Growth, Mortality and Length-Weight Parameters for Some Kuwaiti Fish and Shrimp

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Abstract

As a (small) contribution toward reestablishing communication between Kuwait-based fishing research and other research conducted elsewhere in the tropics, the growth parameter estimates and the "a" and "b" values of length-weight relationships of 25 fish and three penaeid shrimp species from Kuwait waters are presented, along with the methods used to estimate them. This will hopefully encourage their use in comparative studies of vital statistics of fish and shrimp.

Introduction

The Kuwait Institute for Scientific Research (KISR) was, until the Iraqi invasion of August 1990, among, if not the best, research institution in the Arab World. It maintained a very active Mariculture and Fisheries Department (MFD) which published the Kuwait Bulletin of Marine Science and organized regular management workshops. This enabled representatives of the industry, MFD and the Government to reach a consensus on how the valuable shrimp and finfish fisheries should be managed.

Between workshops, MFD staff ran trawl and other resource surveys, aged fish, performed various assessments and also raised fish in what were the most sophisticated mariculture installations in the region. The reference list gives examples of the various types of publications produced by KISR/MFD.

Unfortunately, much unpublished material was destroyed during the Iraqi occupation, and it will take a while before the MFD's ability to respond to queries for information or copies of documents is fully restored.

This contribution presents therefore a summary of vital statistics of Kuwaiti fish and shrimp, based on MFD documents to which the senior author presently has access, and based in large part on collaborative work between him and his coauthor, with whom no contact could be reestablished to date.

Measurements and Methodology

For finfish, all ages are in years and all lengths in cm total length, measured to the nearest cm below (i.e., 0 = 0.00-0.99 cm; 1.0 = 1.00-1.99 cm; 2.0 = 2.00-2.99 cm, etc.). All weights refer to whole fish (fresh, or wet) in g. All ages are based on the examination of otoliths using annual marks (Samuel and Mathews 1987; Williams 1986; Samuel et al. 1987), except for the otoliths of *Pomadasys argenteus* which were aged by using otolith microstructure, i.e. "daily marks" (Brothers and Mathews 1987). The highest age recorded in the sample studied was recorded as T_{max} (years) in Table 1, and is regarded as an estimate of the maximum age reached by fish in the population in question. Similarly, the maximum length of the fish in the available samples was denoted L_{max} (cm; TL), and was regarded as an estimate of the maximum length of fish in the population.

For some species (small fish which are important components of the shrimp by-catch) Mathews and Samuel (1987, 1991) showed that the usual analyses of age at length samples gave biased estimates of growth parameters, probably because of sampling problems. For these species, the ELEFAN I program (Pauly 1987) was used to determine L_∞ and K, but T_{max} was estimated using annual marks on otoliths.

Total annual instantaneous mortality rate (Z) was estimated from the age frequency of the samples; for *Epinephelus suilis* (usually referred to as *E. tauvina* in the Kuwaiti literature), it was possible to compare values of L_∞, K and Z obtained in this way over several years with values obtained from age/

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vided growth parameter estimates for three years, and a Z estimate for one year, based on the age structure of the whole catch, rather than that of a sample. The growth parameters obtained were very close, with overlapping ranges (Table 1).

On the other hand, the estimates of Z were rather different, probably because (unlike the growth parameter estimates) they were dependent on estimates of effort which were probably not as reliable as the ageing procedures. It is likely that estimates of growth parameters and of Z based on the age frequency of a sample will give reliable estimates of growth and mortality parameters.

When the growth parameters were obtained using ELEFAN I, Z was estimated from length-converted catch curves. Wherever possible, the parameters provided here are given together with an estimate of the sample size upon which they were based. The size of the samples upon which the growth and mortality parameters were based is provided, and includes the number of specimens of known age at length (sample numbers in column 2 of Table 2). For the small by-catch species, i.e., those for which there were sampling problems, the number of fish measured for application of ELEFAN I is given (in parenthesis) in addition to the sample size from which the maximum age was estimated. The sample size (n) upon which the length-weight relationships were based is also given. Where it is not available, it should be assumed that the number of fish weighed was equal to or larger than the sample size used for ageing fish (substantially larger if the number of otolith pairs available for ageing was small).

For the three commercially important species of shrimp landed in Kuwait, the ELEFAN I and II programs were used to estimate L_∞, K and Z (Mathews et al. 1987), while the estimates of the length-weight parameters a and b were taken from Farmer (1986). Estimates of L_{max} are provided by Mathews et al. (1987) for *Metapenaeus affinis*, by Mathews et al. (1988) for *Penaeus semisulcatus* and from unpublished data for *Parapenaeopsis stylifera*. For shrimp, values in Table 2 are given in carapace length (mm), and total weight (g). Farmer (1986) also gave relevant parameters for conversions between total length, body length and carapace length.

The parameters a and b of the length-weight relationships for finfish were calculated by means of arithmetic mean least squares regressions of log total weight (TW in g) on log total length (TL in cm), i.e.,

$$\text{Log}_{10}TW = a + b\log_{10}TL$$

For shrimp, however, Farmer (1986) calculated the constants a and b by means of geometrical mean least squares regressions.

Results and Discussion

Table 2 presents our results; they require little discussion at this point, except perhaps with regard to the problem posed by extremely large and/or old specimens of fish.

Specimens of *Epinephelus suilis* landed in Kuwait do not usually exceed 111 cmTL (Mathews and Samuel 1985); nevertheless two extraordinarily large specimens were seen at the fish markets during routine visits, measuring 120 and 130 cmTL, respectively. They could not be bought and therefore their otoliths could not be obtained for ageing. It is likely that for this species the maximum age reported here will be less than that of these two large and presumably old specimens, and hence in the population as well.

Except for one unusually large specimen of *E. latifasciatus*, all observed specimens of this species seen were equal to or less than 90 cmTL, corresponding to a maximum age of 19 years. The single very old and large specimen that was taken was 30 years old and 135 cmTL (Mathews and Samuel 1987). Similarly, *E. chlorostigma* varied from 3 to 26 years old in the samples with one exceptional speci-

Table 1. Growth and mortality of *Epinephelus suilis* in Kuwait, as obtained using two different methods.

Parameter	Age/length key	Catch curve
TL_∞ (cm)	98.2	93.1*
Range	91.0 - 102.0	90.0 - 99.2
K (year^{-1})	0.141	0.166*
Range	0.121 - 0.171	0.138 - 0.192
Z (year^{-1})	0.89	0.28*
Range	n.a.	0.24 - 0.32

*Average of the data obtained from four catch curves, 1981-1984 (Mathews and Samuel 1990b).

Table 2. Growth and mortality and length-weight parameters for 28 Kuwaiti populations.

Species	Sample numbers	T_{max} (years)	L_{max}	L_∞	K (year^{-1})	Z (year^{-1})	a	b	n	Source[f]
Lutjanus malabaricus[a]	>2,000	46	89	68.90	0.3581	0.18	n.a.	n.a.	n.a.	1
Epinephelus chlorostigma	98	26[i]	75	64.83	0.195	0.05	0.0110	3.025	361	2
Epinephelus latifasciatus	131	19[i]	92	82.11	0.328	0.21	0.00965	3.088	179	2
Epinephelus jayakari	49	28	77	72.65	0.273	0.07	0.0167	2.964	54	2
Cephalopholis miniatus	36	26	37	34.11	0.110	0.10	n.a.	n.a.	n.a.	2
Epinephelus areolatus	153	25	46	39.10	0.288	0.11	0.117	2.999	277	2
Epinephelus bleekeri	50	24	65	n.a.	n.a.	n.a.	0.0183	2.891	223	2
Epinephelus suilis[b]	1884	22	111	93.07[g]	0.166[g]	0.28	0.0144	3.024	1912	2
Epinephelus malabaricus[c]	3	18	130	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	2
Lethrinus nebulosus	159	20	62	62.73	0.193	0.37	0.0173	3.010	139	3
Arius thalassinus	365	19	79	106.4[j]	0.064	0.26	0.00877	3.022	190	4
Acanthopagrus bifasciatus	20[h]	21[h]	38	34.89	0.189	n.a.	0.0176	3.001	n.a.	3
Pomadasys argenteus	7	19	66	66.9	0.283	n.a.	n.a.	n.a.	n.a.	6
Acanthopagrus berda[d]	287	14	37	37.35[g]	0.325[g]	0.39	0.0171	3.016	n.a.	5
Acanthopagrus latus[e]	1,031	14	50	44.48[g,h]	0.225[g]	0.60	0.0287	2.792	n.a.	5
Acanthopagrus cuvieri	231	11	83	81.86	0.278	0.36	0.0116	3.037	n.a.	5
Helotes sexlineatus (25,080)	292	9	24	26.5	0.46	3.02	n.a.	n.a.	n.a.	7,8
Platicephalus indicus	355	7	67	48.86	0.34	0.92	0.00224	3.320	n.a.	9
Saurida tumbil (11,687)	285	7	41	39.5	0.28	1.23	0.00555	3.084	n.a.	7,8
Saurida undosquamis (12,126)	197	7	34	33.0	0.55	2.25	0.00601	3.025	n.a.	7,8
Pseudorhombus arsius	247	7	38	44.00	0.16	0.80	0.0030	3.418	n.a.	10
Nemipterus tolu (8,665)	656	6	30	32.0	0.42	2.14	0.00870	3.001	n.a.	7,8
Mulloidichthys auriflamma (7,535)	94	5	17	24.5	0.39	2.44	0.0126	3.013	n.a.	7,8
Nemipterus japonicus (11,574)	457	5	32	33.6	0.51	1.76	0.0245	2.790	n.a.	7,8
Otolithes argenteus	1,012[h]	5	54	69.6	0.505	1.46	0.0100	3.000	>500	1,11
Penaeus semisulcatus	n.a.	1.5	44	48.2	0.96	4.80	0.00196	2.746	581	12,13
	n.a.	2.0	56	53.2	1.07	2.40	0.00266	2.648	874	12,13
Metapenaeus affinis	n.a.	1.5	37	37.7	0.95	3.14	0.000674	2.971	408	11,12
	n.a.	2.0	49	48.0	0.92	1.13	0.000773	2.903	396	11,12
Parapenaeopsis stylifera[k]	n.a.	1.5	n.a.	31.3	0.83	1.66	0.00109	2.726	15	11,12
	n.a.	2.0	35	23.0	0.92	1.77	0.00118	2.716	135	11,12

[a]Usually referred to as *L. coccineus* in the Kuwaiti literature.
[b]Based on four years' data (1981-1984)*.
[c]L_{max} and T_{max} are probably underestimates.
[d]Based on two years' data (1984, 1985).
[e]Based on five years' data (1981-1985).
[f]Authors: 1. Mathews and Samuel (1985); 2. Mathews and Samuel (1987); 3. Baddar (1987); 4. Bawazeer (1987a); 5. Samuel and Mathews (1987); 6. Brothers and Mathews (1987); 7. Mathews and Samuel (1990a); 8. Mathews and Samuel (1991); 9. Bawazeer (1990); 10. Bawazeer (1987b); 11. Mathews et al. (1987); 12. Farmer (1986); 13. Mathews et al. (1988).
[g]Values of L_∞ and K are mean values from 2 to 5-year observations, as indicated in this table. The values reported by Mathews and Samuel (1990b) are the values for each year separately.
[h]Value reported by Mathews and Samuel (1990b) was erroneous.
[i]See discussion about exceptionally old fish.
[j]Author noted the large value of L_∞ compared to L_{max}.
[k]Farmer (1986) drew attention to the small sample set, especially for males, and suggested that these regressions be regarded as provisional - they should be used with caution.

N.B. Where Mathews and Samuel (1989), and Mathews and Samuel (1991) differ in estimates of any parameter estimated by length-based analysis, the latter values are preferred as they are based on more extended analysis using a later, improved version of ELEFAN.

years old in the samples with one exceptional specimen aged 41 years old.

Such very large and old individuals of *E. suilis*, *E. latifasciatus* and *E. chlorostigma* probably belong to a growth phase distinct from that of the bulk of the population, with the fish in question having a different diet; these fish are thus clearly uncharacteristic of the populations they belong to (Mathews and Samuel 1987). They have been excluded from the data summarized in Table 1, since the growth should be described by curves other than the von Bertalanffy growth model, e.g., the two-phase growth of Soriano et al. (1990).

Three very large specimens of *Epinephelus malabaricus* ranging up to 20 years old and 135 cmTL were found in the fish market being sold as "hamoor", i.e., *E. suilis* (Mathews and Samuel 1987). *E. malabaricus* is very similar to and easily confused with *E. suilis*, which has been reported (anecdotally) to reach very large sizes, up to 150-220 cmTL or more in Saudi Arabia. It is probable that the three specimens of *E. malabaricus* landed in Kuwait are within the usual age and size ranges for the Gulf population of *E. malabaricus*. This species is probably sold together with *E. suilis* in both Saudi Arabia and Kuwait under the name of "hamoor". Specimens of *E. suilis* only rarely exceed about 111 cmTL in the North Western Gulf.

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