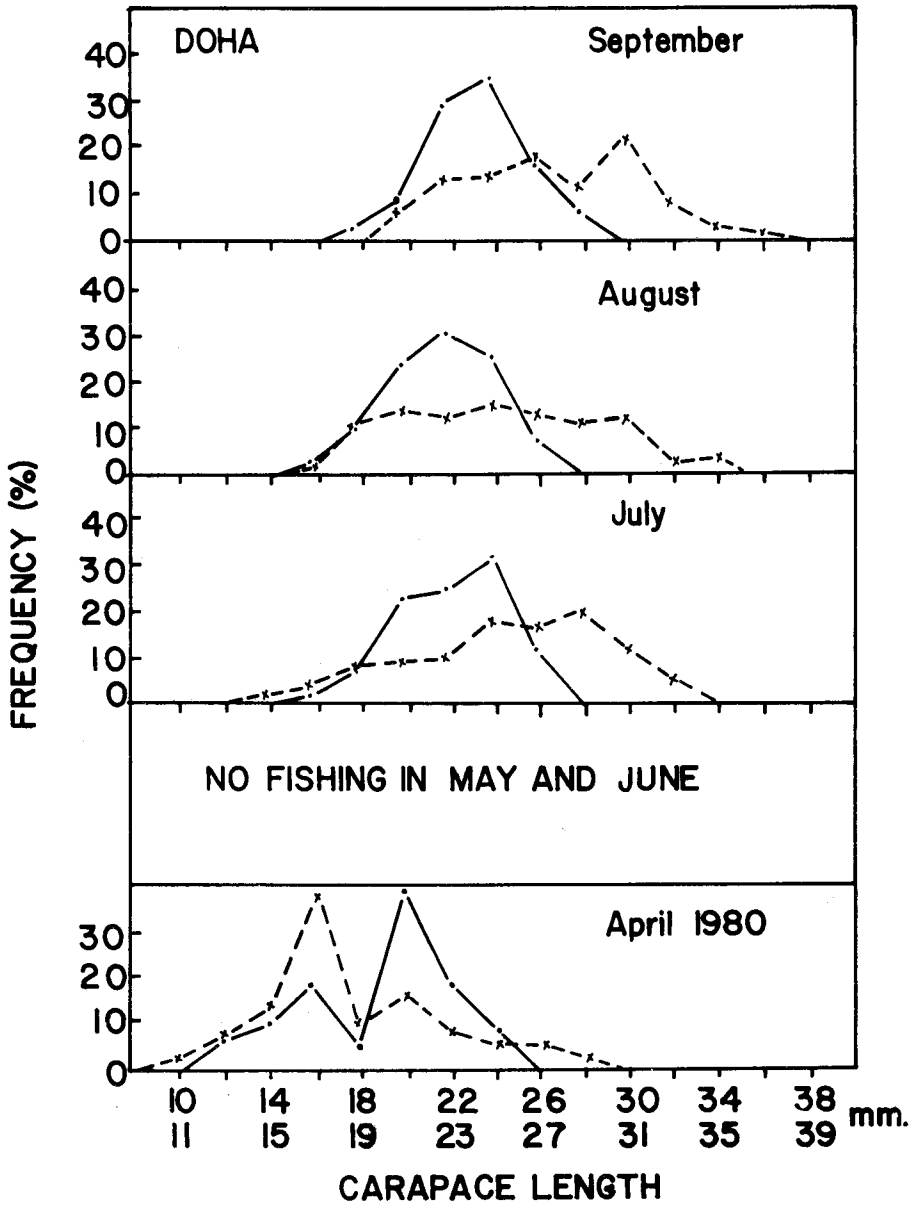


Fig. 6. Carapace-length frequency distribution for shrimp landings in Doha, between April 1980 and Sept. 1980.



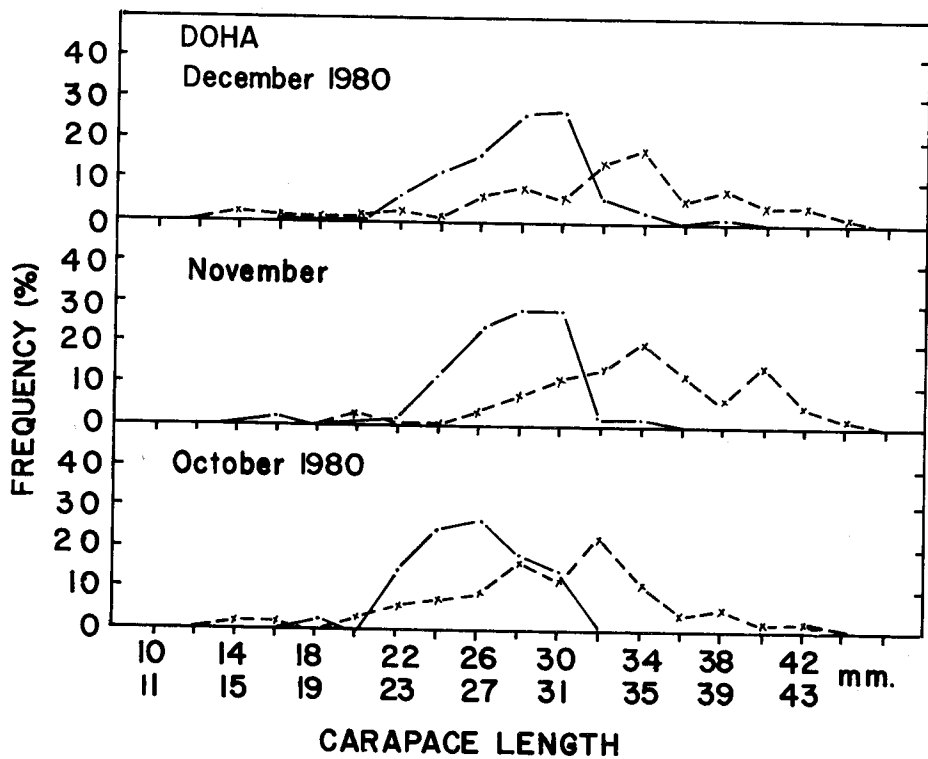


Fig. 7. Carapace-length frequency distributions for shrimp landings in Doha, between Oct. and Dec. 1980.

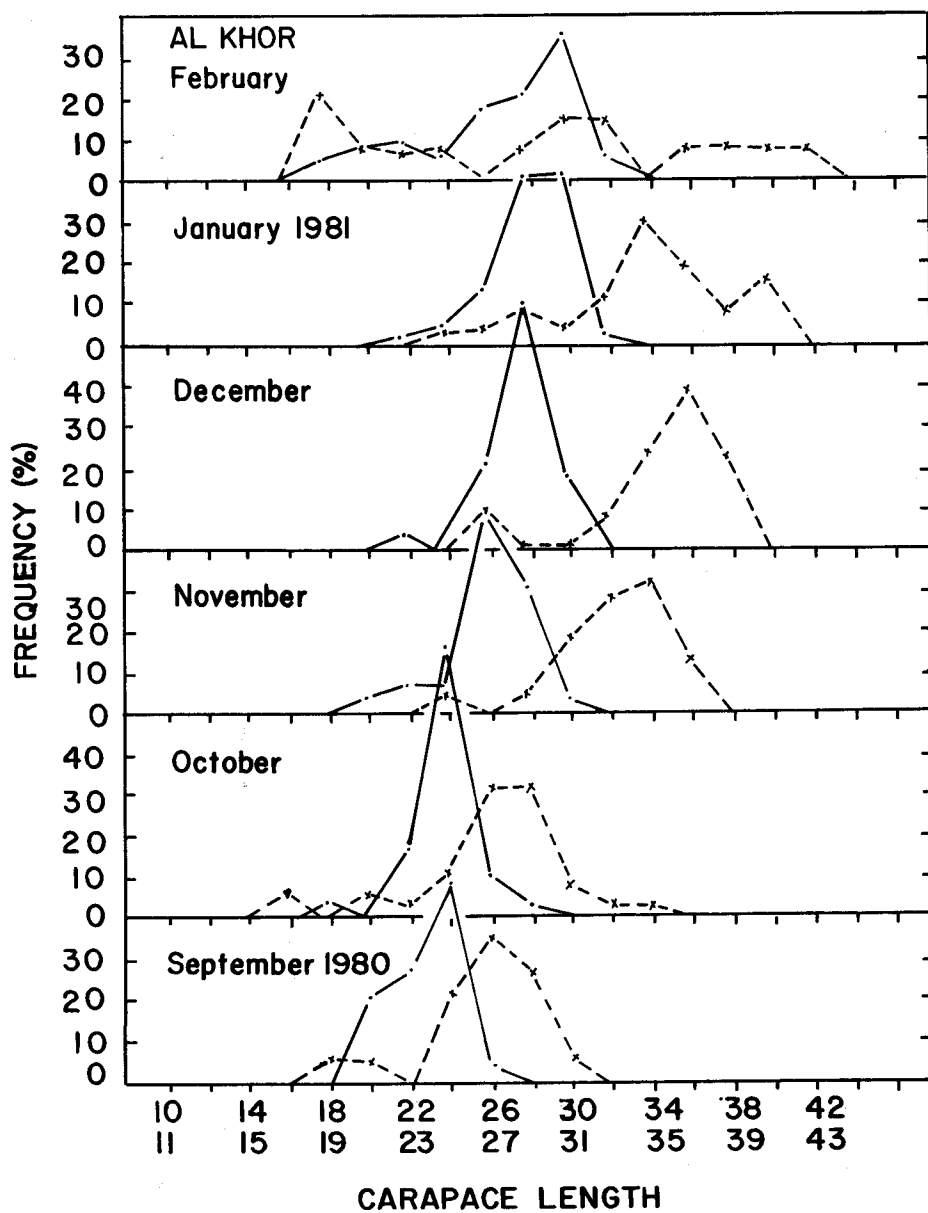


Fig. 8. Carapace-length frequency distributions for shrimps landings at Al Khor, from Sept. 1980 to Feb. 1981.

The appearance of very small modal groups of less than 22mm carapace length, around April and between October and December in the Doha catch, and around February and September/October at Al Khor, are possible indications of fresh recruitment. Maximum carapace lengths observed from the males and females entering the fishery, were 36 and 44mm at Doha and 34 and 42mm at Al Khor, respectively.

It appears from the size range entering the fishery, that at least a component of the shrimp stock on the eastern coast of Qatar is vulnerable to the inshore artisanal fishery over a greater part of their life. The size range in the deeper, waters, beyond the reach of the traditional crafts, is not known. Because of the small mesh size in the trawlnets, the entire size range of shrimps in the inshore fishing grounds is vulnerable to the gear used. The length-frequency distribution for the *Metapenaeus elegans* observed in the samples, is shown in Figure 9.

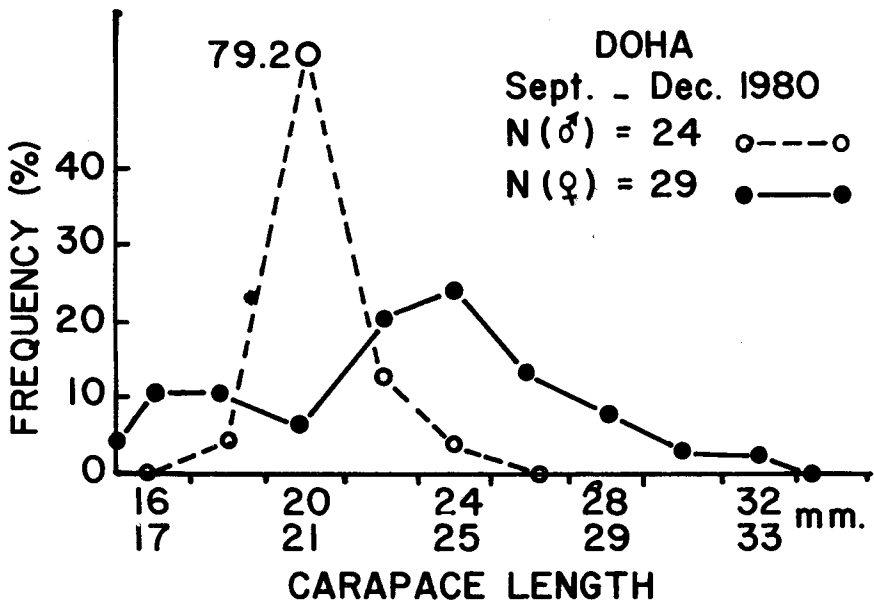


Fig. 9. Carapace-length frequency distribution of *Metapenaeus*.

### Sex Ratio

The ratio of males to females was checked from the samples (which were taken monthly) and was found to be 0.98:1 in Doha and 2:1 at Al Khor, for the whole season. However, there was no homogeneity in the series of monthly values. A chi-square test, according to Brandt and Snedecor's formula, revealed a very

significant heterogeneity in the series of monthly ratios for Doha and Al Khor; the small size of each sample and any error in the sampling could have contributed to this. However, a similarity in monthly variation of the sex ratios, within the season, was noticed in the samples from the two fishing centres (Fig. 10). Comparison of this monthly variation with the corresponding length frequency distribution indicates that the proportion of females tends to be relatively higher in the months in which young shrimps commence to enter the fishery, particularly in the southern part of the fishing ground. Further investigations are necessary to determine, whether higher rate of growth of the females increases its vulnerability to the fishery and/or causes an early migration into deeper waters to project a higher proportion of males with the progress of the fishery.

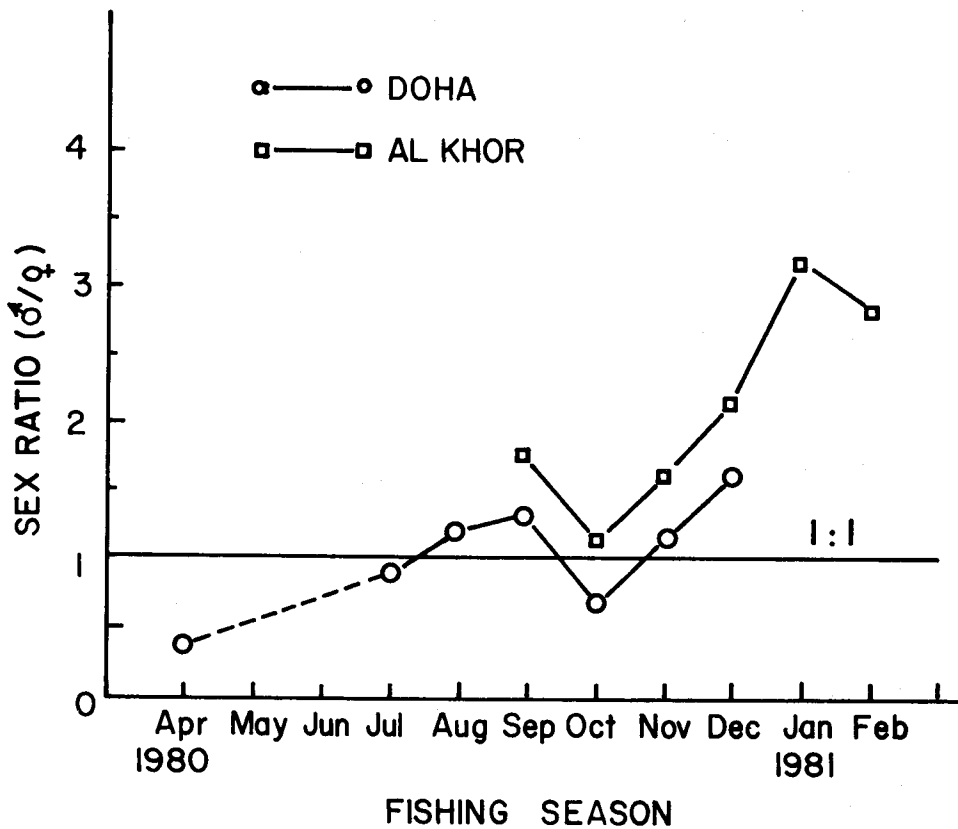


Fig. 10. Monthly variation of the sex ratio in the samples taken.

## Length - Weight Relationships

In view of the differences in the monthly mean size of the shrimp, observed in the landings at Al Khor and Doha, the relationship between Carapace-length ( $L_c$ ) and Total-length ( $L_t$ ), Total-length and Body-weight ( $W_b$ ), as well as Carapace-length and Body-weight, were determined separately for the two sexes and the two fishing centres.

The relationship between Total-length and Carapace-length fitted a linear regression and the differences due to sex and fishing centres, were not statistically significant. Hence, a regression equation common to both sexes and both fishing centres, was derived (Fig. 11a).

$$L_c = -1.68 + 0.22L_t$$

Though the females tend to have a slightly longer carapace than the males at similar body-weight, the differences, due to the sex and the fishing location, were not statistically significant (Fig. 11b)

$$W_b = 1.24622 \times 10^{-3} L_c^{2.86}$$

The relationships between Body-weight and Total-length also showed no significant differences due to sex and the location of the fishing centre (Fig. 11c).

$$W_b = 4.89913 \times 10^{-6} L_t^{3.08}$$

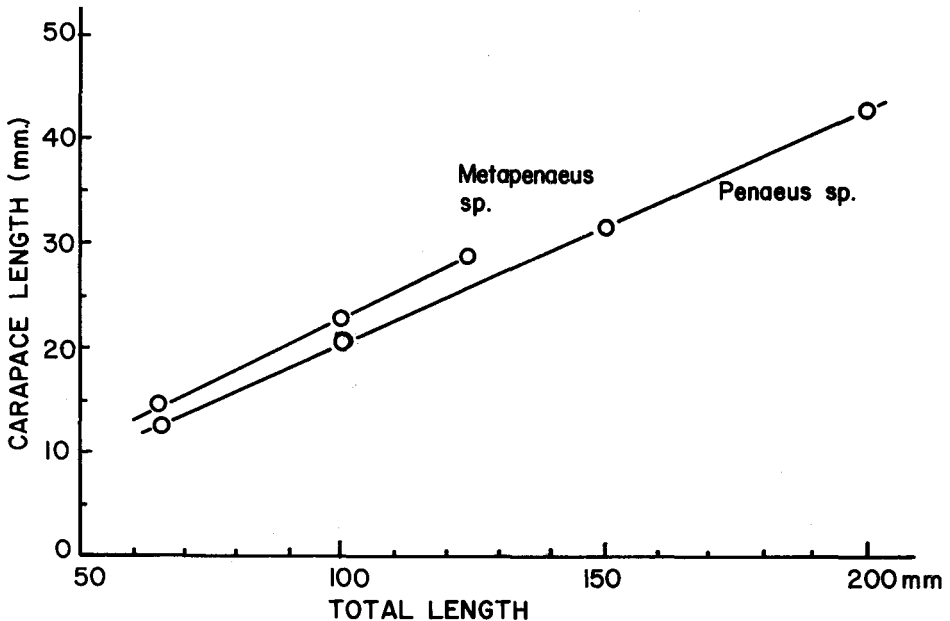


Fig. 11 a. Correlation between Total-length and Carapace-length of *P. semisulcatus* and *Metapenaeus* sp., from Doha and Al Khor.

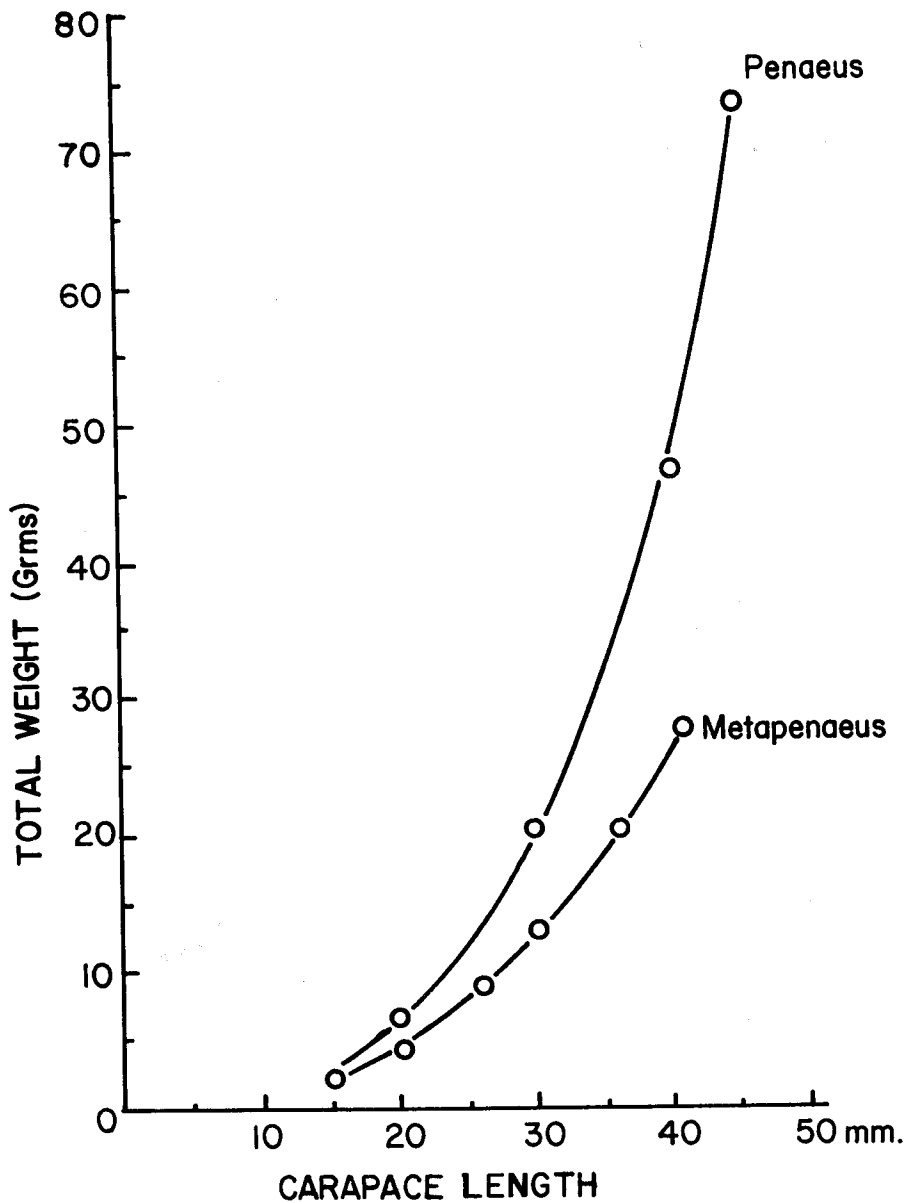


Fig. 11 b. Relationship between Carapace length and Total weight of *P. semisulcatus* and *Metapenaeus*, from Doha and Al Khor.

Generally, the commercial fishery records show the shrimp production in terms of Tail-weight and number of tails per unit weight. Hence, regressions for the

Body-weight and Tail-weight ( $W_t$ ) and Carapce-length and Tail-weight, determined for the convenience of any future utilization of the data from commercial fishery records (Figs. 11d and 11e).

$$W_t = 0.27 + 0.63W_b$$

$$W_t = 1.68447 \times 10^{-3}L_c^{2.64}$$

A common regression equation for the Carapace-length vs Body-weight, for both sexes of the *Metapenaeus elegans*, was also derived from the measurements of the small numbers of this species in the samples taken (Fig. 11.b).

$$W_b = 3.195 \times 10^{-3}L_c^{2.45}$$

### Growth Rate, Age and Spawning

The mean Carapace length of the males and females, as well as the monthly shift in the mean Carapace length of the shrimp landed at Doha and Al Khor, were observed to be different (Fig. 12).

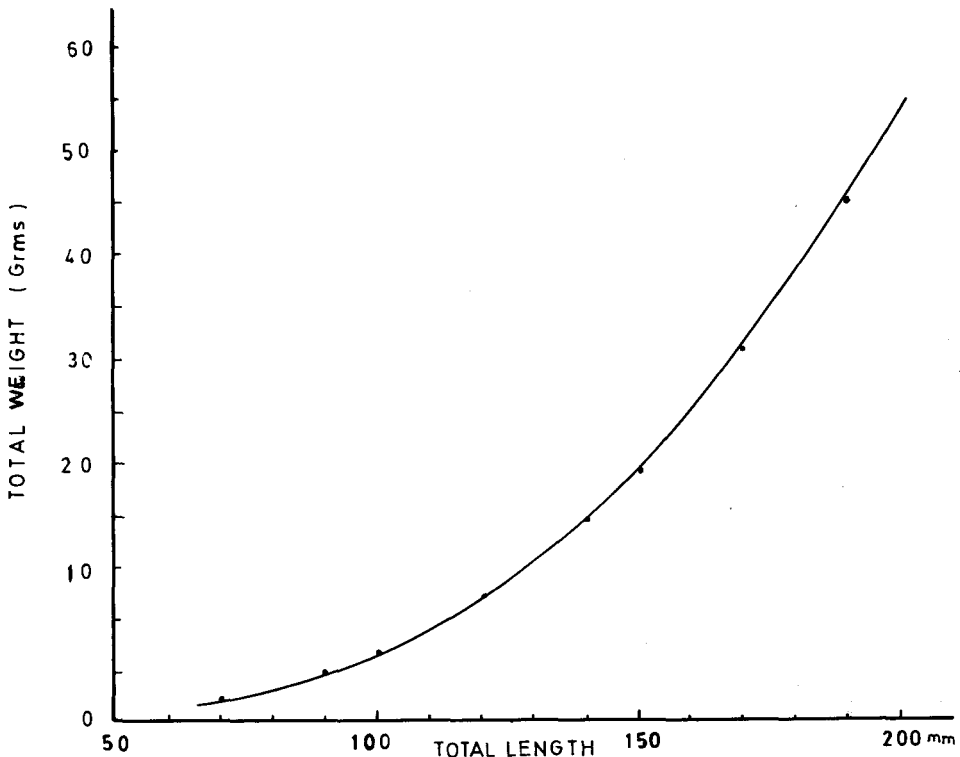


Fig. 11 c. Relationship between Total length and Total weight of *P. semisulcatus* from Doha and Al Khor.

Unfortunately, at Al Khor length frequency sampling was not carried out in March, April and May 1980 and the mean Carapace lengths were found to be less than those for Doha catches, when the fishery at Al Khor re-commenced in September. The mean Carapace lengths of males and females in the Doha catches reached their maximum in November and showed a decrease in December, when the fishery was suspended because of extremely poor catch-rates. On the other hand, in the Al Khor fishery, the mean Carapace length reached its maximum (equivalent to that of Doha) in December, which was a month later than in Doha, and it decreased in January and February. The observed decrease at Al Khor and Doha were partly influenced by the entry of smaller shrimps into the fishery and the decline in the density of larger shrimps, due to exploitation and/or migration into deeper waters.

To overcome the influence of recruitment, exploitation and migration, the monthly progression of modal size groups (Carapace length) was plotted (Fig. 13). A more or less linear progression was observed for the size range entering the inshore fishery, indicating that growth rate during this phase of their life may be fairly steady. From the slopes, it is estimated that, on an average, the female gain 2mm and the males 1.8mm in Carapace length per month. If one assumes that these average rates of growth are maintained, even during the early stages of development and metamorphosis, when in fact it should be greater, then it would

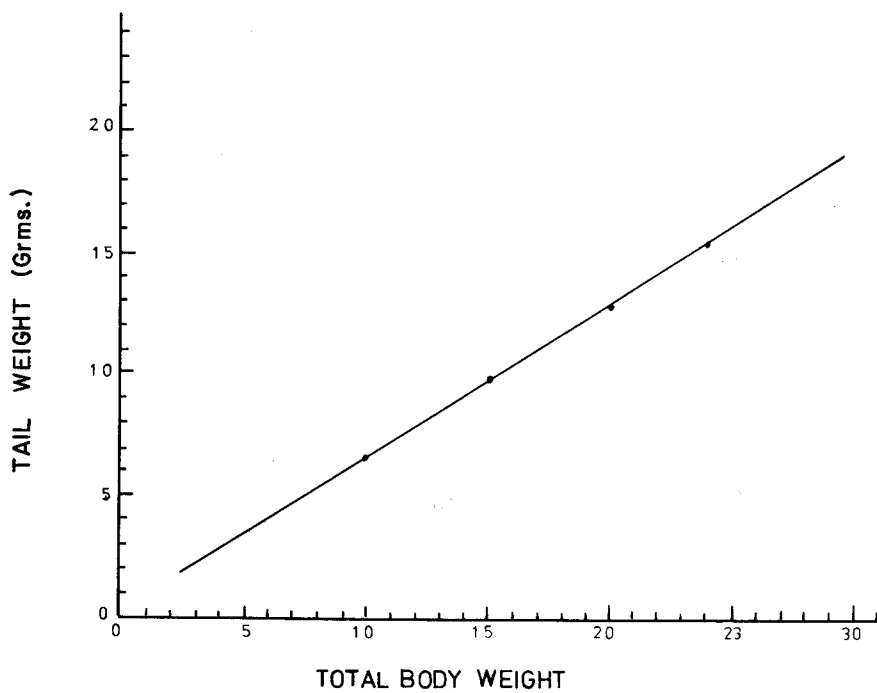
have taken about 22 months to attain the maximum size observed in the fishery. However, compensating for higher rate of growth during the first two months at least, it is likely to have taken between 18 and 20 months to reach the observed maximum size. On this basis, the male and females should have a Carapace length of 24 - 28mm and 28 - 32mm respectively, when they are about one year old, but the rates of growth, estimated by Mohamed (1978), for the males and females of the species around Bahrain, were slightly lower and higher, respectively, than the values presently estimated for Qatar waters.



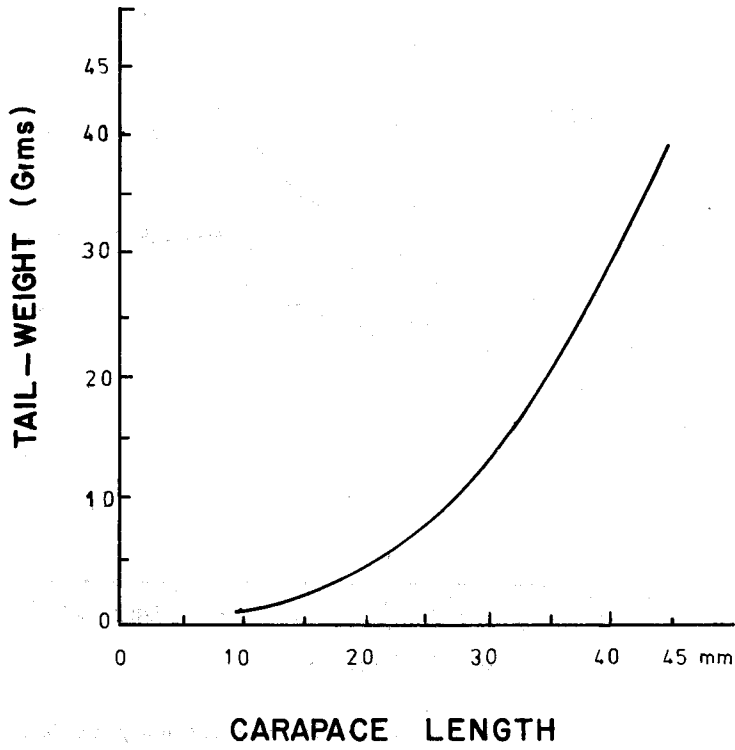
Bearing the above interpretation in mind, and considering the length frequency distributions in which indication of fresh recruitments were evident during April - June and October - December, it is inferred that there are probably two spawning seasons or a very wide spread-Staggered spawning season with two peaks at either ends of the season, in Qatar waters. Though the fishery during the main fishing season in any one year would be exploiting mainly the recruits from a single spawning period, smaller components of larger shrimps from the preceding spawning season and new recruits from the succeeding spawning season also contributed to the fishery. The main stock of any year becomes depleted by the end of the calendar year and the whole process seems to be repeated each year. Grouping of the plottings for the modal progression was attempted on this basis, as shown in Fig. (13). Certain degree of scattering of the plotted points was observed, and this was attributed to each spawning being spread over a period of at least two months (based on the range of their Carapace lengths), possible error in the sampling and small size of each sample. Hence, the progression of the modal group from each recruitment is represented by a broad strip.

Sampling for size frequency and maturity, conducted during November 1978 to June 1979 by the second author, revealed that over 60 % of the females had ripe ova in November and March. A few individuals with ripe ova were observed in other months, except January and June, when none of the females displayed ripe ova. Considering the seasons of noticeable recruitment, the seasons with high percentage of females carrying that peak spawning may have taken place approximately around March/April and October/November 1979/80.

As environmental conditions are generally related to spawning, the mean maximum and mean minimum water temperatures, recorded at Doha (Jackson, 1979-1980), were used as indicators of the trend in seasonal changes in temperature in the adjacent shrimp grounds and according to which, both in March/April and October/November, the average maximum and minimum temperatures ranged between 25 - 30°C and 20 - 25°C, respectively. During the rest of the year, the temperatures were either higher or lower than the above ranges.



*Fig. 11 d.* Relationship between Total body weight and Total weight of *P. semisulcatus*, from Doha and Al Khor.



*Fig. 11 e.* Relationship between Carapace length and Tail weight.

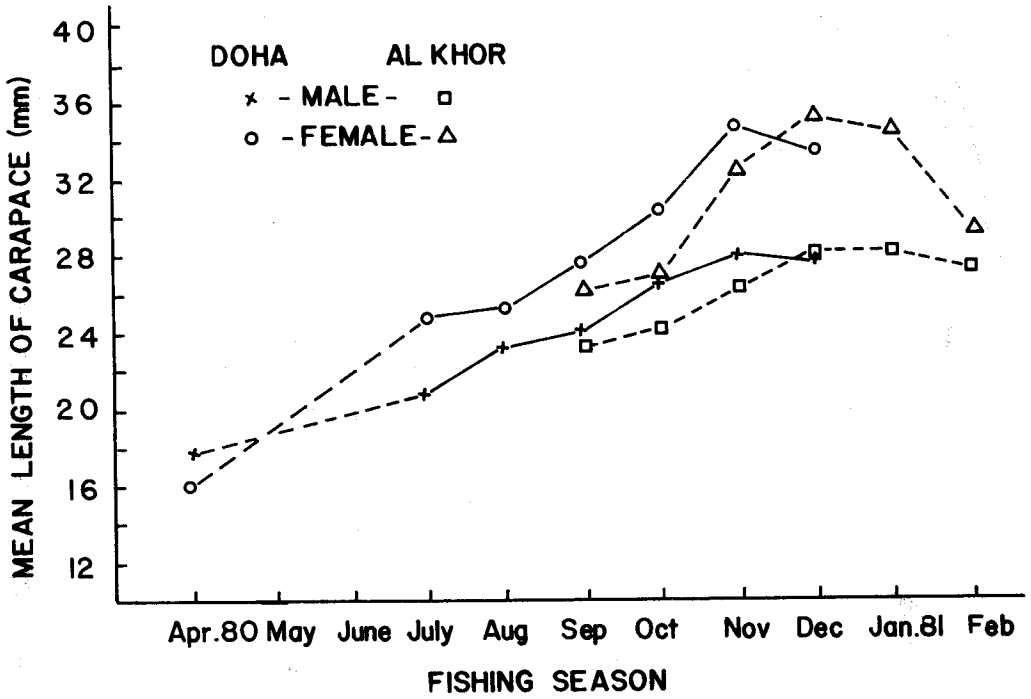


Fig. 12. Monthly variation in the mean carapace-lengths of males and female shrimp at Doha and Al Khor.

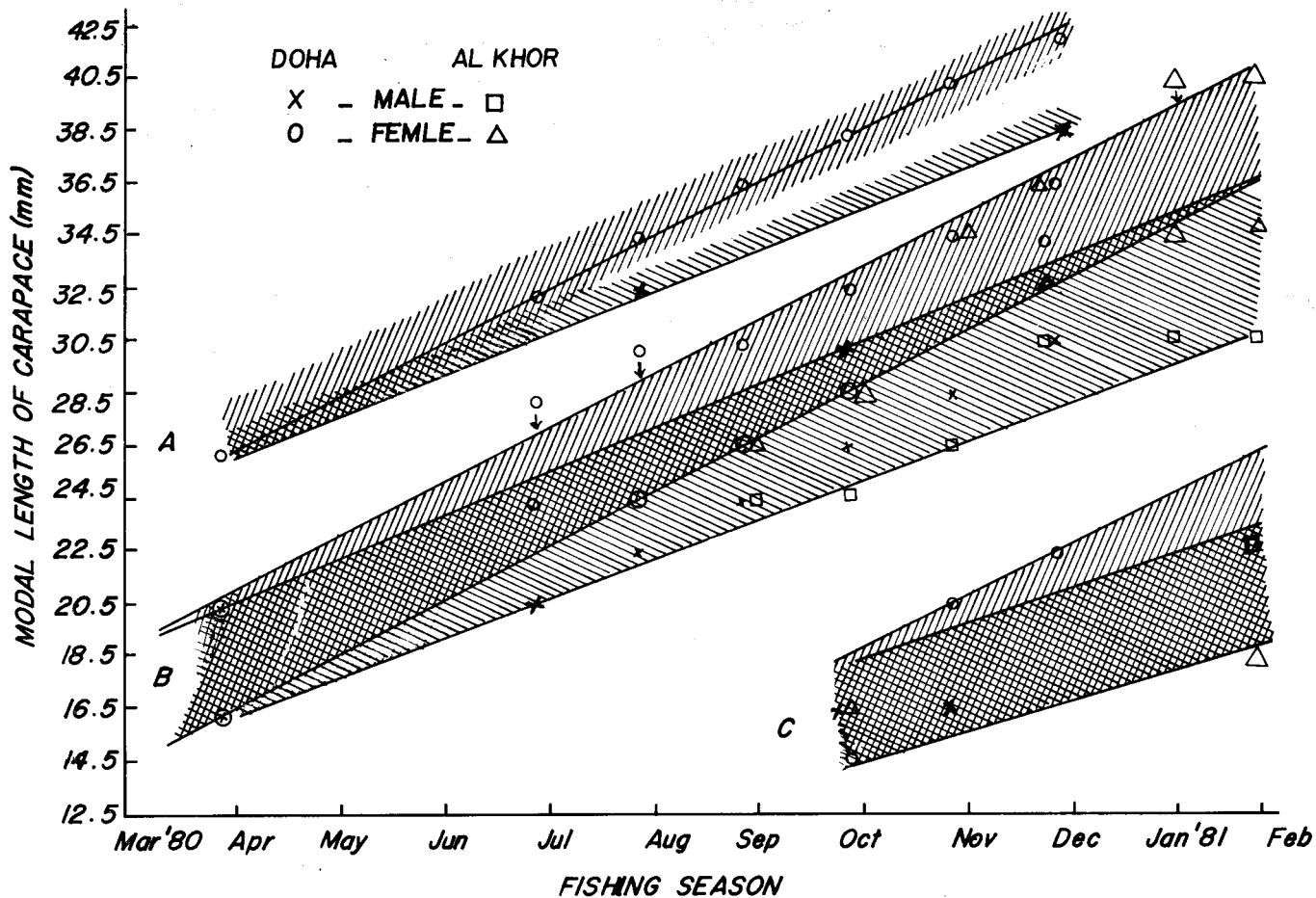


Fig. 13. Modal progressions for male and female shrimp from Doha and Al Khor.

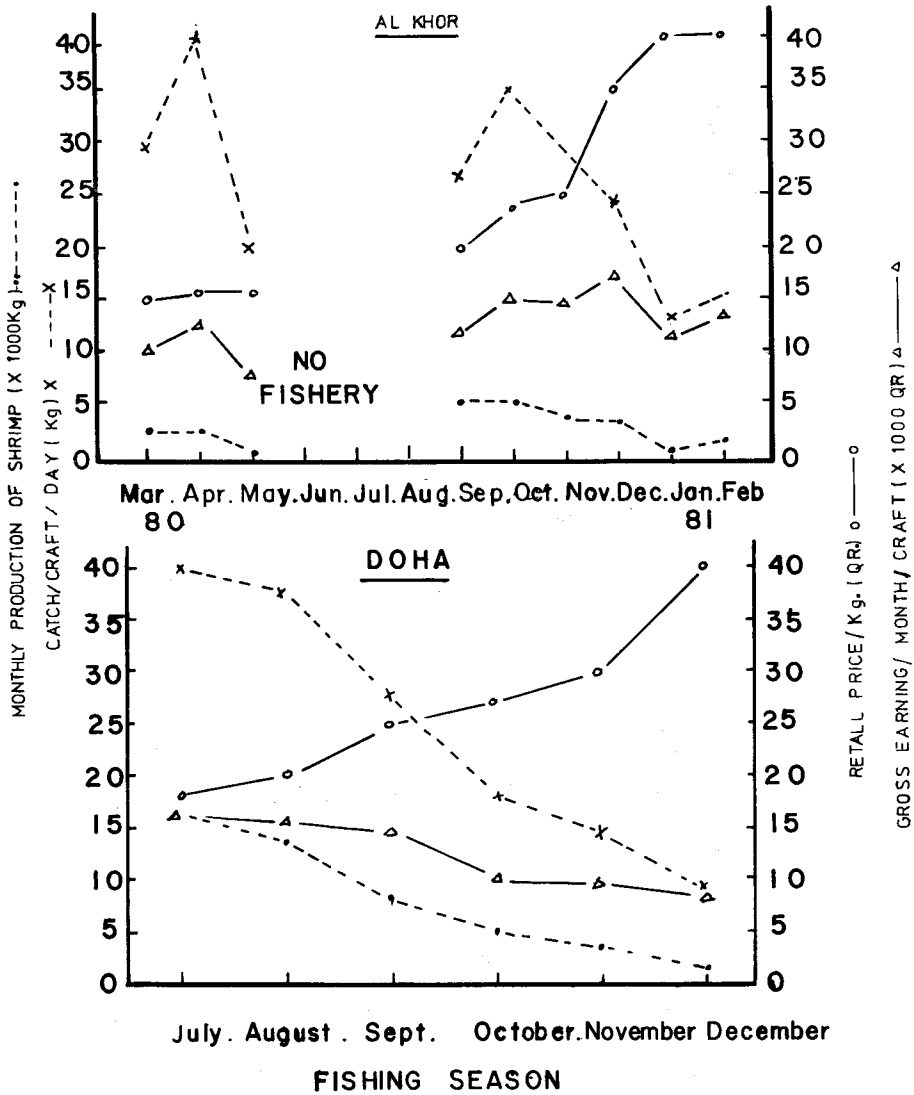


Fig. 14. Monthly catch rates, Production, retail price and gross earning per craft, at Al Khor and Doha, during 1980.

Based on the above discussion, the modal groups A and B (Fig. 11) were probably spawned in the spring and fall of 1979 and group C in the spring of 1980. This is also supported by the fact that when the progression of the modal group for the largest size shrimp (A) was extrapolated, it tends to reach the modal plottings for the smaller size shrimps in the fishery of May/June 1979. This approach also suggests, that the maximum size of shrimps recorded would be about 19-20 months old and that the modal length of Carapace at the end of one year would be in the region of 28-32mm for females and 24-30mm for males. At the beginning of the main fishing season, the main stock entering the fishery will be about 7 - 8 months old and continues to support the fishery until they are about one year old. At the end of the year, the density of this stock declines to a level uneconomical for exploitation, due to intensive fishing and/or migration into areas beyond the reach of artisanal crafts.

### **Population Density and Mortality in the In-shore Fishing Ground**

From the foregoing discussion, it appears that in 1980 the fishery in the inshore waters of Qatar was mainly dependent on the "O" age group and the population density at the beginning of the main fishing season around the middle of the year would have been affected by the exploitation of the juveniles and the young shrimps during the first half of the year 1980, mainly by the Al Khor fleet and partly by the Doha fleet. The decline in the catch rates during the main season projects a decline in the density by weight, which is less than the decline in density by numbers, because of the increase in weight due to growth during the period of exploitation.

An almost steady increase in mean Carapace length during the main fishing season indicates the absence of significant levels of recruitment during this period, except towards the end of the year (1980), when commencement of entry of new recruits and reduction in the density of older shrimps tend to lower the mean length. The mean length would have continued to decline until the recruitment was completed in the first quarter of 1981, but the catch rates would begin to recover to a level dependent on the strength of the recruitment.

In order to obtain some idea of the total instantaneous mortality rates (Z) in the inshore fishing grounds, during the main fishing season, the monthly mean catch rates were used as indices of abundance and the indices in terms of numbers of shrimps obtained by using the monthly mean Carapace length, sex ratio and the relationship between Carapace length and Body-weight. Then, considering.

$$Z = \log_e \frac{N_t}{N_{t+1}} \frac{t}{1}$$

( $N_t$  number of shrimp of age  $t$  in any month and  $N_{t+1}$  is the number in the succeeding month)

and assuming that the Al Khor fleet exploit mainly the northern sub-area, with the Doha fleet fishing mostly in the southern sub-area of the shrimp ground, the monthly total mortality rates were estimated separately for the two sub-areas and combined for the three overlapping months. A wide range of values were obtained (Table 2).

Table 2

Total instantaneous mortality rates (monthly) of shrimps in the inshore waters of Qatar.

FISHING AREA	S E A S O N						
	July/ Aug.	Aug./ Sept.	Sept./ Oct.	Oct./ Nov.	Nov./ Dec.	Dec./ Jan.	Jan./ Febr.
DOHA	0.30	0.44	0.69	0.42	0.46	—	—
AL KHOR	—	—	0.10	0.51	0.27	0.66	0.40
COMBINED	0.30	0.44	0.20	0.49	0.33	0.66	

The migration of juveniles into the main fishing ground, localised movement of the medium sized shrimp and the migration of mature shrimps into deeper waters for spawning, have influence on these values.

The extremely low or even negative values were obtained for recruitment periods and extremely high values were obtained during periods when outward migration is suspected to take place, as evident from the shifting of the length frequency distribution and mean Carapace lengths. Considering only the months in which the stock is not likely to be influenced by these factors, it is estimated that the total instantaneous mortality rates (monthly) of the shrimps in the inshore water vary between 0.30 and 0.49.

### Economic Aspect

Biological and economic aspects have to be considered as the basis for determining effective management measures. In Qatar, the high standard of living,



high costs of labour, non-taxation of income, predominance of expatriate fishermen and the traditions and culture, have a combined effect on the demand for fish and shell-fish, fish production, consumer preferences, investments in fishing ventures, marketing of fish and shell-fish etc., which are, perhaps, not akin to the situation prevailing in the developing and developed countries in other regions.

The shrimp fishery in Qatar is carried out on a 50/50 profit sharing basis between the owner and the crew, after deducting the operational costs. The shrimps landed in Doha are not auctioned, but handed over to retailers who take 10 % of the gross earnings. On the other hand, the shrimp from Al Khor are auctioned in Doha (6 % commission to auctioneer) and the retailer makes a profit of 10-15 %. The retail price varies between QR. 15. - and QR. 40 - per kilogramme, depending on the monthly production and size of shrimp. The mean size and retail price increase steadily with the decline in the monthly production and the catch rate (Fig. 14), during the main fishing season. Shrimps are also brought to Doha from Iran (by dhows, on ice) and Oman (by trucks, in ice boxes) but their quality is relatively poor and, hence, the demand and price for the fresh shrimps from Qatar are always higher than those for shrimps from Oman, Iran or the frozen shrimp tails in Super-markets.

The fixed and variable costs involved in the operation of shrimp trawling dhows in Doha and Al Khor were estimated from information collected through interviews and the revenue per craft in 1980 was estimated from the monthly mean catch rates and the price paid for the samples purchased every month. The costs (fixed and variable) for the operation of a shrimp-dhow at Doha and at Al Khor were estimated as QR 135. - and QR 165 - per day, excluding crew wages. The average nett income for a shrimp trawling dhow in Doha (7 month operational in 1980) and at Al Khor (9 months operational in 1980) were estimated QR. 50,000. - and QR. 40,300. - per annum (1980), respectively. The share received by each crew member was estimated as QR 12,400. - in Doha and QR. 13,450. - at Al Khor for the whole of 1980 ( \$ 1. - = QR. 3.67 approx.). Considering the average ex-vessel price for the whole season, the break-even point for a shrimp trawling craft in Doha was about 10 kg/day and that at Al Khor was 17 kg/day. However, the very high price obtained close to the end of the fishing season, lowered the break-even point by 38 % and in fact the catch rate realised during the last week of the fishing season was 4 kg/day in Doha. Thus, the economic viability of the operation continues to prevail for catch rates from 40 kg/day to 6 kg/day.

### **Management of the Shrimp Resources Around Qatar**

Unlike the management of the shrimp stocks in the north-western part of the Gulf, which is an international problem, the management of the exploited shrimp

stock on the eastern side of Qatar should be relatively easier because it is only a national problem and most likely involving a stock which is independent of other exploited stocks in the Gulf.

The present level of production and the decline in density with the present level of effort indicate that the shrimp stock in the inshore fishing ground is rather small and that the rate of exploitation is high. In the absence of any data on the production during preceding years, it is not possible to state whether there was an annual decline but continued monitoring of the catches in the succeeding years will be extremely valuable in determining the effects of the present level of effort and rate of exploitation. However, from the presently available information, it seems reasonable to conjecture that there is hardly any room to increase the effort on the inshore component of the stock. Also, there is no information at all on the size of the off-shore component of this stock. In view of the prevailing situation in the fishery and the lack of more complete information, stringent management measures cannot be enforced, but a few of the practicable measures are discussed below.

#### **A — Staggered entry into commercial scale shrimp fishery**

The new Qatar National Fishing Company is planning to carry out commercial scale shrimp fishery in Qatar waters and this may have significant consequences resulting from the interaction between artisanal and commercial fisheries. The shrimp stock(s) in the off-shore waters commercial fisheries. The shrimp stock(s) in the off-shore waters adjacent to the inshore shrimp ground should be investigated to determine the characteristics and size of the component and to ascertain whether such an entry would be detrimental to the stock or to the existing fishery and also to examine the viability of a commercial fishery with a sustainable level of yield from the off-shore waters. Exploratory fishing in other areas around Qatar may be useful to detect additional shrimp resources.

#### **B — Closed season**

This conservation measure has been introduced in the Arabian Gulf States and the period from 1st February to 30th June is a common closed season for all the shrimp fisheries on the Arabian side of the Gulf. This measure is to protect the juvenile shrimps and it helps to increase the yield per recruit. In Qatar waters, the spring spawning of late winter, which seem to commence entry into the fishery around the middle of the open season/main fishing season (Figs. 5-8 and 11), will not be protected by the prevailing closed season. However, the strength of the

recruitment from this spawning period, is not clearly evident from the present study and it is very likely that the recruitment was not completed before the end of the main fishing season. Perhaps decline in the fishing effort, towards the tail end of the fishing season, reduces the exploitation of the juveniles at the initial stage of entry. The spawning with peaks at both ends of the winter period, results in a staggered recruitment which necessitates a protracted closed season and it is very essential that measure is strictly enforced.

### **C — Mesh size regulation**

Restricting the use of shrimp trawls with mesh size below 40mm, in addition to the closed season, will help to protect the recruitment occurring during the main fishing season and also reduce the effect of any trawling, illicitly conducted during the closed season. It will be evident from the results presented, that shrimp fishing was continued, particularly at Al Khor, throughout the closed season in 1980/81.

### **D — Closed area**

From the evidence on monthly mean Carapace lengths and catch rates for Doha and Al Khor, it is cautiously conjectured that the larval, post-larval and early juvenile stages are concentrated more towards Al Khor and that they move southwards, close to the two islands, before migrating into deeper waters. It has also been stated: "Al Khor is also a major area, where juvenile shrimps grow up and is vulnerable to catching too small a size to fetch a good price at the Doha market" (Kristjohnsson, 1978). Further, it has been stated under the section on fishing ground, that Al Khor fishermen operate just inside and outside the entrance to the bay, during the closed season. In view of these facts, shrimp trawling inside and at the mouth of the bay at Al Khor should be prohibited, initially.

### **E — Minimum size marketable**

In Qatar, very small size shrimps and juveniles are marketable and, hence, hardly any are discarded. Sale of shrimps below specified size in length and weight, should be prohibited at the landing point and in the Doha market. Such a regulation would also discourage shrimp fishery during the closed season and in the closed area. The authorised minimum size of capture, for the same species in Iranian waters, is 10cm (Barimani *et al*, 1977).

## **F — Limiting the fishing effort.**

Though exploitation of juveniles could be reduced considerably by the introduction of a combination of above mentioned measures, limiting the number of crafts and limiting the total effort on the shrimp stock, are relatively more difficult measures to enforce.

A more or less open ended upper limit for the market value of this variety, permits the lowering of the break-even point to extremely low catch rates and, hence, the economic basis appears to be too flexible to function as the controlling factor at present. The entire shrimp fleet in Doha do not operate every day, but they are solely dependant on the shrimp fishery, unlike the Al Khor fleet. Shrimp trawling crafts in Doha should be encouraged to divert their effort, without loss of income and to be operational throughout the year, without idling for nearly six months in a year. In fact, inshore gillnetting for finfish is lucrative between December and April and the Doha shrimp trawling crafts are well suited for this fishery.

At Al Khor, all major fishing activities come to a halt from June to the end of August and, hence, the closed season will be followed by two additional months without operation. The fishing effort on shrimps close to Al Khor is not very high, but the crafts must be encouraged to direct their whole effort on off-shore gillnetting, from January to April or May.

On the other hand, if the existing shrimp trawling crafts carry out innovation of their gear and mechanisation of fishing gear operation, the efficiency will certainly improve. In which event, the production may have to be controlled through direct limitation of the number of crafts or their total effort on the shrimp stock.

Certain other steps have to be implemented in order to reflect some degree of success in enforcing the regulatory measure already introduced, and others that may be introduced.

1. Fishing gear importers should be convinced about the need for mesh size regulations, so that they may import only the specified mesh size for shrimp trawls.
2. A fishery extension service unit must be established, to provide the necessary assistance, advice and encouragement, to divert effort into other remunerative fishing activities.

3. A statistical unit should be established, for continuous monitoring of the shrimp and fish landings and analysing the annual catch trends.
4. The fishing craft registration scheme should be activated as a stepping-stone to future introduction of a licencing system.

### **Acknowledgements**

The authors are grateful to the University of Qatar for providing the opportunity to carry out this study. The support and encouragement provided by Prof. M. I. Kazem, President of the University of Qatar, Prof. Omar Abdul Rahman, Director of the Centre for Scientific and Applied Research, Prof. A. Mubasher, Dean of the Faculty of Science and Prof. El Benhawy, Head of the Department of Marine Science, are gratefully acknowledged. The Technicians in the department of Marine Science are thanked for their valuable assistance in taking measurements of the samples. The cooperation rendered by numerous fishermen at Al Khor and in Doha was vital to the successful implementation of this project.

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# دراسة بيو اقتصادية لمصايد الربيان القطرية

سيفا سيرامانيام محمد أمين ابراهيم

قسم علوم البحار - جامعة قطر

## ملخص

أظهرت الدراسة التي تمت خلال العامين الماضين أن قوارب الصيد الأهلية من الدوحة والخور تضطلع بصيد الربيان من الشاطئ الشرقي لشبه الجزيرة القطرية بين أعماق تتراوح بين ٢ - ٦ قامات خلال موسم صيد الربيان الذي يمتد من يوليو حتى ديسمبر .

ولقد بلغ الإنتاج السنوي ( مارس ١٩٨٠ - فبراير ١٩٨١ ) حوالي ٧٦ طن وأن معدلات الصيد خلال ذلك العام تراوحت بين ٤٠ - ٤ كيلوجرام / قارب / رحلة بمتوسط قدره ١٦ كيلو جرام للقارب من الدوحة ، ٢٧ كيلو جرام للقارب من الخور .

وقد قدرت كثافة الربيان الصغير في مناطق صيد الربيان القطرية بحوالي ٨٦ طن عند بداية الموسم في يوليو ١٩٨٠م بمعدل تفوق كلى قدره ٠.٣ - ٠.٤٩ر. وظهر أن أحجام درقة أفراد الربيان التي تدخل المصيد تتراوح بين ١٠ - ٤٤ مم أي ما يعادل من ٥ إلى ٢٠سم من الطول الكلي للفرد وأن الاناث تنمو أسرع من الذكور . إذ أن متوسط معدلات النمو الشهرية كانت ٨ر. سم بالنسبة للذكور ، ٩ر. سم للاناث من الطول الكلي .

وفي ظل الظروف السائدة سنة ٨٠ / ١٩٨١م تراوح ربح القارب الواحد من مصايد الربيان بين ٤٠ - ٥٠ ألف ريال قطري خلال العام . وبالرغم من تتابع الانخفاض في الإنتاج من ٤٠ - ٦ كيلوجرامات من الربيان / قارب / رحلة فان تتابع زيادة السعر عملت على حفظ مستوى الدخل عند حد مجزى .

وفي ضوء معدلات استغلال المخزون القليل من الربيان في المياه القطرية فقد طرح هذا البحث العديد من التوصيات للمحافظة على مصايد الربيان القطرية من بينها منع الصيد في أوقات وأماكن معينة ، توجيه القوارب لصيد أنواع أخرى من الأسماك خلال تلك الأوقات ، وضع حد أدنى لفتحات الشباك المستخدمة لصيد الربيان بالإضافة إلى غيرها من التوصيات . كما أشار البحث إلى ضرورة إجراء دراسات موسعة في هذا الخصوص مع الاهتمام بتنفيذ الاحصاء السمكي وخدمات ودراسات المصايد القطرية .