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SOME BIOLOGICAL ASPECTS OF *Solea elongata* FROM THE SHATT AL-ARAB ESTUARY, NORTH WEST ARABIAN GULF

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ABSTRACT

Aspects of the biology of 1086 *Solea elongata* from the Shatt Al-Arab Estuary, Northwest Arabian Gulf were described during for the period Jun. to Dec. 2000. The length frequency distribution of the whole sample exhibited unimodal distribution; one peak observed at length 90 mm indicates that catches were exclusively based mainly on one year-class individuals. *S. elongata* had not been caught during November. Length-Weight relationship was found to be: $W= 2.6 \times 10^{-6} L^{3.285}$. Growth rate was estimated to reach the length 100-109 in 1.1 year. Feeding activity values ranged from 50 to 85 %, while the minimum feeding intensity ratio was 0.4 point/fish and the maximum 3.2 point/fish. Diet of *S. elongata* was exclusively on molluscs (bivalves, *Bithynia* sp.).

INTRODUCTION

The soles (Soleidae), a family, of flatfishes, widely distributed in the world, including 135 species in 28 genera both and fresh waters. The genus *Solea* is represented by 11 species and many soles are commerical species: the common sole, *Solea solea*, is disturbed in northern Europe and the Mediterranean (Froese and Pauly, 2006). Soleidae in the Arabian Gulf are represented by 6 species; *Aseraggodes cyanecus, Pardachirus marmoratus, Solea elongate, Synaptura orientalis, Zebrias synapturoides* and *Zebrias quagga* (Kuronuma and Abe, 1986). Mohamed *et al.* (2001) recorded four species of this family; *Synaptura orientalis, Zebrias synapturoides, S. elongate* and *S. bleckeri* in Iraqi marine waters. *S. elongata* Day, 1877 is a demersal fish distributed from western Indian Ocean
(Red Sea and Arabian Gulf) to the west and east coast of India, Sri Lanka and China. Adults inhabit shallow sand and mud bottoms in coastal waters

to a depth of 8 – 28 m (Menon, 1984). The total catch of *S. elongate* was 403.6 tons and formed 0.72% from the total fish production in Bangladesh waters during 1989-1990 (Ahmad, 2005). Hasan *et al.* (2005) caught *S. elongate* together with other 22 species of fishes from various parts of Indus delta, Pakistan. Agah, *et al.* (2007) recorded low methylmercury fraction in the smallest specimen of *S. elongate* (TL, 18-21cm) compared with other six species sampled by bottom trawl survey at Mogham and Lengeh ports located in the Hormozgan province, southern Arabian Gulf.

Soleidae species are landed in small quantities in Iraq, as a by-catch species mixed with other flatfishes species, and none of these comprises a single species fishery. However, the highest catch rate of Soleidae species by trawling in Iraqi marine waters was 2.4 kg/h in April 1990 (Mohamed, 1993). Ali, *et al.* (1998) reported that the total landing of black sole *Euryglossus* (*Synaptura*) *orientalis* by marine artisinal fisheries in Iraq was 20.9 tons in 1990. Soleidae larvae (*S. elongate* and two unidentified species) were one of the most abundant fish larvae at the offshore stations, northwest Arabian Gulf during December 1990 as stated by Hussain and Ahmed (1995). The recruitment, distribution and abundance of *S. elongata* larvae were widely reported in Kuwait Bay, north Arabian Gulf (Dames and Moore, 1983, Houde *et al*., 1986, Wright, 1989, Grabe *et al*. 1992.).

No published works were traced concerned the biology of *S. elongata* in the Arabian Gulf. The aim of the present work was to study the main aspects of the biology of *S. elongata*, namely length frequency distribution, length-weight relationship, growth and food nature, in the Shatt Al-Arab Estuary.

MATERIALS AND METHODS

Monthly samples of *S. elongata* were collected from the trawl catches of R.V 'Behar' of the Marine Science Centre, Basrah University as a by-catch of the general fish survey during 2000 at the Shatt Al-Arab Estuary, northwest Arabian Gulf. (Fig. 1). Collection of fish made using 20 x 1.5m trawl with a stretched mesh size of 1cm of the net and 3cm of the wings. The specimens were immediately preserved in crashed ice for subsequent analysis. The species was identified after Fischer and Bianchi (1984).

The total length and the weight for each fish in the samples were recorded to the nearest mm and 0.1g, respectively, and then were classed into 1 cm categories to plot the length frequency distribution. The length-weight relationship was obtained by fitting the equation: (LeCren, 1951) $W = aL^b$, where W= weight (g), L= total length (mm), and a and b are constants).

The length cohort analysis (Jones, 1984) was applied to provide information on the growth rate of *S. elongata*. A value of $L\infty$ (Fischer and

Bianchi, 1984, Menon, 1984) and the K value obtained was 0.40 (Jones, 1984).

Stomachs were individually assigned a fullness index value (Ball, 1961). Percentage feeding activity of each monthly sample was calculated after Dipper *et al*. (1977) and mean monthly feeding intensity was estimated according to Gordon (1977). Index of relative importance, IRI, (Pinkas *et al*. (1971) was employed to assess the importance of each food item in the diet.

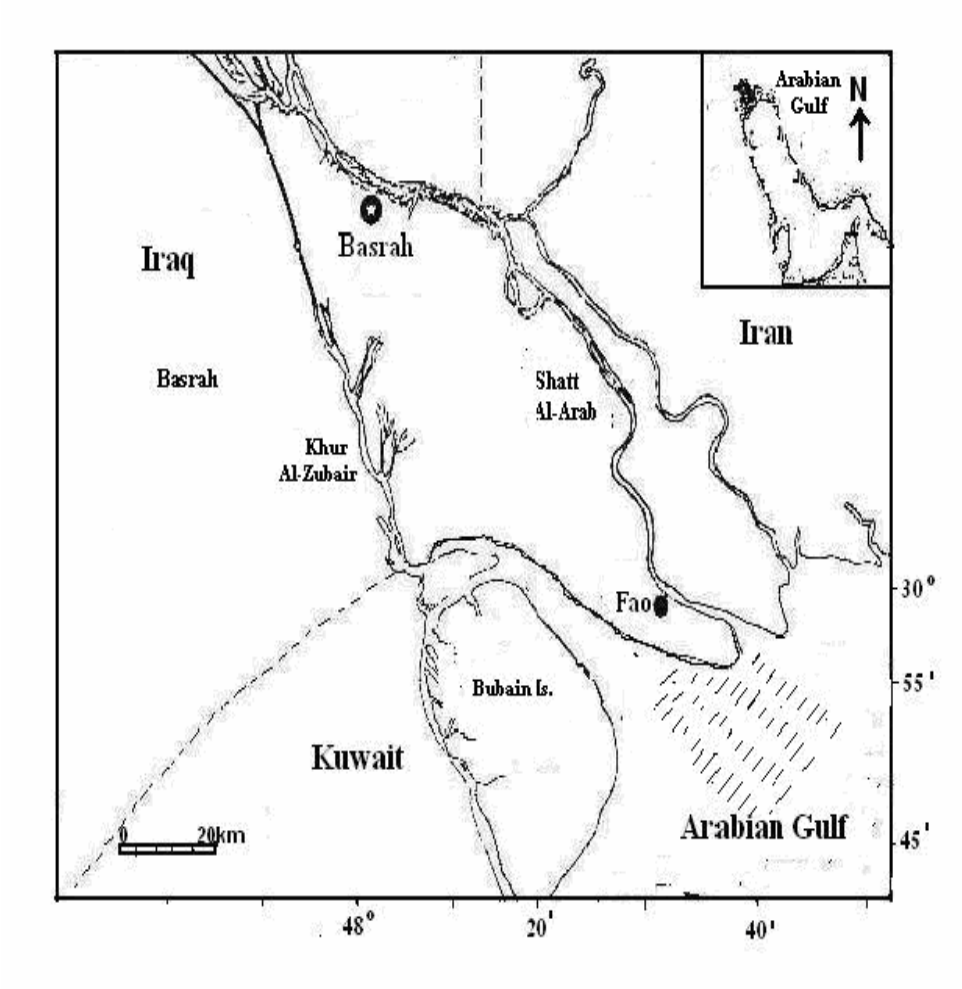

Fig. 1: Map of the Shatt Al-Arab estuary, northwest Arabian Gulf, showing the sampling area (shaded).

RESULTS

Length Frequency Distributions

A total of 1086 specimens of *S. elongata* were caught throughout the study period. The monthly length frequency distributions of the species are illustrated in Figure 2. The species was collected in every month except November. The smallest individual (45 mm) and the length(129 mm) were appeared in the catch in July.The length frequency distributions clearly show the small sizes of fish caught and exhibited one mode in all months.

The length frequency distribution of the whole sample exhibited unimodal distribution, one peak observed at length 90 mm. The fish at length groups 80 to 100 mm formed 98.2% of the total catch. The main length group (90 mm) was dominant and representing 40.10% of the total number of endividuls and the second important length group was 80 mm forming 30.9% and length group 100m constituted 14.80% of the total catch. These were young-of-the-year settlers collected from their feeding ground in the Shatt Al-Arab Estuary.

Growth

The length–weight relationship of *S. elongata* was represented with the following equation: $W= 2.6 \times 10^{-6} L^{3.285}$ (TL= 45-129mm, r2 = 0.99, n = 205) and (b) was statistically significant.

The results of length cohort analysis of 1086 fish ranging from 45 to 129mm are given in Table (1). The growth curve of *S. elongata* is constructed by plotting the lengths against corresponding relative ages (Fig. 3). The species was grown to 95mm T.L in the end of the first year.

Table 1. Data for length cohort analysis of *S. elongata* in the Shatt Al-Arab estuary.

Length group (mm)	No. of fish	t_1	t_2	Relative age (year)
50-59	3	0.455	0.547	0.5
60-69	5	0.557	0.653	0.6
70-79	3	0.664	0.764	0.7
80-89	336	0.775	0.879	0.8
90-99	457	0.892	1.001	0.9
100-109	161	1.014	1.128	1.1
110-119	112	1.142	1.263	1.2
120-129	9	1.277	1.405	1.3

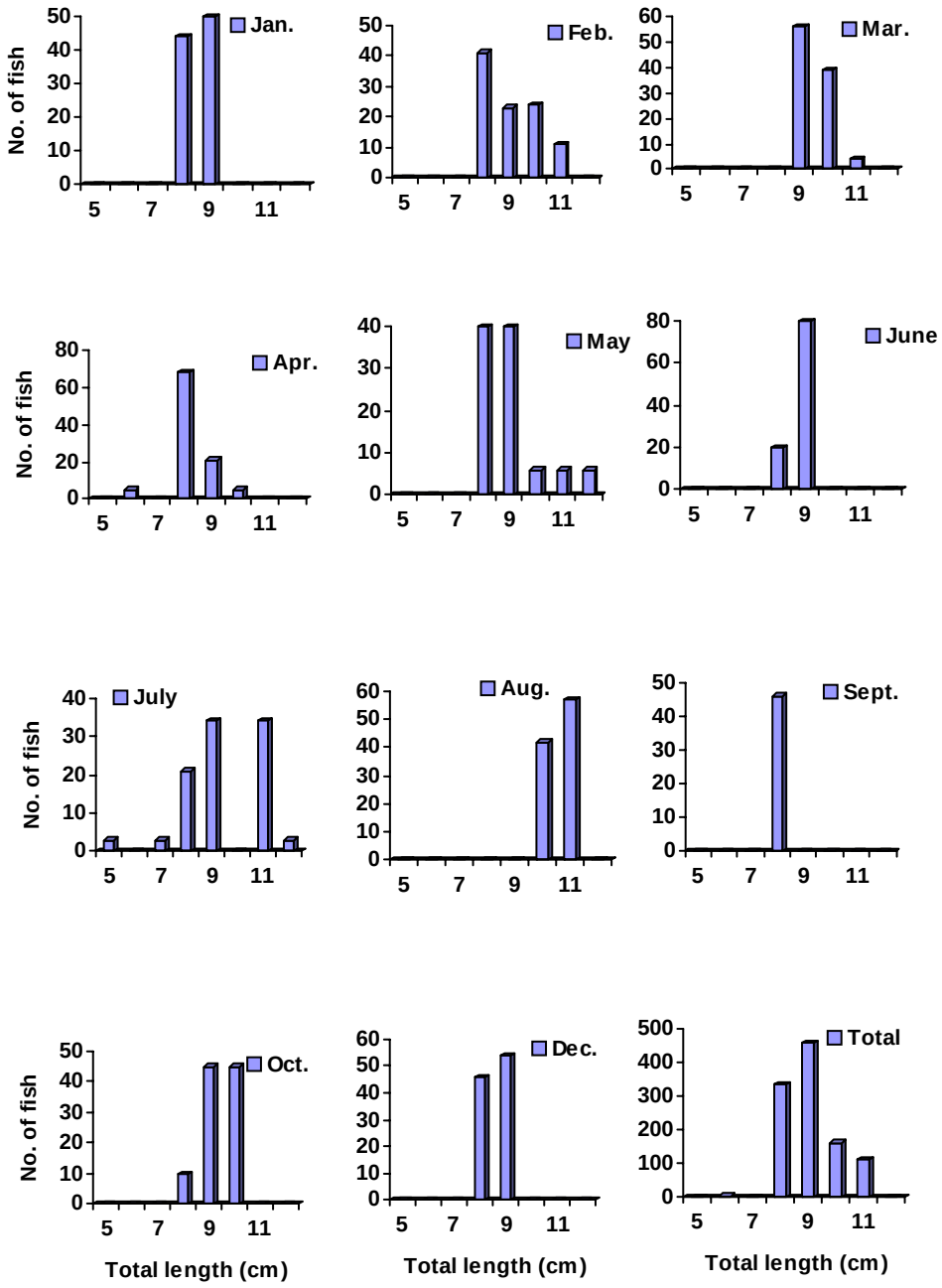

Fig. (2): Monthly length frequency distributions of *S. elongata* in the Shatt Al-Arab Estuary

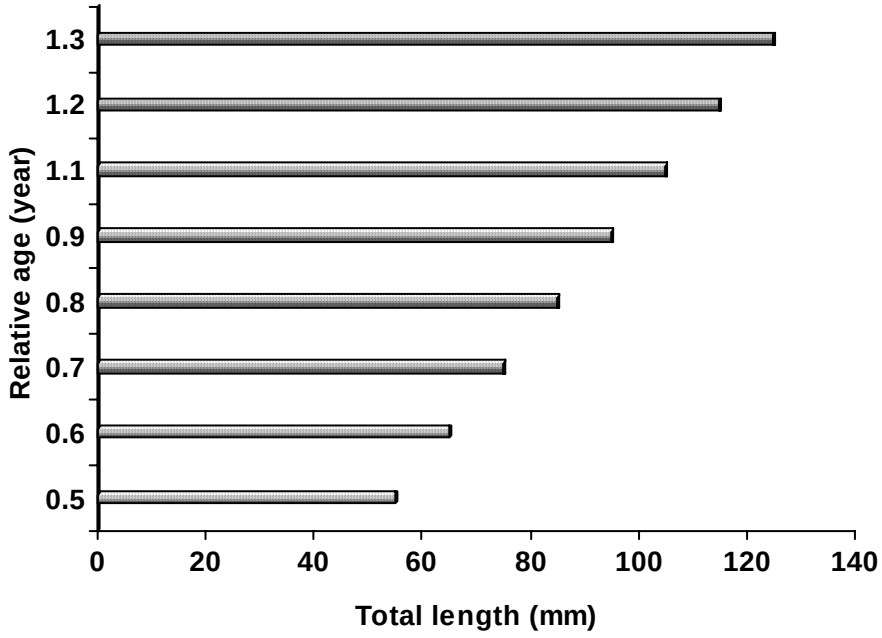

Fig. (3): The relative ages at their lengths of *S. elongate* in Shatt Al-Arab estuary.

Food Analysis

Figure (4) illustrates monthly variations in mean feeding activities and feeding intensities of *S. elongata* in the Shatt Al-Arab Estuary. It could be concluded that this species never cease feeding all over the year. Feeding activity values are ranging from 50% in February to 85 % in June. The minimum value of feeding intensity (0.4 point/fish) was calculated in February, while mean maximum intensity (3.2 point/fish) was encountered in June. It is clear that the trend of this criterion almost resembles that of the feeding activities.

The analyses of the stomach contents of *S. elongata* revealed that this species fed exclusively on molluscs (bivalves, *Bithynia* sp.). The index of relative importance (IRI)% equal to 100 %.

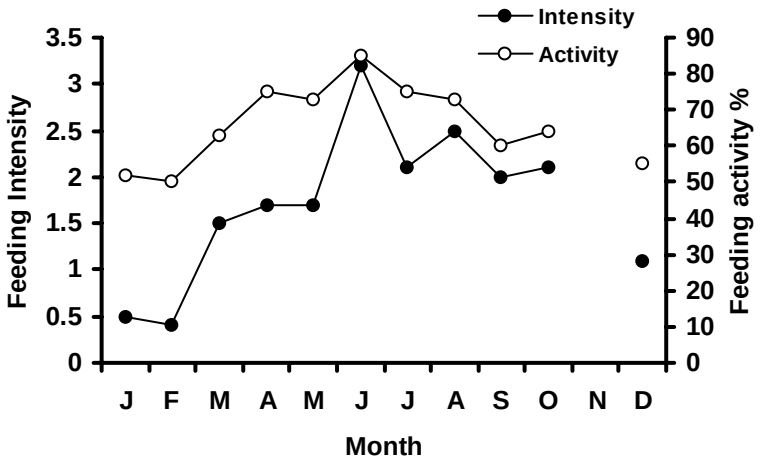

Fig. (4): Monthly variations in feeding activity and feeding intensity of *S. elongata* in Shatt Al-Arab estuary.

DISCUSTION

Wright (1986) concluded that the *S. elongata* spawn in the late autumn and winter months and the larvae of the species appeared in Sulaibikhat Bay, inshore of Kuwait Bay, at the northern end of the Arabian Gulf during January at a modal length glass of 20-30mm, remained in the bay with a peak abundance in March and fish at lengths 10-70mm formed 95.3% of the total catch. The same conclusion found by Dames and Moore (1983) and Grabe *et al*. (1992). Hussain and Ahmed (1995) suggested that the actual spawning activity of *S. elongata* occur offshore Iraqi marine water. However, the size of *S. elongate* found in the study area ranged from 45 to 129 mm and the fish at lengths 80 to 100 mm formed 98.2% of the total catch of this species, indicated that the larvae transport to inshore water to complete the first year of their life in the Shatt Al-Arab estuary as a feeding ground. Mode of the monthly length frequencies for *S. elongata* (90mm) corroborated first-year length estimate determined from the length cohort analysis. Iraqi marine waters form the estuarine part of the Arabian Gulf and are considered the most productive part of the Gulf (Bibik *et al*., 1970 and Al-Zubaidi, 1998). Consequently, this high productivity tends to attract many species to the estuary. These waters are turbid due to the Gulf tidal currents and Shatt Al-Arab River sediment loads. The Shatt Al-Arab estuary plays important role as feeding, nursery and protective grounds for many fish species (Hussain, *et al*., 1999).

Fischer and Bianchi (1984) and Menon (1984) considered that 300mm is the maximum length for *S. elongata* in the fishing area of the Arabian Sea and the Arabian Gulf. We recorded 129mm as the biggest length obtained in Shatt Al-Arab estuary. The differences between the maximum length and the obtained one could be as a singe that the population of *S. elongata* extends offshore in the Arabian Gulf in greater depths a way from Shatt Al-Arab estuary. Amara (1995) postulated that the spawning ground of *S. solea* in Biscay Bay located off shore. The larvae immigrate during the first year to the coastal area. This could explain the absence of bigger length groups in the monthly samples. Mohamed *et al* (2002) studied the growth of tongue sole *Cynoglossus arel* in the Iraqi marine waters and found that the values of L_∞ and K were equal 35.2cm and 0.42 respectively, and the length of fish at the end of the first year was 12.3cm.

Most of the literature revised indicated that Solidae are a carnivorous. The same was realized in the present study in which the species fed mainly on molluscs (bivalves). However, Wright (1986) mentioned that the diet of *S. elongate* was consistently dominated by amphipoda (48.9%), polychaeta (23.4%) detritus (21.3%) and bivalvia (6.4%) with several other items being present as traces. Rodriguez (1996) studied the diet of juveniles and adults of two species of Soles in Northern France and found that they were carnivorous and their diet consist mainly of soft bottom benthic invertebrates (Polycheats, Shrimps and Mysids). Allam (1995) studied the food and feeding of several soles (*S. vulgaris, S. impar, S. aegyptiaca* and *S. kleini*) in Abu-kir (Southeast Mediterranean Sea, Egypt), these species are carnivorous and depend on crustaceans and bivalves.

Darnaude (2005) described the diet of the juveniles and adults of five important flatfish species (*Arnoglossus laterna*, *Buglossidium luteum*, *Citharus linguatula*, *S. lascaris* and *S. solea*) in the Rhone River delta (NW Mediterranean).The five species showed important differences in food preferences and diet adaptability despite occupying the same habitats. *B. luteum* had the last specialized diet, with similar proportions of polychaetes, molluscs (mainly bivalves) and crustaceans. *S. solea*, *S. lascaris* and *A. laterna* also preyed on a wide variety of benthic organisms but showed clear preferences for polychaetes, bivalves and crustaceans, respectively. In *C. linguatula* the diet was highly specialized, consisting almost exclusively of fish and crustaceans (mysids and shrimps).

In a previous study conducted in the Sado Estuary, Portugal, Amaral and Cabral (2004) mentioned that the wiskered sole *Monochirus hispidus* fed mainly on amphipods and polychaets, and they also emphasized the low importance of bivalves in the diet of this species, whereas, in the Mediterranean, identified polychaets, bivalves and echinoderms as the main prey of *M. hispidus*. These differences in the diet of *M. hispidus* according

to geographical area may be due to the variety of habitats, prey availability, season and range of fish lengths analyzed in these studies. Nonetheless, bivalves are quite abundant in the Sado Estuary and are eaten by several flatfishes, namely *S. senegalensis,* which contradicts the opportunist and generalist nature of most of the flatfish species in coastal habitats. Several flatfish species co-occur with *M. hispidus* in the main feeding grounds of the Sado Estuary and thus the prey selection of *M. hispidus* may be constrained in order to avoid competition with other species, namely *S. solea* and *S. senegalensis* that fed intensively on bivalves.

The bivalve *Scrobicularia plana* are one of the main items in sole diets in the Tagus estuary, Portugal, this food group item is totally absent in the Douro estuary, which is probably due to the absence of intertidal mudflats where this species is abundant (Cabral, 2000).

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بعض الصفات الحياتية لسمكة *Solea elongata* في مصب شط العرب، شمال غرب الخليج العربي

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الخلاصـــة

وصفت الصفات الحياتية لأسماك *Solea elongata* في مصب شـط العرب، شمال غرب الخليج العربي خلال الفترة من كانون الثاني الى تشرين الثاني 2000. اظهر التوزيع التكراري للأسماك وجـود قمـة واحدة للأطوال عند الحجم 90 ملم، مما يشير بان أفراد النـوع فـي مرحلة نمو واحدة، لم يتم الحصول على النوع خلال شـهر تـشرين الثاني. كانت علاقة الطول الكلي بالوزن: $W= 2.6 \times 10^{-6} L^{3.285}$. بلغ نمو الأسماك 100- 109 سم خلال 1.1 سنة. تراوحت قيم نشاط التغذية للأسـماك بـين 50 % و85 % وشـدة التغذيـة بـين 0.4 نقطة/سمكة و3.2 نقطة/سمكة. تتغذى أسماك *S. elongata* كليا على الرخويات (ذات المصراعين).