STOCK CONDITION OF LARGE-SCALE TONGUE SOLE, 
*Cynoglossus arel* IN THE NORTHWEST ARABIAN GULF

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ABSTRACT

The stock of large-scale tongue sole *Cynoglossus arel* in the Northwest Arabian Gulf was assessed from January 1997 to August 1998. The population parameters estimated were \( L_c = 35.2 \text{cm} \), \( K = 0.42 \), \( Z = 1.58 \), \( M = 0.88 \) and \( F = 0.70 \). Bimodal of unequal strength pulses separated by six months characterized the recruitment pattern. The exploitation rate obtained \( (E = 0.44) \) was slightly lower than the \( E_{max} \) value, which found to be equal to \( (0.49) \). However, the length at first capture \( (L_c = 12.9 \text{ cm}) \) should be rise up to 15.0 cm to avoid any over-fishing recruitment problem. The study emphasized on the necessity of continuous assessment of Northwest Arabian Gulf fisheries to define the impact of the increasing fishing effort on the fishery resources in this region.

INTRODUCTION

The flatfishes are of diverse group including 500-600 species (Froese and Pauly, 1994). Pauly (1994) reported that the global catch of this group was increased from 1,084,400 ton in 1980 to 1,207,800 ton in 1990.

Flatfishes in the Arabian Gulf are represented by 26 species (Kuronuma and Abe, 1986). The suborder Soleoidei includes two families, one of them is cynoglossidae for which the studied species large-scale tongue sole *Cynoglossus arel* is belong (Al-Daham, 1984).

The seasonal occurrence of *C. arel* in the Iraqi marine waters Northwest Arabian Gulf was carried out by Hussain and Naama (1989) and Ali and Hussain (1990) in Khor Al-Zubair, Ali (1993) in the open waters and Hussain *et al.*, (1999) in Khor Abdullah. Those studies indicated that this species is one of the commonest Iraqi marine fishes. The recent biological study of Mohamed (1997) in Khor Al-Amaya revealed that *C. arel* is benthoephagic mainly depends on bivalves as previously pointed by Hussain *et al.*, (1992) in Khor Al-Zubair.
The only age-based method used to estimate the growth parameters of *C. arel* in the Arabian Gulf was otolith (Williams, 1986, Brothers and Mathews, 1987, and Mohamed, 1997). However, length-based method using ELEFAN program was yearly applied by Mathews et al., (1989) during the period from 1978-1986.

The present work is the first attempt to assess the stock of *C. arel* in the Iraqi marine waters using the most recent program FiSAT (Gayanilo et al. 1996).

**MATERIALS AND METHODS**

**Fish Samples**
Fish samples were collected on monthly basis from Khor Al-Amaya, part of Iraqi marine waters Northwest Arabian Gulf (Fig. 1) during January 1997 to August 1998, through a fishery-oceanography survey carried out by the Marine Science Centre, University of Basrah since September 1995. Small shrimp trawler “Behar” was used for fishing operations. Samples were collected for seven consecutive fishing days with an average of 5-6 hauls per day and 2-3 hours for each, i.e., ~35 hauls per week. Length frequency data based on total length (measured to the nearest cm) were recorded after each haul.

**Analytical methods**
Length-based method was applied to assess the stock condition of *C. arel* using FiSAT Programe of Gayanilo et al. (1996). This programe is the most recent software designed for fish stock assessment produced as a result of merging the two main programs ELEFAN developed by ICLARM and LFSA developed by FAO. The program package consisting of robust methodologies used with microcomputers, enabling users to formulate management options for fisheries in data-sparse, tropical contexts (Gayanilo et al., 1996).

The monthly length frequency data of the following periods were pooled (January-February 1997), (March-May 1997), (June-August 1997), (September-November 1997), (December1997), (March-May 1998) and (June-August 1998). The length frequency of these seven periods (quarters) were inputted in the program through the first routine (File) with length group interval 1 cm. Each quarter is represented by mid-sampling time. The sample manipulation file adjusted the originals content of the length frequency data depending on the (L_{50%} and L_{75%}). These lengths at which
The sampling area

Fig. 1. Location map of Iraqi marine waters, northwest Arabian Gulf, showing

Sampling area

Stock condition of large-scale tongue sole

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50% and 75% of the fish are retained by the gear were estimated to be 9.8cm and 11.4cm respectively. The corrected lengths were used in further analysis. The mean length of each cohort was obtained by Bhattacharya’s modal progression analysis (Bhattacharya, 1967).

The mean lengths of each successive pairs within the same cohort, which used as input for growth increments file allows to draw the growth curve, and give estimates of asymptotic length ($L_\infty$) and growth coefficient (K) using Gulland and Holt plot (1959).

The length converted catch curve (Pauly, 1984) was applied to estimate the total mortality coefficient (Z). The coefficient of natural mortality (M) was estimated as exponential of (M) calculated by calculated the empirical Pauly's equation (Pauly, 1980).

$$\log \, M = -0.0066 + 0.279 \log \, K = 0.6543 \log \, L_\infty + 0.4634 \log \, T$$

T: the annual mean of water temperature of the study area, which equal in the present study 25 °C.

The fishing mortality (F) was expressed according to the formula (Z=M+F), hence the exploitation rate (E) was estimated as (F / Z). This has been defined as "actual exploitation rate " in the present study to distinguish it from other related exploitation rates.

The recruitment pattern was depicted by projecting each length-frequency sample backward onto the time axis. The peaks and troughs of the graph obtained reflect the recruitment pattern of the stock in question. The relative yield per recruitment ($Y'/R$) was estimated to predict the yield and stock condition, and hence, to recommend adequate management regimes. The selection ogive technique was adopted.

RESULTS

Length frequency distribution

The lengths of 10127 specimens of C. arel included in the present study were ranged from 7 to 32 cm (Fig. 2). The smallest individuals (<10cm) were of highly abundance in the catches of July and December that represent the widest length range, while the largest specimens were occurred during April-July. The overall length frequency showed that the major peak was at lengths 17-19cm.

Growth

The asymptotic length ($L_\infty$) and growth coefficient obtained by Gulland and Holt plot were equal 35.2cm and 0.42, respectively (Fig. 3).
Fig. 2- Length frequency distribution of *C. arel* in the NW Arabian Gulf.
Fig. 3- Estimation of growth parameters of *C. arel* by Gulland and Holt Plot.

Fig. 4- Length converted catch curve of *C. arel* in the NW Arabian Gulf.
The estimated asymptotic length was slightly higher than the maximum captured length (32.8cm). Seasonal growth was of less significant oscillation (C<0.1). By applying Von Bertalanffy growth formula (VBGF) using the growth parameters obtained, C. arel attained lengths of 12.3, 20.3, 25.5, 28.9, 31.1 and 32.5 at the end of its six relative ages achieved, respectively. It can be concluded that >50% of the growth increment is taken place by this species at the first two years of its life span.

Mortality
The total mortality coefficient (Z) was equal 1.58. This value represents the slope of the descending right arm limb for fully exploited lengths ranged between 19-30cm (Fig.4). The natural mortality coefficient (M) was calculated to be 0.88. Consequently, the fishing mortality coefficient is equal 0.7, hence the exploitation rate (E) was 0.44.

Recruitment pattern
The recruitment of C. arel was of bimodal pattern (Fig. 5). The modes were of unequal strength pulses, the major contributed 87.17% of the total recruits with a peak in May and the minor formed 12.83% with a peak in November.

Relative yield and biomass per recruitment
The maximum relative yield per recruitment (Y’/R) of C. arel in the Northwest Arabian Gulf was equal to \(~0.0217\) which achieved at \(E_{max} = 0.49\) (Fig. 6). This exploitation rate is slightly higher than the actual exploitation rate (E = 0.44) currently characterized the stock of this species. The current relative biomass per recruitment (B’/R) was \(~0.302\). However, the exploitation at which the biomass will reduce to 50% of the unexploited stock was attained at \(E = 0.30\) (Table 1).

The \((Y’/R)\) as a function of exploitation rate and length at first capture \((L_c)\) is illustrated in the isopleth diagram (Fig. 7). It could be concluded that the position of the current \((Y’/R)\) is out of the line pass through the contours. However, the position of the maximum \((Y’/R)\) is located within \(E = 0.49\) and \(L_c/L_{\infty} = 0.45\).

DISCUSSION

The main goal to assess fish stock is to monitor the past state of the stock of investigated species, its response to fishing activities and environmental factors and impacts of changing fishing patterns of from implementation of management and development polices.
Fig. 5 - Recruitment pattern of *C. arel* in the NW Arabian Gulf.

Fig. 6 - \( Y'/R \) and \( B'/R \) of *C. arel* estimated by selection ogive method.
Table 1- Relative yield per recruitment ($Y'/R$) and biomass per recruitment ($B'/R$) of *C. arel* in the NW Arabian Gulf.

<table>
<thead>
<tr>
<th>E</th>
<th>$Y'/R$</th>
<th>$B'/R$</th>
<th>E</th>
<th>$Y'/R$</th>
<th>$B'/R$</th>
</tr>
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<tr>
<td>0.05</td>
<td>0.0041503</td>
<td>0.904541</td>
<td>0.55</td>
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<tr>
<td>0.15</td>
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<td>0.722626</td>
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<td>0.002496</td>
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</tr>
</tbody>
</table>

Optima:
- $E_{max} = 0.491$
- $E_{-1} = 0.461$
- $E_{-5} = 0.295$

Fig. 7- Isopleth diagram of $Y'/R$ of *C. arel* as a function of exploitation rate and length at first capture.
The present study is the first attempt to assess the stock of *C. arel* in the Iraqi marine waters Northwest Arabian Gulf. An intensive fishing effort is executed in this region since 1992. Therefore, it is of great importance to carry out a comprehensive study on stock of the commercial fishes to assess their present condition and the impact of such effort on their future status.

The growth parameters obtained in this study depending on length-based technique were different from those obtained by Mohamed (1997) using otolith method but very close to ELEFAN program results obtained by Mathews *et al.*, (1989). Ali (1999) indicated that growth parameters of several species obtained by length-based method were similar or within the range of those obtained by examining hard parts of fish body.

The bimodal recruitment pattern deduced from the present study was found for other species occupy the Northwest Arabian Gulf as mentioned by Ali (1999). Moreover, this modal was also found for related species speckled tongue sole *C. puncticeps* in Philippine, where the peak of the first was in April and the second in August (Ingles and Pauly, 1984). Such modals indicate the biological importance of the Northwest Arabian Gulf for early stages of many species utilize successively this region as nursery ground.

To conclude the optimum exploitation rate and length at first capture that maximize the \((Y'/R)\) of *C. arel* several values have been tried for these two variables. The results showed that the exploitation rate obtained during the study period was slightly lower than the optimum level and the current length at first capture \((L_c= 12.9\, \text{cm})\) should be rise up to \(15.0\, \text{cm}\). In comparison with this less difference, big differences were deduced for other species that occupied the same as pointed by Ali (1999). The shrimp trawlers were widely used during the last ten years. The fishing effort by this gear was gradually increased even during the period followed this study. Thus, the exploitation rate found during 1997-1998 may exceeds the current level due to a continuous removal of fishes under the optimum length at first capture. The assessment of fish stocks under such fishing condition should be of continuous process to define the extent to which the stocks of commercial fishes are able to be exploit in future.
REFERENCES


**Cynoglossus arel**

في شمال غرب الخليج العربي

عبد الرزاق محمود محمد و ثامر سالم علي و نجاح عبث حسين

مركز علوم البحار- جامعة البصرة- البصرة- العراق

الخلاصة


قدرت مقياس المجتمع التالية:

\[ L_{\infty} = 35.2 \text{ cm} \]

\[ K = 0.42, \quad Z = 1.58, \quad M = 0.88, \quad F = 0.70 \]

تميز نمط الإمداد بكونه ثنائي غير متكافئ القوة في الطورين الذئبي و الفيني التي تفصل بينهما فترة زمنية أدمها ستة أشهر. بلغت قيمة معدل الاستغلال 0.44، وكانت تقل عن قيمة *E_{max}* التي بلغت 0.49 في حين كان معدل الطول عند الصيد الأول *L_{c}*، مساوياً إلى 12.9 سم والذين وجد أنه من الضرورية أن يصل إلى 15 سم بغيّة تحقيق الإنتاج الأقصى للإمداد. أكّدت الدراسة على أهمية التقييم المستمر للمخزون السمكي في شمال غرب الخليج العربي لمعرفة أثر ازدياد جهد الصيد على الموارد السمكية لهذه المنطقة.