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Variability of Catch Rate and Length of Lizard Fish (*Saurida undosquamis*) in the Northwest Red Sea Trawl Fishery

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Abstract. Gulf of Suez is one of the most important Egyptian fishery grounds. *Saurida undosquamis* is the most commercially important fish species from the trawl fishery of the Gulf. Lizardfish was found in all the trawlable bottoms of the Gulf. The catch rate decreases southward. The fish mean length of tow catch increases southward. During the survey, there was clear evidence that the northern part of the Gulf, a wide shallow area, is a nursery ground for *S. undosquamis*. Depth has no significant effect on the fish catch rate. All depths are equally likely to yield 8.4 ± 6.811 kg/hour lizardfish. A significant model relating depth and fish mean length of tow catch was deduced. Fish length increases with increasing depth in a rate 0.33 cm/m of up to about 51 m depth and then decreases in a rate of 0.11 cm/m. Also, a significant relation was estimated modeling the day/night variation of catch rate. Mean catch rate in the daytime is 3 times that of night. Fish mean length of tow catch at night is slightly larger than that of daytime.

Keywords: Lizardfish; bottom trawl survey; Gulf of Suez.

Introduction

Natural behaviour of the fish stocks, such as feeding activity, geographical distribution, migration and the behaviour against the trawl set, may change their availability to the bottom trawl surveys (Karp & Walters, 1991; Godø, 1994). Varying catchability of fish species is the most serious problem facing the reliability of the scientific bottom trawl surveys (Parrish, *et al*., 1964; Engas & Godø, 1986; Godø & Wespestad, 1993; Aglen *et al*., 1999). Diel variability of the fish catch rates is mostly likely to be due to specific natural behaviour that causes varying catchability to bottom trawlers (Engas & Soldal, 1992, Michalsen *et al.*, 1996). Lizardfishes are diurnal predators, specialized ambushers using extreme camouflage necessary for capture of fish during daytime (Moyle & Cech, 1988).

Saurida undosquamis is the most commercially important fish dominating the others from the bottom trawl fishery in the North West Red Sea. Landings of *S. undosquamis* represent the first catch category from the trawl fishery. Economically, *S. undosquamis* comes in the second order after the large shrimps. A long time ago, it has attracted the researchers to study its biological and fisheries parameters using the commercial landings. Latif and Shenouda (1972) studied some biological aspects of the species. Sanders and Kedidi (1984) and Sanders and Morgan (1989) reported some fisheries parameters for the fish species. El-Ganiny (1992) studied some biological aspects of *S. undosquamis* population in the Gulf of Suez. Ramadan (1995) studied some reproductive parameters of the species in the Gulf of Suez.

Landings of *S. undosquamis* fishery in the Gulf of Suez and adjacent area suffer deep fluctuation and continuous decline (Fig. 1). The present study aims to investigate some behaviour characters of *S. undosquamis* to bottom trawling. Such information is essential during the data analysis of the bottom trawl survey to have precise and accurate results.

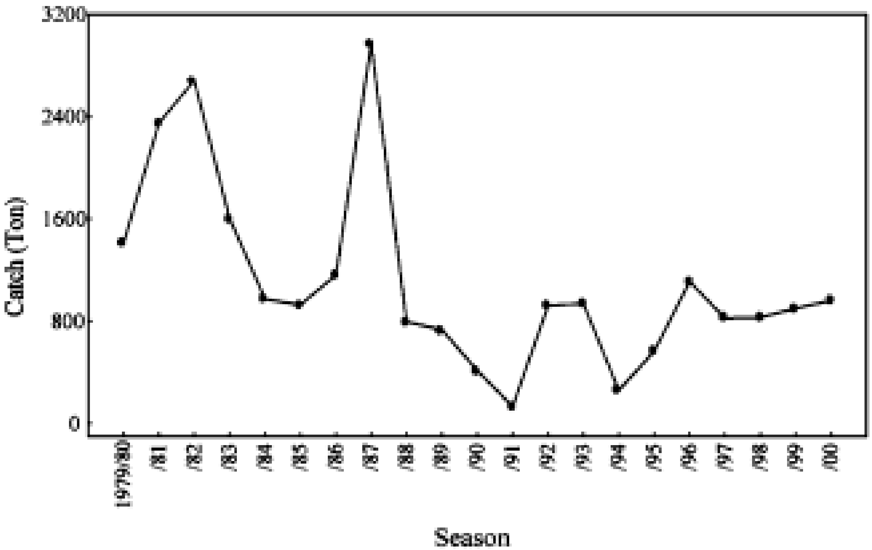

FIG. 1. The seasonal bottom trawl landings of *Saurida undosquamis* from the Gulf of Suez and its adjacent area. Data from the General Authority for the Development of the Fish Resources.

Materials and Methods

The National Institute of Oceanography and Fisheries, NIOF, had conducted a scientific bottom trawl survey through 25 November – 4 December 1998 north-west Red Sea, in the Gulf of Suez and its adjacent area (Fig. 2). The present data were collected during that survey.

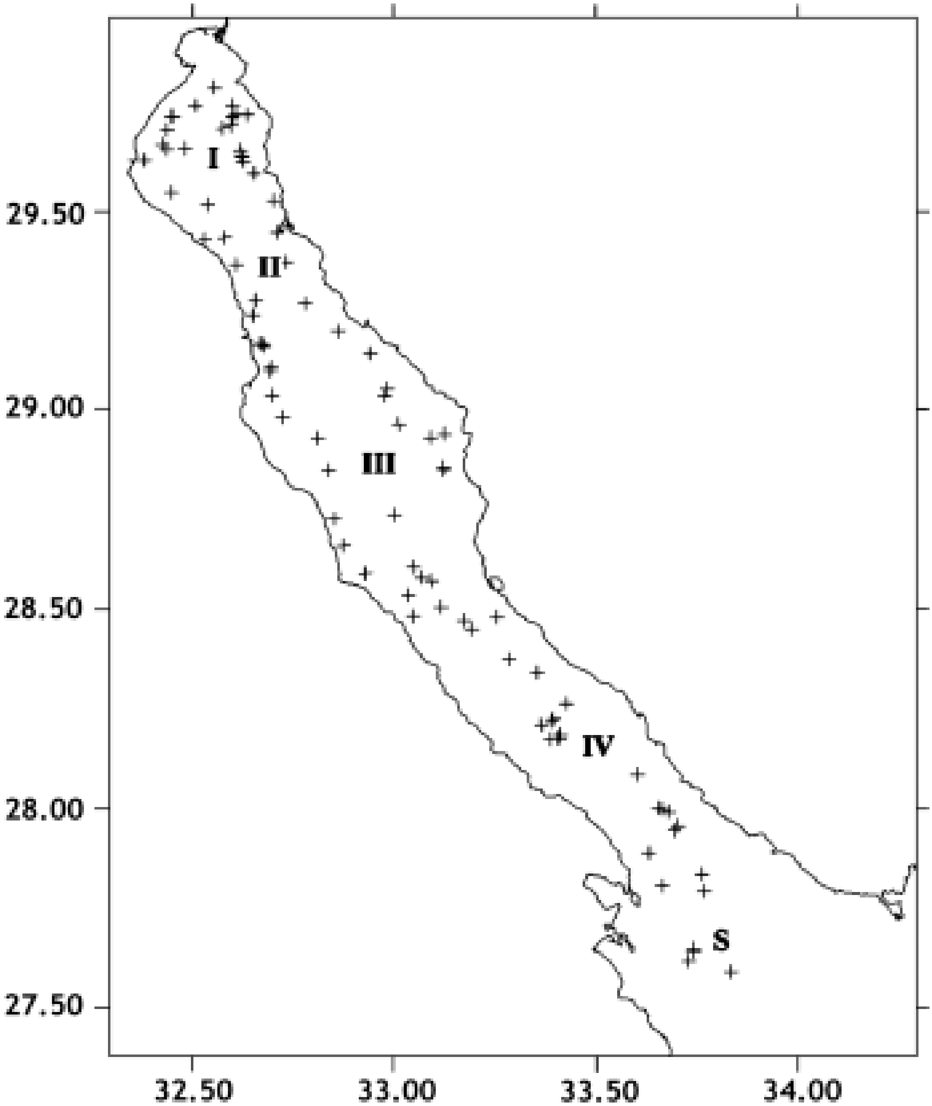

FIG. 2. Geographical distribution of tows caught *S. undosquamis* from the Gulf of Suez and its adjacent area (S), autumn bottom trawl survey, 1998.

Considering the human activity, and the geographical differences along the Gulf axis, the surveyed area was divided into 5 sectors. The longitudinal four sectors (I, II, III & IV) were established to the Gulf and the fifth sector, S, designated the adjacent area.

**Latitudes of the proposed sectors for the Gulf of Suez.

Sector	East Latitude	West Latitude
I	29º50' (Ras Misalla)	29º49.5' (Ras Adabiya)
	29º27'	29º23' (Ras Abu Daraq)
II	29º27'	29º23' (Ras Abu Daraq)
	29º13'	29º07' (Ras Zaafarana)
III	29º13'	29º07' (Ras Zaafarana)
	28º34'	28º30' (Fals Ras Gharib)
IV	28º34'	28º30' (Fals Ras Gharib)
	27º56' (Ras Kenisa)	27º49.5' (Umm El Kiman)

To deduce the relationships of the different variables, the nonlinear module, with Quasi-Newton method was used. The comparison between groups was performed using ANOVA/MANOVA module in the STATISTICA Package V5.0. The significant p value ($p < 0.05$) is bolded and underlined in the table of the results.

The following terms were used:

Length (cm.): It is the total length measured from the tip of the specimen mouth to the posterior end of the upper fork of the tail, to the nearest 1 cm.

Catch Rate (kg/hr): It is the weight of the tow catch of species, in kilograms, divided by the time of the tow duration, in hours.

Results

Geographical Distribution

Aurida undosquamis was caught from all the trawled stations through the Gulf of Suez. It was found in the three areas, eastern and western sides of the Gulf, in the main channel of navigation and in the area adjacent to the south of the Gulf (Fig. 2). All depths trawled in the Gulf of Suez, from 13.9 m to 77.0 m, provided *S. undosquamis*. It was caught from different trawled sea bottom natures including fine, coarse, sandy and muddy bottoms.

Regional Variation

Catch rate

Along the Gulf and adjacent area (Table 1), the first area (I) showed the maximum mean catch rate, 13.2 kg/hr, accompanied by the widest range, 3.5-38.3 kg/hr, and the highest standard error, 2.003. The rate gradually decreased reaching the minimum, 5.1 kg/hr, in the adjacent area. Also, the adjacent area showed the narrowest range, 1.9-8.5 kg/hr, and the lowest standard error, 0.623. The four areas of the Gulf were significantly different in their catch rates ($p < 0.0035$). Excluding the first area, the catch rates of the remaining three areas were not significantly different ($p < 0.3089$). The five areas, four of the Gulf and adjacent area exhibited significantly different ($p < 0.0021$) mean catch rates.

TABLE 1. Regional distribution for the catch rate and mean lengths of *Saurida undosquamis* along the Gulf of Suez and the adjacent area, autumn 1998.

Reg.	**Catch rate (kg/hr)**				**Mean lengths (cm)**			
	N	**Mean**	**Range**	**St. Err.**	**N**	**Mean**	**Range**	**St. Err.**
I	23	13.2	3.5-38.2	2.003	13	20.4	15.5-25.9	0.809
II	10	7.0	3.1-15.1	1.383	7	22.5	21.2-25.4	0.543
III	22	6.9	0.9-16.7	0.839	13	22.7	20.4-23.6	0.240
IV	20	6.6	1.3-18.6	1.199	13	22.4	20.1-23.8	0.282
S	9	5.1	1.9-8.5	0.623	6	22.2	20.5-23.8	0.558
P <	**0.0021**				**0.0055**			

Reg.: Region. N : Number of tows. St. Err.: Standard Error.

Mean length

Fish of the smallest mean length, 20.4 cm, accompanied by the widest range, 15.5-25.9 cm, and the largest standard error, 0.809, were caught from the first area (I), (Table, 1). The other three areas of the Gulf (II, III & IV) and the adjacent area showed nearly similar means (22.5, 22.7, 22.4 & 22.2 cm respectively) with interfering ranges. As in the catch rate case, the means of fish lengths in the four areas of the Gulf were significantly different ($p < 0.0042$). Excluding the first area (I), the remaining three areas were not significantly different ($p < 0.6813$). The five areas, four of the Gulf and adjacent area exhibited significantly different ($p < 0.0060$) mean lengths. The four areas, three of the Gulf, II, III and IV, and the adjacent area showed insignificantly different ($p < 0.5245$) means of fish lengths.

The catches caught from the first area (I) had smaller fish lengths than the other areas (Fig. 3). Such fish lengths were of higher frequencies than the large fish lengths in the first area (I). The frequencies of the larger fish lengths increased southward along the Gulf sectors.

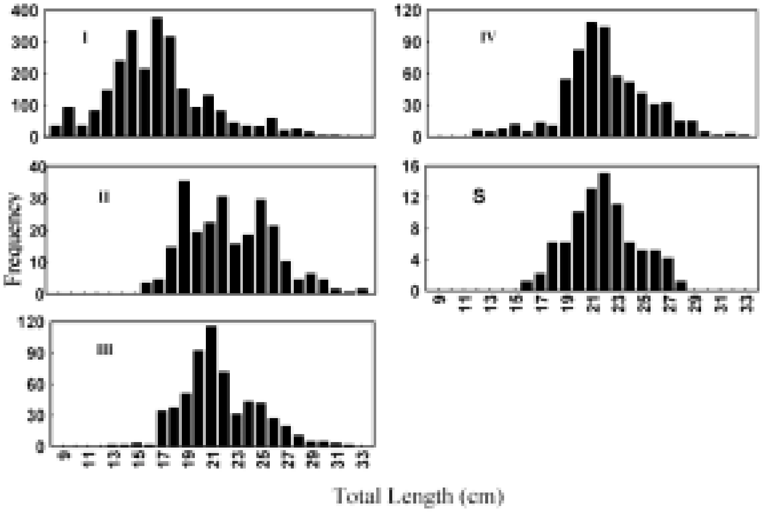

FIG. 3. Length frequency distribution for *S. undosquamis* in the different areas along the Gulf of Suez and its adjacent area, autumn survey 1998.

Depth Variation

Depth ranged from 13.9 to 77.0 m, with a mean of 45.1 ± 16.226 m. The mean depths of tows for the different areas nearly increased southward. Those mean depths were 34.0, 49.7, 40.8, 51.5 and 65.1 m for I, II, III, IV sectors of the Gulf and the adjacent area respectively. They were significantly different ($p < 0.0001$). The four areas of the Gulf were significantly different in their mean depths of tows ($p < 0.0007$).

Catch rate

There was no clear relation between fish catch per hour and depth (Fig. 4). The range of the mean catch rates from the Gulf of Suez and adjacent area was 0.9-38.1 kg/hour. The general average of the catch rate was 8.4 kg/hr with a standard error of 0.743. At depths less than 30m, some stations gave high rates of catch.

Mean length

Removing the two outliers (Fig. 5), the model of the relationship between mean length of tow catch and depth was:

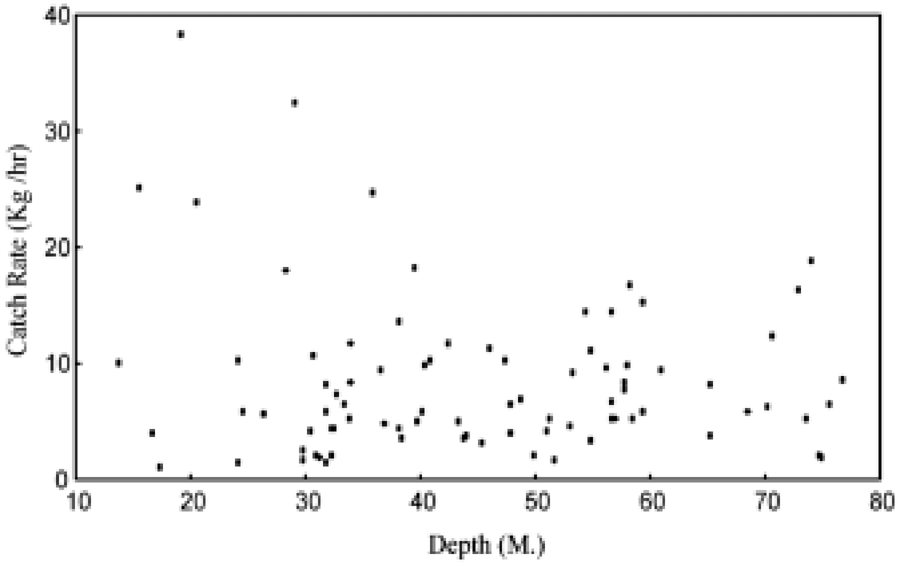

FIG. 4. Catch rate (kg/hr) against depth for *S. undosquamis* caught from the Gulf of Suez and its adjacent area, autumn bottom trawl survey, 1998.

$$ML = \alpha De^{-\beta D} \quad (1)$$

Where ML is fish mean length in cm, D is depth in meter, α = 1.2257, β = 0.0196, the regression coefficient r = 0.7801 and the variance explained = 60.858%. It was evident that mean length increased rapidly with increasing depth down to 45 m. Hence, mean length nearly attains a steady state from depth 45 m to 50 m. Afterwards, it slightly decreases.

The mean length of fish, caught from depths less than 40 m (17 stations), was 19.6 ± 2.860 cm. Fish from depths equal to or deeper than 40 m (40 stations) were of mean length 22.4 cm, with a standard error of 0.179. The fish mean lengths from the two depth categories were significantly different ($p < 0.0001$).

Day-Night Variation

Catch Rate

Excluding the three outliers (Fig. 4), the model relating mid time of tow H and catch rate CR was of the fourth degree polynomial:

$$CR = 5.91269 - 2.5357\ H + 0.6829\ H^2 - 0.0498\ H^3 + 0.0010\ H^4 \quad (2)$$

The regression coefficient r = 0.7448. The explained variance = 55.469%.

It was evident that nearly from 18:00 p.m. to 6:00 a.m. of the next day, catch rate showed lower values, while daytime exhibited higher values (Fig. 4).

The mean catch rate per day (40 stations) was 12.6 kg/hr with a standard error of 0.684. The mean rate per night (37 stations) was 4.0 kg/hr with a standard error of 0.400. Day and night mean catch rates were significantly different ($p < 0.0001$).

Mean Length

As in case of catch rate, Figure (5) shows no clear significant relationship between the tow mid hour and fish mean length. Mean length did not exhibit significant day-night variation. Mean length caught during daytime (39 stations) was 21.5 cm and its standard error was 0.290. Mean length caught at night (18 stations) was 21.8 cm and its standard error was 0.388. Using the mean depths of the different stations as a covariate, the day/night mean lengths were significantly different ($p < 0.0338$).

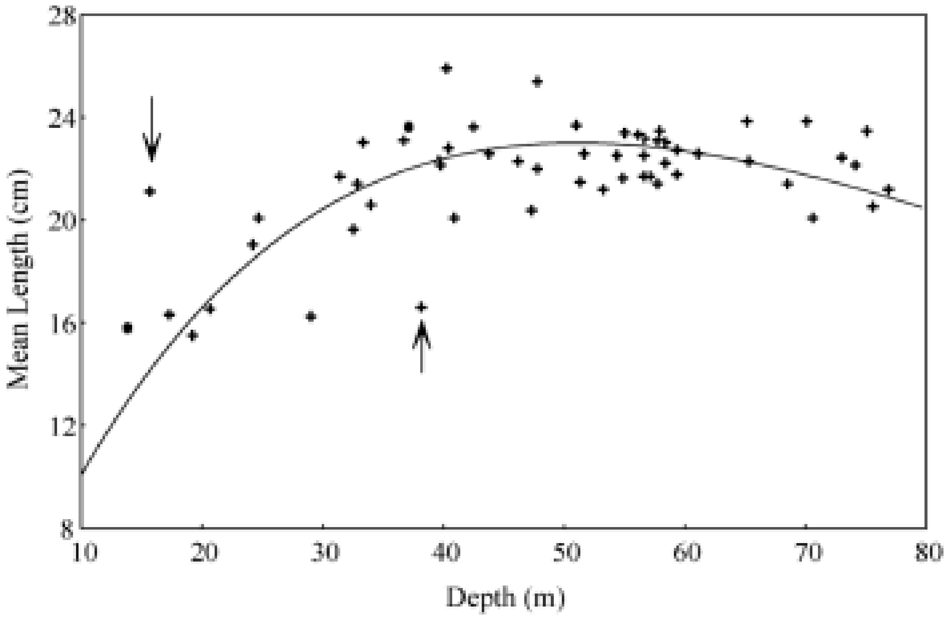

FIG. 5. Mean length against depth and the fit curve for *S. undosquamis* caught from the Gulf of Suez and adjacent area, autumn bottom trawl survey, 1998. Arrowed points are outliers.

Discussion

Considering catch rate, the studied area, Gulf of Suez and its adjacent area, is of three units; the first area of the Gulf (I) is the richest. The three remaining areas (II, III, & IV) form the second unit. Finally, the adjacent area is of the lowest rate. This contradicts with the conclusion in the Azcherniro report (1966) that the catch rate increases southward. Azcherniro report (1966) discussed the results of 1964 and 1965 surveys using the USSR research vessel R.V. Ikhtiology. Ikhtiology was a big research vessel so that it was not able to trawl the shallow areas. The shallow areas of the two wide regions in the northern half of the Gulf of Suez, away from the main axis, are richer and more productive. The deeper regions in the first area (I) are used as waiting areas for the transit ships going through Suez Canal, Suez port and the oil refinery companies. Therefore it is expected to be heavily polluted and consequently less productive.

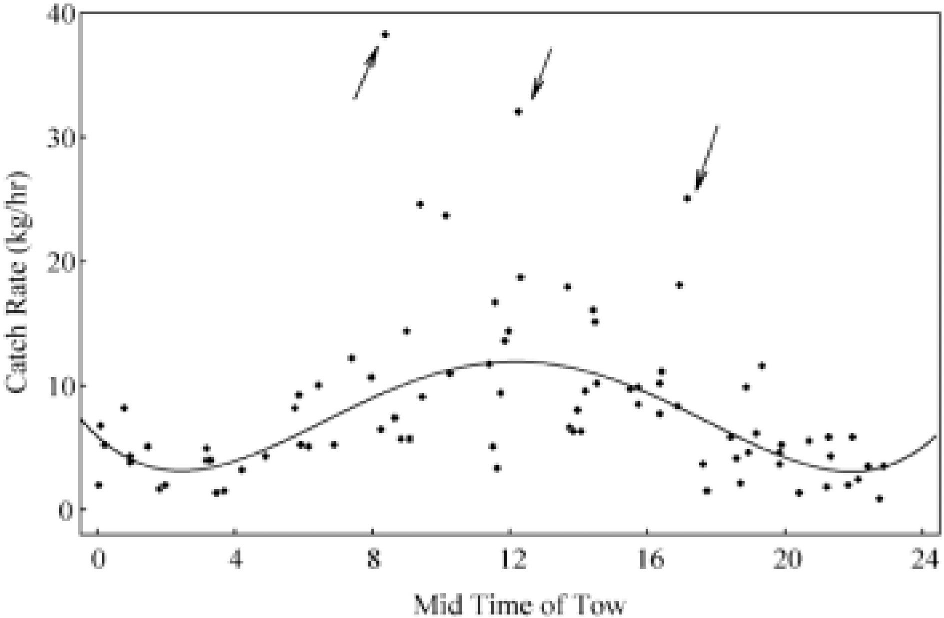

FIG. 6. Catch rate (kg/hr) against mid time of tow and the fit curve for *S. undosquamis* caught from the Gulf of Suez and its adjacent area, autumn bottom trawl survey, 1998. Arrowed points are outliers.

In respect to mean length of tow catch, it may be concluded that the studied area can be distinguished as two distinct longitudinal units. The first area of the Gulf (I) is the first unit and of small fish mean length. The three remaining areas (II, III, & IV) and the adjacent area are of large fish mean length, representing the second unit. The field observations indicated that the first area is an important nursery ground for juveniles of the lizardfish. This may be due to its wide shallow nature as compared to the other areas. The southward increase of the fish mean length nearly matches the southerly increasing mean depth of the tows for each area. This coincides with the result that mean lengths of the different tows increase with increasing depth till 40 m.

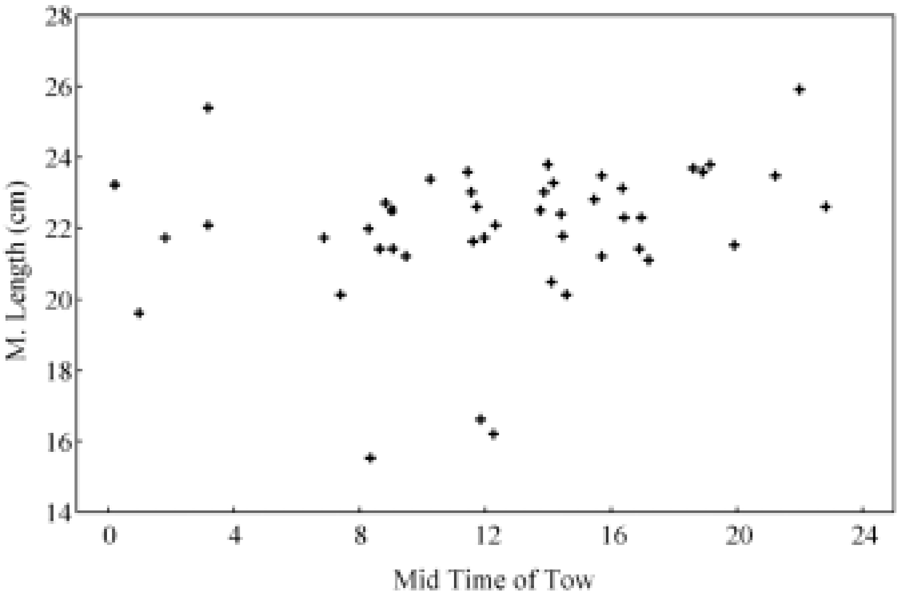

FIG. 7. Mean length against mid time of tow for *S. undosquamis* caught from the Gulf of Suez and adjacent area, autumn bottom trawl survey, 1998.

Generally, all depths are equally likely to yield 8.4 ± 6.811 kg/hour lizardfish. The field observations showed that catches from depths lower than 40 m included small fishes. In addition, these catches comprised large amounts of the lizardfish juveniles. Fishermen return these very small fishes to the sea. These depths may be of nursery grounds rich in juveniles and small adults. Therefore, the increasing rates from some depths less than 30 m may be due to the large amounts of the small fish sizes temporarily occupying lower depths.

The rate of change of the mean length with changing depth is defined by the first derivative of equation (1):

$$d(ML) / d(D) = \alpha e^{-\beta D} (1- \beta D) \quad (3)$$

The term in brackets on the right side of the above equation equals zero at depth about 51.0 m, the inflection point, before which the rate of change is positive and after which the rate is negative. The average rate of increase in mean length with increasing depth is about 0.33. On the other hand, the average rate of decrease in mean length is about –0.11. The decreasing rate of fish length against increasing depth was reported for cod (*Gadus morhua* L.) by Yousif and Aglen (1999).

In addition, fishes caught from depths greater than 40 m are of larger sizes than those from shallower depths. Moreover, these fish sizes are of high commercially importance. Adding the previous information that all depths possess the same probability to produce the same catch rate, from the economic point of view, trawling in depths greater than 40 m may be more valuable. Furthermore, trawling away from shallow depths, which may be nursery grounds, maintains the fish stock. It saves the fish stock against recruitment and growth overfishings.

Catch rates per daytime were three times higher than catch rates per night. Therefore, in terms of catch rates, daytime trawling is greatly more profitable than nighttime trawling. This diurnal variation may be due to the feeding behaviour of the fish. Lizardfish are diurnal predators, specialized ambushers using extreme camouflage necessary for capture of fish during daytime (Moyle & Cech, 1988). Hence, they become more available for bottom trawls during the daytime when they are more active to feed on the ground fish.

Aglen *et al*. (1999) reported greater variability and higher average catch rates during the day than at night for the bottom-trawl catches from the Barents Sea. At night, the ollocklity of Namibian hakes (*Merluccius capensis* and *Merluccius paradoxus*) to bottom trawls is lower, night catches are 85-90% of day catches (Gordoa and Macpherson, 1991). Pillar and Barange (1997) reported close results for the Cape hakes, off the West Coast of South Africa.

The slight decreasing mean length of the daytime may be attributed to the diurnal feeding activity of the fish, which makes all fish sizes available to the bottom trawls. On the other hand, at night all fish sizes may not be active, especially the small sizes which gives rise to the slight higher mean lengths.

Pillar and Barange (1997) reported diel size differences in the hake *M. paradoxus*, with no consistent pattern. Gordoa and Macpherson (1991) found out constant diurnal pattern of the length composition of the catches for cape hakes (*Merluccius capensis* and *M. paradoxus*) species, maintained throughout the year.

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التغير فى معدل الإنتاج الكمى للمصيد و الطول لسمكة الحارت Lizard Fish (*Saurida undosquamis*) في مصايد الجر شمال غرب البحر الأحمر

علي يوسف
المعهد القومى لعلوم البحار و المصايد
ص ب ٣٧١ ، السويس ، مصر

المستخلص. يعتبر خليج السويس واحداً من المصايد المصرية الهامة. و تعد سمكة الحارت *Saurida undosquamis* من أهم الأنواع التجارية التى تنتج من مصايد الجر فى خليج السويس. يتم صيد سمكة الحارت Lizardfish من جميع أراضى الجر فى خليج السويس. ووجد أن معدل الإنتاج بالصيد يتناقص فى اتجاه الجنوب. أما متوسط طول السمكة فى الجرة فإنه يتزايد فى اتجاه الجنوب. و لقد اتضح خلال الرحلة البحرية لجمع العينات أن الجزء الشمالى من الخليج ، و هو منطقة واسعة وضحلة نسبياً ، أرض تحضين لزريعة سمكة *Saurida undosquamis*. لم يظهر للتغير فى العمق أى تأثير على معدل الإنتاج الكمى للمصيد. تعتبر كل الأعماق متساوية الإحتمال فى إنتاج المعدل ٨,٤ ±٦,٨١١ كجم/ ساعة. وقد تم استنتاج علاقة رياضية تربط بين متوسط طول السمكة و العمق. واتضح من خلال تلك العلاقة أن طول السمكة يزداد بزيادة العمق بمعدل ٠,٣٣ سم/ متر حتى عمق ٥١ متراً ثم يتناقص بمعدل ٠,١١ سم / متر. كانت هناك أيضاً علاقة رياضية بين منتصف توقيت الجرة ، فى الليل أو النهار، و معدل الإنتاج. و لقد وجد أن متوسط معدل الإنتاج أثناء النهار ٣ أضعاف متوسط معدل الإنتاج أثناء الليل. و لقد وجد أيضاً أن متوسط طول السمكة أثناء الجر ليلاً أكبر قليلاً منه فى الجر النهارى.