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OBSERVATIONS ON THE PEARL OYSTER FISHERY OF KUWAIT

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ABSTRACT The pearl oyster fishery of Kuwait was monitored daily from January 1989 to May 1990. Landings of pearl oysters in 1989 totalled 287 tons with a market value of U.S. $1.0 million. Commercial pearls (>3 mm) were estimated to be present in one of every 4200 oysters. Most of the pearl oysters landed were new recruits with hinge lengths between 40–56 mm. There was a curvilinear relationship between total weight and size of oysters (length) and the sex ratio approached 1:1. Spawning occurs throughout the year, with a spat settlement peak in early fall. Over the size range examined there was no relationship between the size of oysters and the size of pearls and subsequent resource management strategies are discussed.

KEY WORDS: pearl, oyster, *Pinctada radiata*, fishery

INTRODUCTION

Thriving from historic times until the 1930s, the traditional pearl oyster fishery in the Arabian Gulf was large and revered, furnishing about 80% of the world production of natural pearls, which were famous for their excellent shape and quality (Bowen 1951). Lorimer (1915) described the various pearl oyster banks in the Arabian Gulf (Fig. 1) and estimated the average yearly export values of pearls and mother-of-pearl (shells) to be Pounds Sterling 561,353 and 269,788, respectively, for the period 1873 to 1905. The annual catch for the entire Arabian Gulf was approximately 35,000 tons, a conservative estimate calculated from literature reports of catch rate, number of boats and number of fishermen (Lorimer 1915, Villiers 1969).

Bowen (1951) described the early pearl diving techniques and discussed various aspects of the industry. Pearl fishing in the Gulf was performed originally only during summer, May to September. Except for occasional inclement weather, diving was a continuous operation over this period. The traditional fishery declined steadily from 1930 onwards because of a world recession, the introduction of Japanese cultured pearls, and later with the discovery of oil in the area. In the late 1940s most people deserted the pearl industry for more lucrative oil-related positions.

In the late 1960s, pearl fishing was revived with the introduction of modern diving equipment, such as air compressors and speedboats. Since 1980, pearl oyster fishing is practised year round in Kuwait. A pearl oyster market was re-established in Kuwait in 1982, and the first catch statistics were reported for a five-month period in 1983 (Almatar et al. 1984). The present pearl oyster market of Kuwait is based exclusively on natural pearls from *Pinctada radiata* (Leach), (Khamdan 1988). In the Arabian Gulf this species has variously been referred to as *P. margaritifera* (Steininger 1968, Anderlini et al. 1981, Almatar et al. 1984), *P. fucata* (Mohammad 1976) and *P. radiata* (Sadig and Alam 1989). The objective of this report is to review pearl oyster landings, describe size composition and frequency of pearl occurrence and discuss resource management strategies in light of the present findings.

MATERIALS AND METHODS

Individual boat fishing activity and catches were monitored daily at the single pearl oyster market in Kuwait by interviewing fishermen in the market place. Fishing effort was calculated by multiplying the number of boats by average number of diving hours; the latter was estimated via interviews and direct observation.

Monthly size frequency distribution of the oyster hinge length (HL) were obtained from samples (200–300 oysters) purchased twice a month. Allometric measurements (maximum dorso-ventral height, (DVM), total oyster weight and wet meat weight) were obtained from subsamples. Shell measurements were measured to the nearest 0.1 mm using Vernier calipers. Oysters were cleaned of external fouling material and wiped dry before weighing to the nearest 0.1 g. Oyster meats were shucked from the shell and weighed individually. Sex was determined by gonad color: females were yellow-orange throughout study and mature males were milky white when sexually active or brown-yellow in the resting stage. Oysters of undetermined sex were recorded as immature. Wet mounts of gonads were conducted frequently to confirm sex.

RESULTS

The Current Fishery

The diving fleet during this study consisted of 25 speedboats (3–8 m OAL), most with a single diver. Eleven major pearl oyster beds, varying in size from one to several square kilometers (10–20 m deep), were scattered within the fishing grounds (Fig. 2). An average of six 30-minute dives per day per diver were conducted using hookah air supply systems between 8 a.m. and 12 noon. Divers hand-picked oysters and placed approximately 6 kg in a

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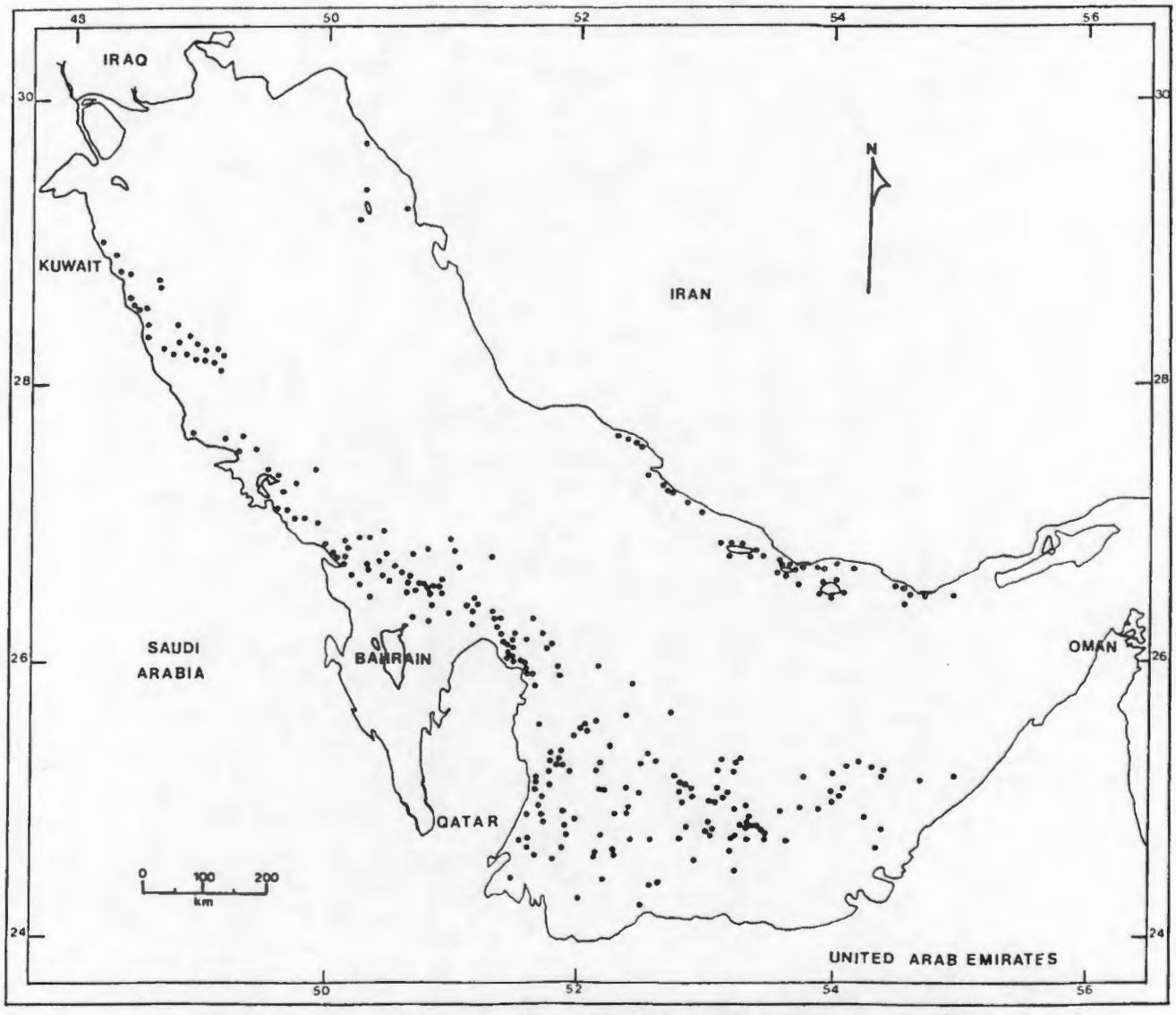

Figure 1. Location of traditional pearl oyster beds in the Arabian Gulf (from Lorimer 1915).

mesh bag. Unsorted oysters were sold to buyers at the market who later opened the oysters to retrieve any pearls which were subsequently resold.

Catch Statistics and Fishing Effort

The mean daily landing of pearl oysters in 1989 was 865 kg, and varied from 146 kg in January to 1716 kg in July (Fig. 3). Landings in 1989 totaled 287 tons or about 6.3×10^6 oysters, worth approximately U.S. $1.0 million.

Landings varied directly with effort; highest effort occurred between June and October. The poor weather/diving conditions between December and March accounted for the lowest effort (Fig. 3). The average catch per hour of diving (CPUE) in 1989 was 37 ± 17.4 kg ($n = 12$); this is a slight overestimate since some diving boats occasionally carried more than one diver. CPUE was lowest in January 1989 and highest in July 1989. Earlier data from 1983 also showed that landings and CPUE increased steadily from May to September 1983 (Fig. 3) (unpublished data).

Size Composition

Total shell and meat weight, wet flesh weight and hinge length (HL) are presented by size groups in Table 1. Quarterly size frequency histograms are shown in Figure 4. The HL of the majority of pearl oysters were unimodal and ranged between 40–56 mm. Oysters less than 40 mm HL were landed throughout the year, but were most abundant in fall and winter.

A linear relationship exists between HL and maximum height (DVM) measurement:

$$DVM = -16.863 + 1.619\ (HL) \qquad (r^2 = 0.79;\ n = 120)$$

The size-weight data (Fig. 5) are best described by curvilinear relationships of the form $Y = aL^b$ (where Y is total weight in g and L is length in mm) as follows:

$$\text{Log (Wt)} = -5.655 + 4.253 \log (HL) \qquad (r^2 = 0.78;\ n = 120)$$

$$\text{Log (Wt)} = -4.246 + 3.228 \log (DVM) \qquad (r^2 = 0.97;\ n = 120)$$

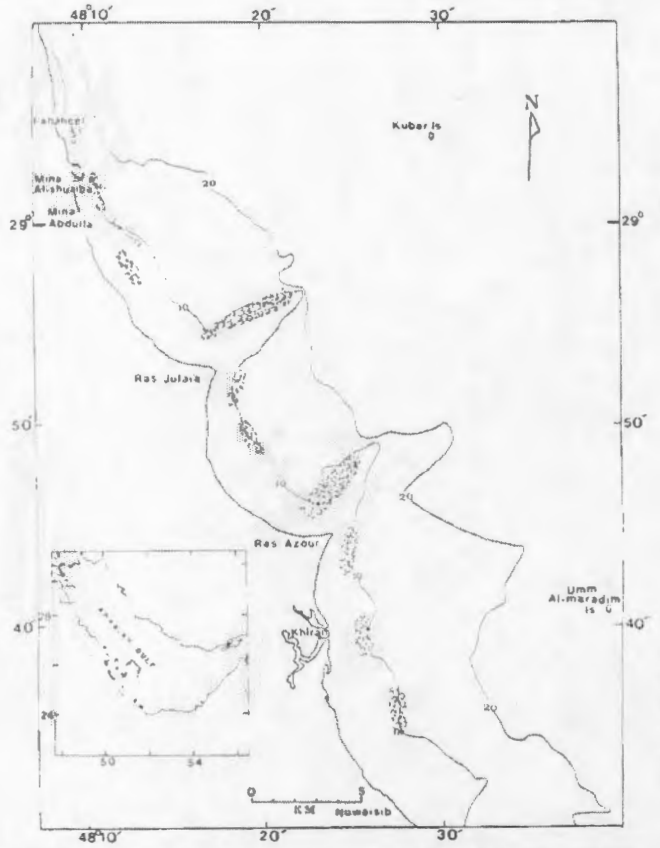

Figure 2. Location of major pearl oyster beds in Kuwait waters; shaded areas offshore indicate oyster beds.

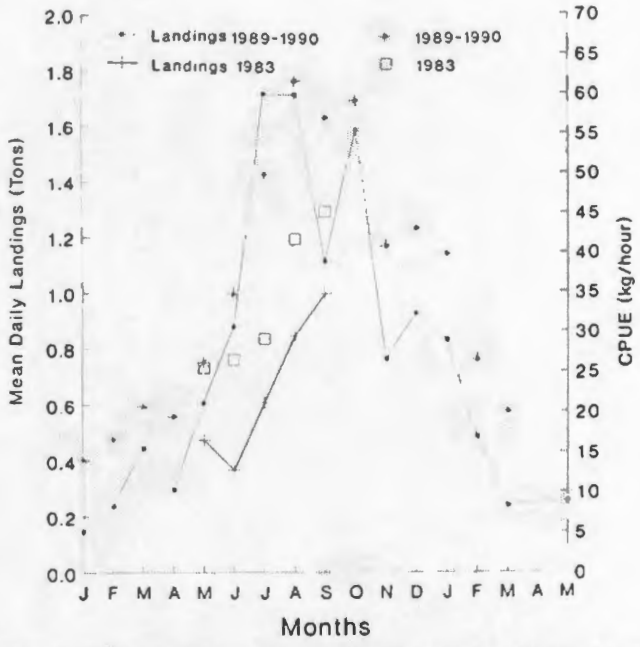

Figure 3. Mean monthly landings and mean monthly catch per unit of effort (CPUE) of *P. radiata* for 1989 and from January to May 1990. Data from May to September 1983 are also shown for comparison. CPUE is defined as amount (kg) of oyster harvested per hour.

Pearl Harvest

Ninety-six of 4414 oysters sampled (2.2%) bore one or more pearls. Oysters with multiple pearls accounted for 17.7% of all pearl-bearing oysters. All pearls recovered from the study were too small (1.53 ± 0.88 mm; n = 132) to be of commercial value. Table 2 displays pearl harvest by size and location over a range of oyster sizes. Pearls found in the mantle were significantly larger (Student's t-test: $t < 0.05$) than those in the gonad. No pearls were found in oysters with HL less than 40 mm and there was no significant correlation between oyster size and pearl size (r^2 = 0.003, df = 130) from the oysters examined. However, the probability of pearl occurrence increases with size of oysters. Three percent of oysters less than 58 mm HL contained pearls whereas the frequency increased to 5 percent for those over 58 mm HL.

From the 5.9×10^6 oysters landed from June 1989 to January 1990, only 400 large pearls (>4 mm) and 984 small pearls (3–4 mm) were sold in the market. Thus, the probability of landing a commercial-sized pearl is one in 4200. This estimate is slightly skewed because a few pearls were sold outside the oyster market.

Maturity

Figure 6 reveals that both sexes matured at the same size (50 mm HL) and there was no evidence of a sex change with size in *P. radiata*, as has been reported for other species (Tranter, 1958). Sex ratio over the period of sampling approached 1:1. Because of the high growth rate of oysters, maturity is probably reached in the first year, and for those spawned in early spring, possibly during the first six months (Tranter 1958; Rose et al. 1990). The presence of small oysters (<40 mm HL) throughout the year indicates that spawning is continuous with the greatest activity occurring in the summer and late fall (Fig. 4).

DISCUSSION

Compared with the harvest rates of pearl oysters in other tropical areas, Kuwaiti waters are highly productive (Pragasam and

TABLE 1.

Total weight and wet flesh weight (mean ± standard deviations) in relation to 2 mm size intervals of HL for subsample of *P. radiata* landings

HL (mm)	n	Total Weight (g)	Flesh Weight (g)
22–23	1	1.17 —	0.34 —
24–26	1	8.51 —	2.51 —
30–32	3	3.45 ± 1.64	0.96 ± 0.40
33–35	2	7.28 ± 3.11	2.10 ± 0.74
36–38	5	8.35 ± 2.54	2.38 ± 0.41
39–41	4	13.83 ± 2.16	3.90 ± 0.46
42–44	8	23.63 ± 14.18	7.23 ± 4.33
45–47	22	34.46 ± 10.40	10.22 ± 2.91
48–50	14	44.23 ± 18.35	13.62 ± 5.24
51–53	16	49.20 ± 18.58	15.92 ± 6.66
54–56	18	64.08 ± 19.05	21.89 ± 5.60
57–59	16	60.85 ± 14.72	21.25 ± 3.35
60–62	9	64.14 ± 25.56	24.08 ± 5.32
63–65	1	81.83 —	29.75 —

(n = number of oysters).

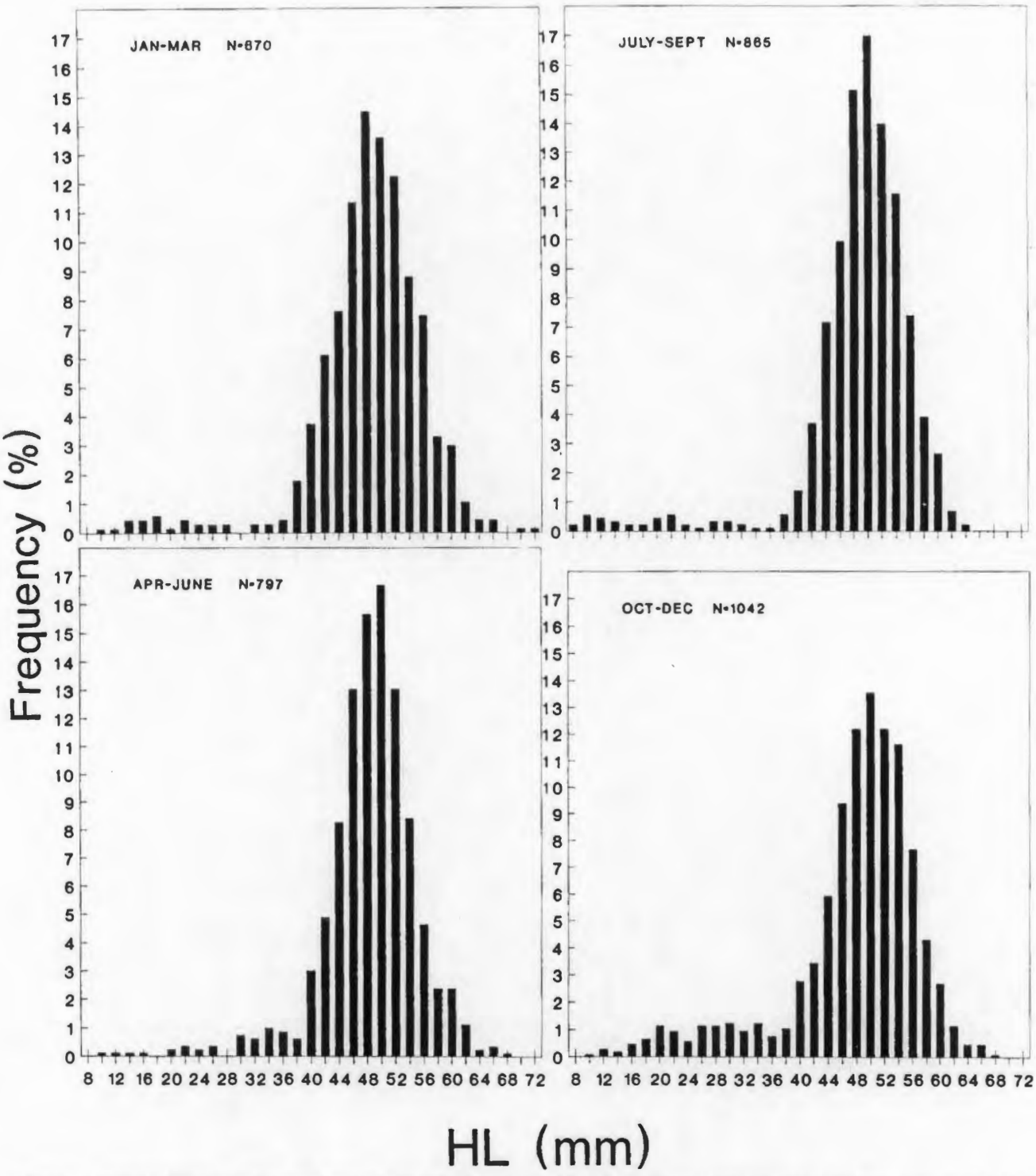

Figure 4. Quarterly hinge length frequency distribution at 2 mm intervals of *P. radiata* collected from landings in the pearl oyster market during 1989 and early 1990.

Dev 1987; Easwaran et al. 1969; Dybdahl and Rose 1986). Indeed, catch data from this study are relatively high—780 oysters or 37 kg per hour of diving. Direct observation and interviews indicate that our CPUE calculations may have been overestimated by 25 percent at most.

Due to the high annual harvest rates, the fishery in Kuwait relies heavily on recruitment of young oysters. Narayanan and Michael (1968) reported a growth rate of *P. vulgaris* in the Gulf of Kutch of 38.4 mm HL in the first year while Jeyabaskaran et al. (1983) reported a growth rate of *P. fucata* in the Gulf of Mannar

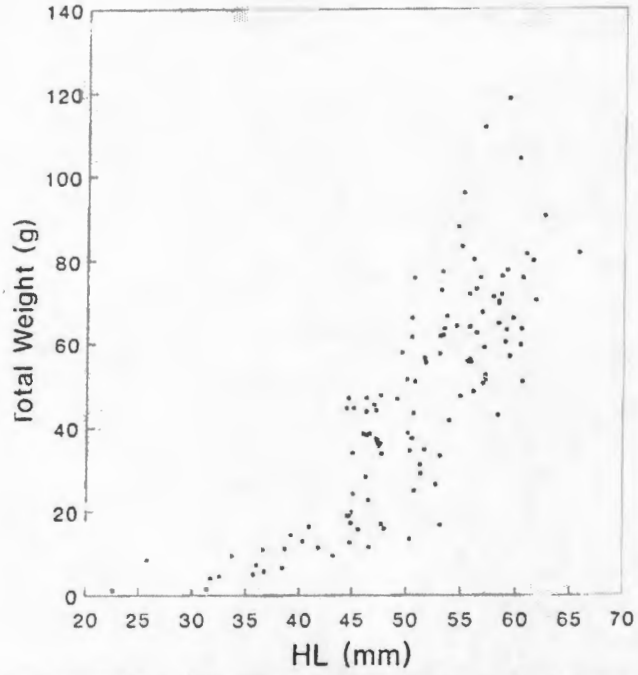

Figure 5. Total weight versus HL for *P. radiata* collected throughout the course of the study. The length-weight relationship is $W = 0.00000221\ L^{4.253}$ ($r^2 = 0.78$, n = 120).

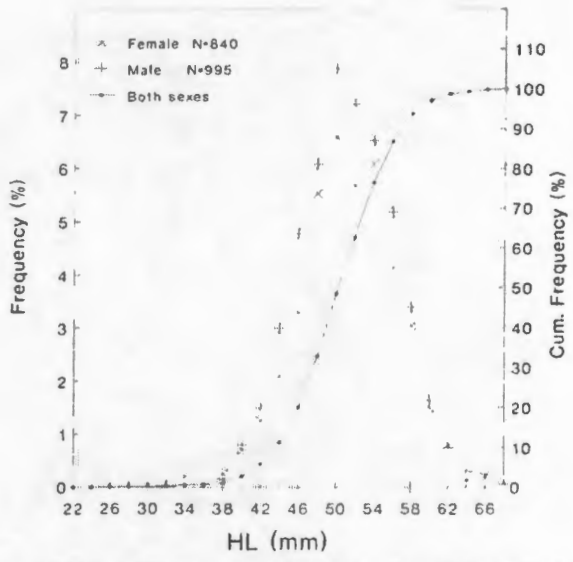

Figure 6. Percent HL frequency distribution of male and female and cumulative HL frequency distribution of combined sexes for *P. radiata* collected during 1989 and early 1990.

of 41.2 mm in its first year. Nayar et al. (1992) concluded that the growth of *P. radiata* in Bahrain waters was higher than the growth of pearl oysters in the Gulf of Mannar (corroborates unpublished data of the present study). It appears that the majority of the commercial Kuwaiti catch is composed of 0+ or 1+ year-classes.

Although increased effort yields increased landings, other factors that affect landings are poorly understood. Annual fluctuations and sources of spat settlement are virtually unknown. Extensive beds in Saudi Arabian waters could be significant sources of spat, since they lie within protected zones near oil wells. There are no data to suggest that the present fishing pressure (about 1000 hours per month) is sustainable. Ongoing data collection subsequent to the Gulf War (May–November, 1992) indicates no apparent change in fishing pressure, but there is a slight drop in catch volume. This decreased volume may be due to overharvest or environmental damage to oyster beds caused by oil spills and combustion products of oil fires during the war.

The objective of managing the pearl oyster fishery is not to maximize the landings of oysters, but rather to maximize the value of pearls—via increased numbers or sizes of pearls. The present study found no relationship between pearl size and oyster size over the range 40–68 mm HL and agrees with earlier findings for the same species (Almatar et al. 1984). Large valuable pearls (>3 mm) observed in the market (not taken from our subsamples) were not found in unusually large oysters. This study did find an increase in occurrence of pearls in larger (>58 mm HL) versus smaller (<58 mm HL) oysters. Studies of other species have also related pearl yield to age of oyster (Pearson 1933; Easwaran et al. 1969). Results of this study indicate that the total value of pearls could be increased if the fishery were managed to promote harvest of oysters greater than 58 mm HL.

TABLE 2.

Number, size (mean diameter ± s.d.) and location of pearls found in relation to 2 mm HL intervals of pearl oysters.

HL (mm)	Number Oysters Searched	Number Oyster with Pearls	Pearl Location: Mantle n	Mantle size (mm)	Gonad n	Gonad size (mm)
<40	127	0	—	—	—	—
41	376	1	3	1.0 ± 0.3	0	—
45	355	4	3	1.4 ± 0.7	1	0.5
47	501	13	10	1.8 ± 1.0	8	1.3 ± 0.3
49	572	11	12	2.3 ± 1.7	2	1.0 ± 0.1
51	626	15	10	1.1 ± 0.8	7	1.2 ± 0.4
53	564	17	14	1.9 ± 0.8	8	1.3 ± 0.3
55	391	7	7	1.6 ± 0.3	2	1.1 ± 0.2
57	294	7	6	2.0 ± 0.8	6	1.4 ± 0.8
59	188	10	0	—	13	1.5 ± 0.9
61	106	6	9	1.1 ± 0.1	5	1.1 ± 0.2
63	52	3	1	2.6	2	1.8 ± 0.1
65	28	1	0	—	1	2.0
>67	8	1	0	—	1	2.5

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LITERATURE CITED

Almatar, S. M., G. R. Morgan & S. Hakim. 1984. The pearl oyster fishery of Kuwait. *In:* C. P. Mathews (ed.). *Proc. of Shrimp and Fin Fisheries Management Workshop*, 9–11 Oct., 1983. Kuwait Institute for Scientific Research No. 1366, 2:575–600.

Anderlini, V. C., L. Al-harmi, B. W. De lappe, R. W. Risebrough, W. Walker, B. R. T. Simoneit & A. Newton. 1981. Distribution of hydrocarbons in the oyster, *Pinctada margaratifera*, along the coast of Kuwait. *Mar. Pollut. Bull.* 12:57–62.

Bowen, R. LeB. 1951. The pearl fisheries of the Persian Gulf. *Middle East Journal* 5(2):161–180.

Dybdahl, R. & R. A. Rose, 1986. The pearl oyster fishery in Western Australia. *In:* A. K. Haines, G. C. Williams & C. Coates (eds.). *Torres Strait Fisheries Seminar, Port Moresby*, 11–14 Feb. 1985. Aust. Gov. Publ. Service. Canberra: 122–132.

Easwaran, C. R., K. R. Narayanan & M. S. Michael. 1969. Pearl fisheries of the Gulf of Kutch. *J. Bombay Nat. Hist. Soc.* 66:338–344.

Jeyabaskaran, Y., D. S. Dev, I. Nalluchinnappan & N. Radhakrishnan. 1983. On the growth of the pearl oyster *Pinctada fucata* (Gould) under farm conditions at Tuticorin, Gulf of Mannar. *Proc. Symp. Coastal Aquaculture* 2:587–589.

Khamdan, S. A. 1988. The Bahrain pearl oyster: Their genetics and systematics. Univ. College of North Wales, U.K. MS Thesis. 132 pp.

Lorimer, J. G. 1915. Gazetteer of the Persian Gulf. Appendix C. The pearl and mother-of-pearl fisheries of the Persian Gulf, 2:2220–2293. Calcutta, India.

Mohammad, M-B. M. 1976. Relationship between biofouling and growth of the pearl oyster *Pinctada fucata* (Gould) in Kuwait, Arabian Gulf. *Hydrobiologia* 51:129–138.

Narayanan, K. R. & M. S. Michael. 1968. On the relation between age and linear measurements of pearl oyster, *Pinctada vulgaris* (Schumacher), of the Gulf of Kutch. *J. Bombay Nat. Hist. Soc.* 65:441–452.

Nayar, K. N., M. Al-Rumaidh & H. Al-Sayed. 1992. Experimental study of the settlement and collection of spat of the pearl oyster *Pinctada radiata* (Leach) from Bahrain waters. *In: Proc. of Symp. on Mariculture Technology and Investment Opportunities*. 9–10 May 1992. Bahrain Centre for Studies and Research, 16 p.

Pearson, J. 1933. The maximum pearl-yield of a pearl oyster bed. *Ceylon J. Sci.* (V):1–20.

Pragasam, B. & D. S. Dev. 1987. Studies on the pearl oyster population in pearl oyster grounds off Tuticorin in the Gulf of Mannar. *In: The Seas around India*. Spl. Pub. Bull. Cent. Mar. Fish. Res. Inst. 42:79–83.

Rose, R. A., R. E. Dybdahl & S. Harders. 1990. Reproductive cycle of the Western Australian Silverlip Pearl Oyster, *Pinctada maxima* (Jameson) (Mollusca: Pteriidae) *J. Shellfish Res.* 9:261–272.

Sadig, M. & I. Alam. 1989. Metal concentration in pearl oyster, *Pinctada radiata*, collected from Saudi Arabian coast of the Arabian Gulf. *Bull. Environ. Contam. Toxicol.* 42:111–118.

Steininger, F. 1968. Recent marine molluscs. *In:* W. Fuchs, T. E. Gattinger & H. F. Holzer (eds.). *Explanatory text to the Synoptic Geologic Map of Kuwait*. Geologic Survey of Austria, Vienna, 87 pp.

Tranter, D. J. 1958. Reproduction in Australian Pearl Oysters (Lamellibranchia) I. *Pinctada albina* (Lamarack): Primary gonad development. *Aust. J. Mar. Freshwat. Res.* 9:135–143.

Villiers, A. J. 1969. Sons of Sinbad. Scribner, N.Y. 414 pp.