Population Dynamics and Exploitation of *Metapenaeus affinis* in Kuwaiti Waters*

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Abstract

Length-frequency data of *Metapenaeus affinis* collected from the trawl catches of *R/V Bahith* in Kuwaiti waters from 1985 to 1989 were combined with estimates of monthly total catch by the commercial and small-scale fleets operating in Kuwait, and analyzed using the Compleat ELEFAN software package.

A major recruitment pulse of *M. affinis* occurs in spring and a minor one in autumn. Optimum relative yield per recruit (Y'/R) is obtained with the length-at-first capture (L_c) of 24.4 mm CL for females and ≤ 17.6 m CL for males. Virtual population analysis results indicated that the biomasses have decreased during the last three-year period for which data were available.

Introduction

Metapenaeus affinis is a commercially important species in Kuwaiti waters, especially in small-scale fisheries where it comprises around 52% of the catch (Mohammed et al. 1981).

Some attempts have been made to manage the fishery by imposing closed seasons (Mathews 1985). However, even after imposing a closed season, it is evident that catch-per-unit effort of *M. affinis* has declined from year to year for both sexes (Mathews et al. 1987a). Exploitation levels of *M. affinis* in Kuwaiti waters are also found to be high (Mathews et al. 1987b) indicating the necessity to manage the fishery. Al-Attar (1984) showed that the April and May recruits of *M. affinis* to the fishery probably originate from spawning occurring outside Kuwait Bay, as this species appears to prefer less saline waters near the outflow of Shatt-Al-Arab. This paper deals with the recruitment patterns of *M. affinis* in Kuwaiti waters and the application of the yield-per-recruitment model and Virtual Population Analysis (VPA), with a view to identifying appropriate management strategies.

Materials and Methods

Length-frequency (carapace length, CL in mm) data of *M. affinis* were collected from the catches of *R/V Bahith* from May 1985 to September 1989. Further details on the method of collection of length-frequency data are given in Mohammed (in prep.). Total monthly landings of *M. affinis* from three fishing fleets (i.e., small-scale, Seif industrial and Shuaiba industrial fleets) were obtained from the official records of Kuwait Institute for Scientific Research (Table 1). The length-frequency data of *M. affinis* in the catches of *R/V Bahith* covered the size ranges of catches of all three fishing fleets; therefore, it was assumed that the length-frequency samples of *R/V Bahith* represent the actual size composition of the landings of the industrial and small-scale fisheries for *M. affinis* in Kuwaiti waters.

Using the growth parameters for female and male *M. affinis* estimated by Mohammed (in press), seasonal recruitment patterns were estimated using the method of Pauly (1987) implemented in the Compleat ELEFAN Software package (Gayanilo et al. 1989). Selection pattern curves for *M. affinis* were obtained by the backward projection of the right, descending arm of length-converted catch curves, as described by Pauly (1987).

Relative yield-per-recruit (Y'/R) values for different exploitation rates were obtained by sex using the model of Pauly and Soriano (1986).

The form Virtual Population Analysis described as VPA III by Pauly (1987), which is part of the Compleat ELEFAN software package (i.e., a combination of age-structured VPA and of length-structured cohort analysis) was used to analyze the catch-at-length data obtained by raising the L/F samples to the combined total catch of the three fleets (Table 1). The weights of length-frequency samples were estimated using the carapace length (CL)-total weight (W) relationship, $W = 0.002171\ CL^{2.59}$ for females and $W = 0.001264CL^{2.78}$ for males (Abdul-Ghaffar, unpubl. data) and the method of Beyer (1987) for the mean weight of the shrimps in a given length class.

Missing length-frequency samples were interpolated. For the period January to April 1985 and October to December 1989, length-frequency samples representing the months from other years (1986 and 1988, respectively) were used. For the months of June 1986, March and December 1988, samples from June 1985, March 1987 and December 1987 were used. These interpolations are based on the assumption that the growth and recruitment of *M. affinis* follow similar patterns from year to year.

* This contribution is based on a study stage spent at ICLARM, February-March 1990.

Table 1. Monthly total catch (kg) of *M. affinis* in Kuwaiti waters and availability of length-frequency data. (1985-1989; —— indicates closed seasons)

Month	Small-scale fleet	Seif industrial fleet	Shuaiba industrial fleet	Total catch	Female	Male	L/F data available Y/N?
Jan - 85	33,760	33,219	806	67,785	46,778	21,007	N
Feb - 85	14,784	12,289	858	27,931	19,275	8,656	N
Mar - 85	——	——	603	603	416	187	N
Apr - 85	——	——	39,035	39,035	26,938	12,097	N
May- 85	——	——	78,304	78,304	54,038	24,266	Y
Jun - 85	——	——	86,283	86,283	59,544	26,739	Y
Jul - 85	32,083	46,034	56,508	134,625	92,905	41,720	Y
Aug- 85	12,794	80,755	79,586	173,135	119,480	53,655	Y
Sep - 85	10,622	14,238	25,660	50,520	34,864	15,656	Y
Oct - 85	3,572	9,205	20,843	33,620	23,201	10,419	Y
Nov- 85	45,240	31,782	17,219	94,241	65,036	29,205	Y
Dec - 85	7,525	15,762	8,573	31,860	21,987	9,873	Y
Jan - 86	7,314	18,379	1,031	26,724	18,442	8,282	Y
Feb - 86	12,586	41,365	2,486	56,437	38,947	17,490	Y
Mar - 86	——	——	——	——	——	——	Y
Apr - 86	——	——	——	——	——	——	Y
May- 86	——	——	——	——	——	——	Y
Jun - 86	——	——	——	——	——	——	N
Jul - 86	——	——	——	——	——	——	Y
Aug- 86	24,183	32,056	86,681	142,920	98,629	44,291	Y
Sep - 86	24,651	6,999	54,189	85,839	59,237	26,601	Y
Oct - 86	2,966	67,115	68,470	138,551	95,614	42,937	Y
Nov- 86	42,727	80,068	164,776	287,571	198,453	89,118	Y
Dec - 86	44,375	18,035	45,943	108,353	74,775	33,579	Y
Jan - 87	13,974	877	2,047	16,898	11,661	5,237	Y
Feb - 87	41,728	5,140	5,966	52,834	36,461	16,373	Y
Mar - 87	24,406	3,248	6,977	34,631	23,899	10,732	Y
Apr - 87	——	——	——	——	——	——	Y
May- 87	——	——	——	——	——	——	Y
Jun - 87	——	——	——	——	——	——	Y
Jul - 87	——	——	——	——	——	——	Y
Aug- 87	——	——	——	——	——	——	Y
Sep - 87	70,433	39,193	87,817	197,443	136,255	61,188	Y
Oct - 87	95,699	19,280	48,133	163,112	112,564	50,548	Y
Nov- 87	67,258	13,489	46,665	127,412	87,927	39,485	Y
Dec - 87	31,123	2,287	9,097	42,507	29,334	13,173	Y
Jan - 88	7,790	1,471	1,051	10,312	7,116	3,196	Y
Feb - 88	31,199	2,651	2,047	35,897	24,773	11,124	Y
Mar - 88	32,514	0	0	32,514	22,438	10,076	N
Apr - 88	10,947	761	576	12,284	8,477	3,807	Y
May- 88	——	——	——	——	——	——	Y
Jun - 88	——	——	——	——	——	——	Y
Jul - 88	——	——	——	——	——	——	Y
Aug- 88	——	——	——	——	——	——	Y
Sep - 88	47,392	26,532	14,346	88,270	60,915	27,355	Y
Oct - 88	3,786	4,600	5,738	14,124	9,747	4,377	Y
Nov- 88	362	401	468	1,231	850	382	Y
Dec - 88	49	48	44	141	97	44	N
Jan - 89	74	82	64	220	152	68	Y
Feb - 89	0	0	0	0	0	0	Y
Mar - 89	0	0	0	0	0	0	Y
Apr - 89	——	——	——	——	——	——	Y
May- 89	——	——	——	——	——	——	Y
Jun - 89	——	——	——	——	——	——	Y
Jul - 89	——	——	——	——	——	——	Y
Aug- 89	——	——	——	——	——	——	Y
Sep - 89	9,704	0	0	9,704	6,697	3,007	Y
Oct - 89	7,041	0	0	7,041	4,859	2,182	N
Nov- 89	28,078	0	0	28,078	19,377	8,701	N
Dec - 89	13,916	0	0	13,916	9,603	4,313	N

Results and Discussion

Peak recruitment of male *M. affinis* to the fishing grounds occurs from February-March to April-May, and from September to October, while the recruitment of females occurs from March-June, and from July to August (Fig. 1). Young *M. affinis* recruit to the small-scale fishery from March to May, and to a lesser extent from September to December (Mathews 1985, 1986; Mathews et al. 1987b). The large spring recruitment pulse is probably due to the autumn spawning. Al-Attar (1984) showed that larger shrimps are likely to spawn in Kuwait Bay during autumn. These postlarvae, as represented by the larger postlarvae in benthic samples at this time, may overwinter during the cold months.

The natural mortality (M) of the females, M = 1.76 year^{-1} while that for males = 2.3 year^{-1} were assumed to be constant throughout the lifespan of the recruited shrimps. The yield and biomass per recruit values at the various levels of E as well as at the different age at first capture are shown in Figs. 2 and 3. As might be seen, optimum Y'/R occurs in females at lower values of F than for the males.

The estimated mean lengths at first capture were 24.1, 24.2, 28.7, 24.0 and 26/7 mm for females and Lc = 22.0, 23.0, 23.4, 22.2 and 24.5 for males, in 1985, 1986, 1987, 1988 and 1989, respectively. The maximum yield-per-recruit, as shown in Figs. 3 and 4, is reached when Lc = 24.9 mm CL for females, which is very near the mean Lc for the five-year period. Males, on the other hand, are observed to achieve maximum Y'/R at Lc<17.6 mm CL which is much smaller than the five-year mean (Lc = 23.0 mm CL). The Lc value roughly corresponds to the length of the mature females. Any decrease in mesh size in the hope of increasing Y'/R for males would thus bring the Lc of females down towards the lengths of immature females.

Biomass Estimation

Monthly estimated biomass and the corresponding fishing mortalities are shown in Fig. 5, by sex. This figure also shows that the highest biomass for the

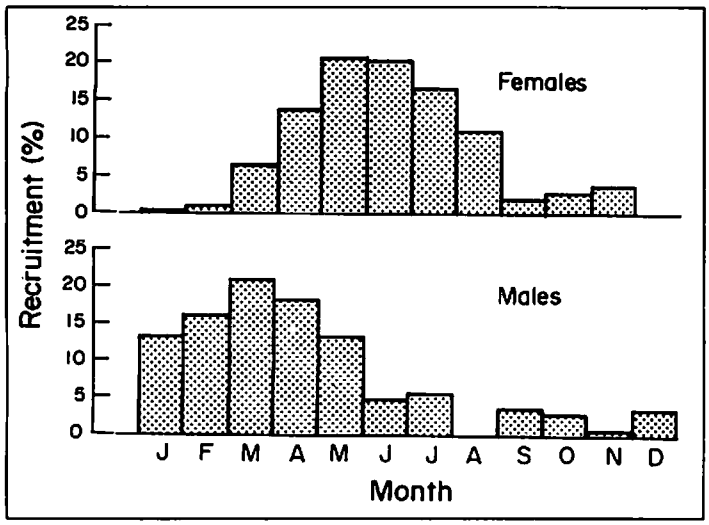

Fig. 1. *Recruitment pattern for* **M. affinis** *in Kuwaiti waters.*

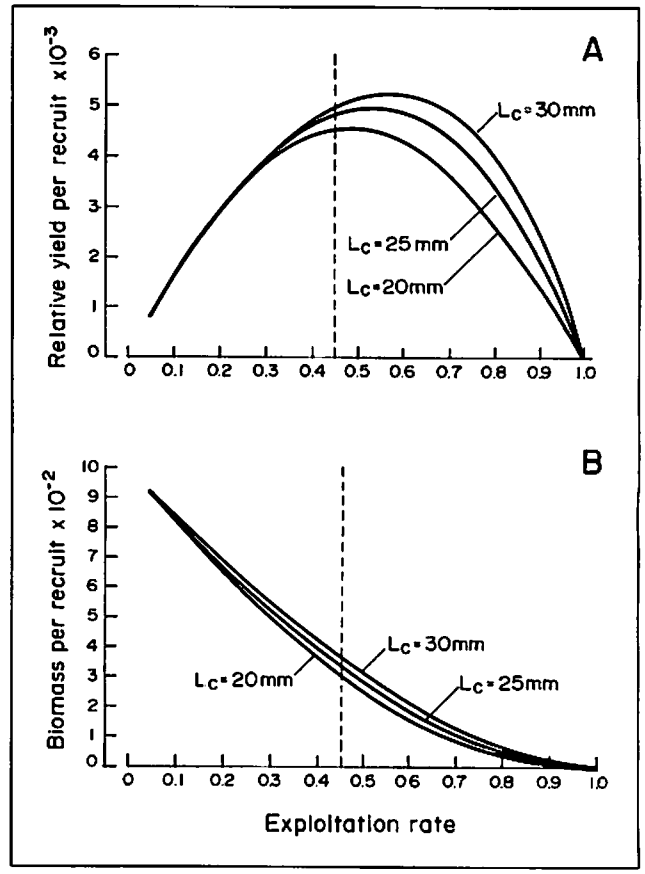

Fig. 3. *Relative yield (A) and biomass-per-recruit (B) for* **M. affinis** *females in Kuwaiti waters.*

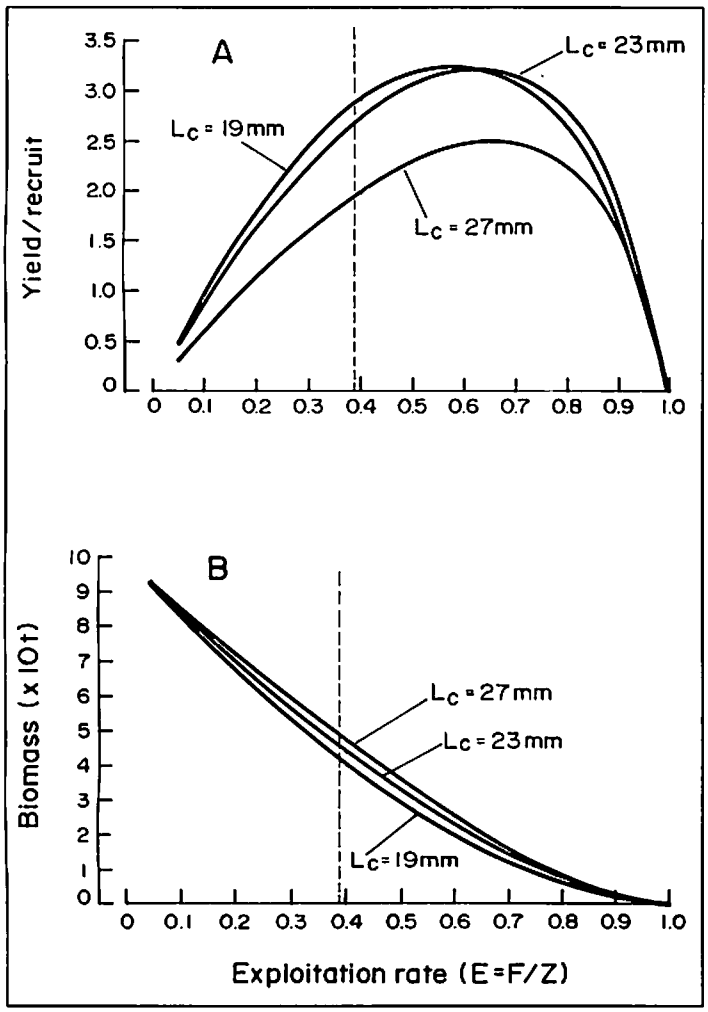

Fig. 2. *Relative yield (A) and biomass-per-recruit (B) for* **M. affinis** *males in Kuwaiti waters. Dotted vertical lines show the exploitation rate for the 1991/92 season (E = 0.39).*

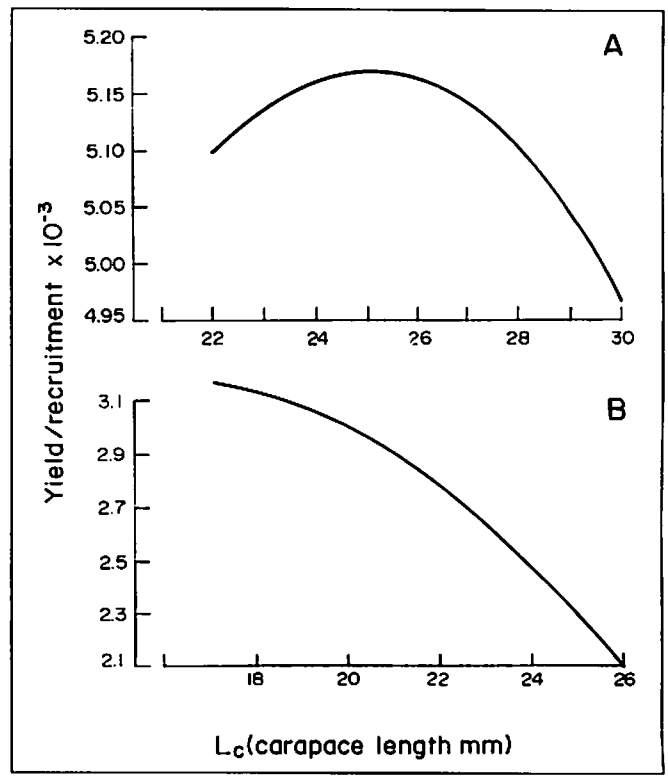

Fig. 4. *Relative yield-per-recruit of* **M. affinis**, *females (A) and males (B) in Kuwaiti waters, with different length at first capture (Lc). The mean Lc for a five-year period was 25.5 and 23.0 mm CL for females and males, respectively.*

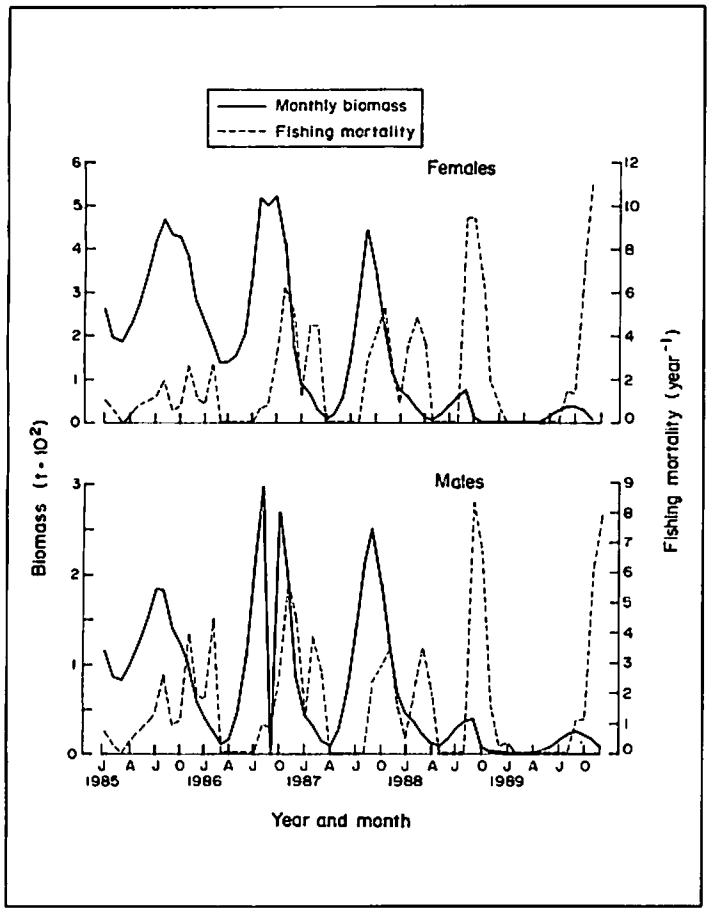

Fig. 5. ***Monthly biomass (open circles) and fishing mortality (squares) of M. affinis, females (A) and males (B) in Kuwaiti waters.***

five-year data appears during the hottest months (June to September), which incidentally coincides with the period of closed fishing. The trend of biomass for both sexes throughout the study period decreases towards 1989. This could be explained by the increasing levels of fishing during the latter years due to increased concentration of trawlers in Kuwaiti waters. Another reason for this could be the unusual flow of water coming from inland water river systems into the Shatt-Al-Arab and out to the Arabian Gulf, which disrupts the reproductive cycle of *M. affinis* (Siddeek et al., unpubl. data). Spawning shrimps normally proceed to less saline waters near the outlet of Shatt-Al-Arab (Al-Attar 1984), and beyond into the brackishwater marshes of the Shatt-Al-Arab (Mathews 1986). Thus, unusually large amount of outflow restricts the entry of spawning individuals into the Shatt-Al-Arab.

The analysis presented here suggests that the closed seasons for fishing should start prior to the month of highest recruitment (March). The closed season usually starts between February and March but since 1986-87 it has been shifted to April. It is recommended that the closed season start in February.

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