Bull. Nat. Inst. Oceanogr. & Fish., ARE, 14 (2), 1988: 87 - 98.

AGE DETERMINATION AND GROWTH STUDIES OF LETHRINUS NEBULOSUS (FAMILY LETHRINIDAE) OF QATAR WATERS, ARABIAN GULF.

MOHAMED A. IBRAHIM,* KAMAL A. EL-BARY,** AND JASSIM A. AL-KHAYAT*

* Mar. Sci. Dept., University of Qatar
**Fish. Dept., Minist. Ind. and Agri. Qatar.

ABSTRACT

Bi-monthly length frequency and biological sampling were undertaken from MAY, 1987 to June, 1988 on **Lethrinus nebulosus** of Qatar waters. This species was ranked as number one, in terms of abundance, among the four species comprising this fish family in the above mentioned waters.

Age determination performed by more than one method indicated that, it takes the fish 9-10 years to reach 68 cm which was the largest fish size caught from these waters. Spawning takes place for the first time at 3-4 years of age, at more than 35 cm total length, during April-May.

The size range of 40-52 cm was relatively rare in the trawling grounds, while dominant in the shallow and reef areas. It was suggested that this species performs a spawning migration to those areas.

The study suggested fishing of older age groups, over 3 years of age with corresponding length of more than 35 cm other than the smaller sizes. It also suggested protecting the spawners in the spawning grounds through trap mesh-size management.

INTRODUCTION

Family Lethrindae is one of the most important fish groups in Qatar waters. It was represented by about 26% in the total landing of the country, and by about 54% of Qatar National Fishing Company (QNFE) landing during 1987. However, little is known about the biology of such family in Qatar waters. Most of the work done on the family in Qatar waters dealt mainly with its systematics (Siva and Ibrahim, 1982).

In order to establish a sound fishery management program in Qatar; a number of different measures should be available to control both the amount of fishing and the size of fish caught. These measures should be based upon a thorough understanding of the parameters controlling the biology of the major fish groups. Among these parameters is the age composition of particular fish populations.

It had been known that annulus formation on fish scale is annual due to fluctuations in both physical and biological factors (Nikolsky, 1963). Yet, the problem with tropical fishes is that microscope examination of scales reveals difficulties in interpretation of the age groups especially in older-age fishes.

The aim of the present study is to determine the age composition and growth rates of Lethrinus nebulosus, which may reach a relatively old age and may exceed 68 cm in total length in Qatar waters, for being used by the fisheries department in Qatar for future follow up assessment of this important fish family in Qatar waters.

MATERIALS AND METHODS

Sampling was carried out twice a month during the period from May, 1987 to June, 1988. The sources of the samples were the commercial catch of the three bottom trawls of QNFC as well as the artisanal trap fishery and the catch of the special bottom trawl of Qatar National Musem (QNM).

Length frequency analysis to the nearest mm, as well as body scales were based on random sampling of three baskets (ca. 40 kg each) of any one fishing trip of QNEC picked at random. In case of categorizing the in baskets (according to market needs) prior to analtsis, then the frequency was calculated according to each category percentage in the total catch.

For every fish taken for further study in the laboraroty; the following data was obtained: total length, total and gutted weight, sex, gonad weight and stage of maturity. For age determination; scale samples were taken from the region of the left pectoral fin below the lateral line. The scales were soaked in 5% ammonia solution overnight, cleaned rinsed in distilled water then mounted dry between two glass slides for examination and measurement with a binocular microscope at magnification of X 10. The distance from the scale focus to the rim of the scale (radius) was used in calculating the scale-length-relationship, while that from the focus to each successive annuli was used to calculate the length of each successive age group (Van Oosten, 1963).

Based on the length-frequency data; the "Integrated Method", as described by Pauly (1983) was used to determine the age by fitting a growth curve directly upon the length frequency graph of each month repeated over and over along the time axis by the help of a curved ruler. The length-at-age was determined from the growth curve by the aid of a binocular microscope at X 10 to the nearest cm. Analysis of data was carried out according to the standard statistical methods described by Snedecor (1956). Computation of biological statistics of fish populations was performed according to the standard methods described by Ricker (1978).

RESULTS AND DISCUSSION

Species Composition and Distribution:

Family Lethrinidae is a commercially valuable group in Qatar waters with main concentration in the 10-30 fathom depth range in the east, north east and south of Qatar water. It is represented by four species. **Lethrinus nebulosus** and **Lethrinus lentjan** are found in all areas and stand at equal footing in terms of abundance. Each species is represented by about 45% in QNFC landing. They are followed by **L. miniatus** (about 6%), then **L. kallopterus** (about 4%) with density declining in deeper and inshore waters. On the other hand, among the artisanal trap fishery, the ratios of the mentioned species were about 50%, 30%, 5% and 15% respectively.

Length-Weight Relationship:

Efforts were made to obtain fish of wide range of sizes, down to age group 0 which was obtained from the special bottom trawl of QNM. The well established power equation was used in this respect to correlate the weight and length of fish, where (W) is total body weight in gm, (L) is total body length in cm, (A) ia a constant and (B) is the functional regression (GM) rather than the productive regression according to Ricker (1978).

In the absence of statistical difference at the 95% confidence level between the means of the calculated lengths of both sexes of this species; the extensive data were pooled to calculate the regression of 935 fish ranging in size from 15.5 to 67.8 cm. Statistics showed that the length-weight relationship of **L. nebulosus** in Qatar waters is given by the equation:

$$W = 0.02L^{2.89}$$

Length-Depth Relationship:

The relationship between the length and the depth of fish is of major importance in fishery management. Through this relationship, one can control the size of fish being caught either by a net and/or a fishing trap.

Based on samples of 1582 specimens of **L. nebulosus** ranging in size from 12.4 to 67.8 cm in total length; the length-depth relationship was given by the equation:

$$D = 0.564 + 0.322\ (L)$$

Age Determination:

1- Body-Scales Relationship:

According to Hashem et al. (1981) the criterion used for identifying annuli on the scales of Lethrinoids is that a true annulus can be traced completely around the scale and generally exhibits crossing over in the posterior portion

of the lateral fields. However, clear annuli are found only in the scales of young and moderate-age fishes. The problem of identifying the annuli on the periphery of the scales of old fish may be encountered as the main difficulty in determining the age of such species. They reported a direct proportionality between the body scales and the total length of both **L. mehesna** and **L. xanthochilus** from the Red Sea.

The same difficulty was encountered in the present study; and it was noticed that, half way between each successive true annuli there is a nearly false or nearly true annulus (obscure annulus). This could be mislead the scale reader to great extent even with repeated readings. Taking this notice into consideration, the regression statistics of scale radius in micrometers on the total length in cm of 995 fish ranging in size from 12.4 to 66.0 cm is given by the equation:

$$L = 0.88 (S) - 3.52$$

This equation suggests a changing rate with age. Ricker (1978) pointed out that, if scale annuli are taken as directly proportional to body length in a population where they are actually proportional to a less constant quantity; the calculated first-year group is always too small and it becomes smaller the greater the age of the fish from which it was calculated. The above mentioned true annulus was found to occur at the scale margin during April-May, while the obscure annulus occurs at the margin during September-October.

2- Length Frequency:

Unlike the body-scales measurements; bi-monthly length frequency analysis was performed only on the samples of the QNFC landings. The inherited problem in these samples is that fish of size less than 15-20 cm is thrown overboard as by-catch. However, effort was made to obtain these fishes separately just for reference, but not included in the analysis. It is accepted that, size-selective mortality does not necessarily change the shape of the length distribution of the year-class according to Jones (1956). Ricker, 1969 also stated that even quite severe non-linear selection changes the variance too little to be detectable in practice. The monthly length-frequency histograms of **L. nebulosus** for the months from June, 1987 to May, 1988 are presented in Fig. 1. The histograms show an unprecedented phenomenon, to the best of our knowledge, not pointed out before. It is that, the size range of **L. nebulosus** covering the range from 40-52 cm in total length is relatively rare in the trawling grounds of Qatar waters. This size range was found to represent the age groups 4-7 years. It may be postulated in this regard that the members of this group migrate either to more deeper water or to shallower water for commencement of spawning. Sporadic samples from the trap fishery revealed that the mentioned size range was represented in this fishery by about 50-65% in the catch with a mean length of 46.3 cm.

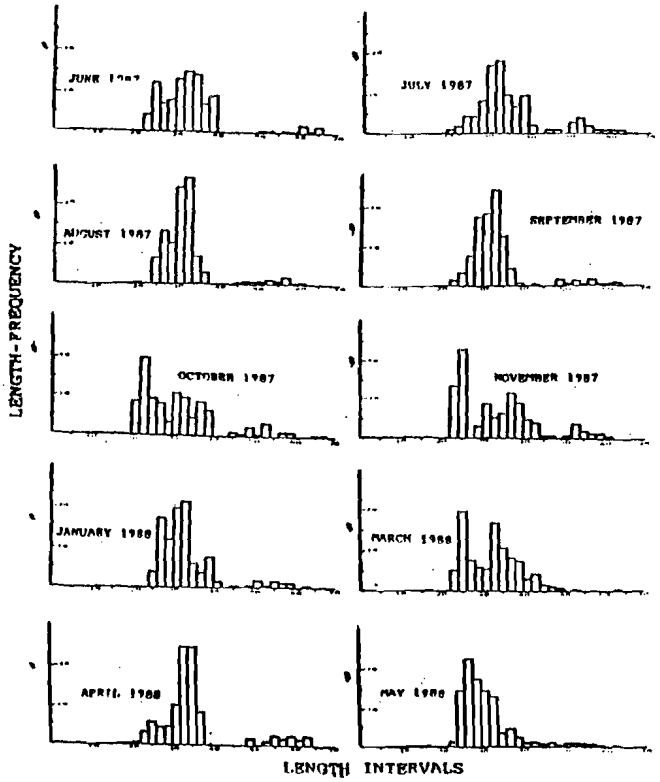

FIG. 1
Monthly length frequency distribution of
Lethrinus nebulosus of Qatar waters as obtained from the bottom trawling during June 1987 to May 1988. (December 1987 and February 1988 samples were not valid for analysis).

Applying the integrated method in determining the age of fishes ranging in size from 20-67.4 cm, the fitted curves were extrapolated to the age axis. The resulting length of any particular year-group obtained from the monthly curves were averaged to calculate the mean length at-age and are presented in Figs. 2A and 2B. The estimated length at-age obtained from both the body scales and the integrated method are shown in Table 1. Statistics showed that there is no significant difference at the 95% confidence level betwen the mean obtained by both methods, due to a calculated (t) of 1.86. compared with the tabulated one of 2.10.

Based on the above mentioned results, the Ford-Walford method was usaed to calculate the growth parameters required for fitting the Von Bertalanffy Growth Formula (VBGF).

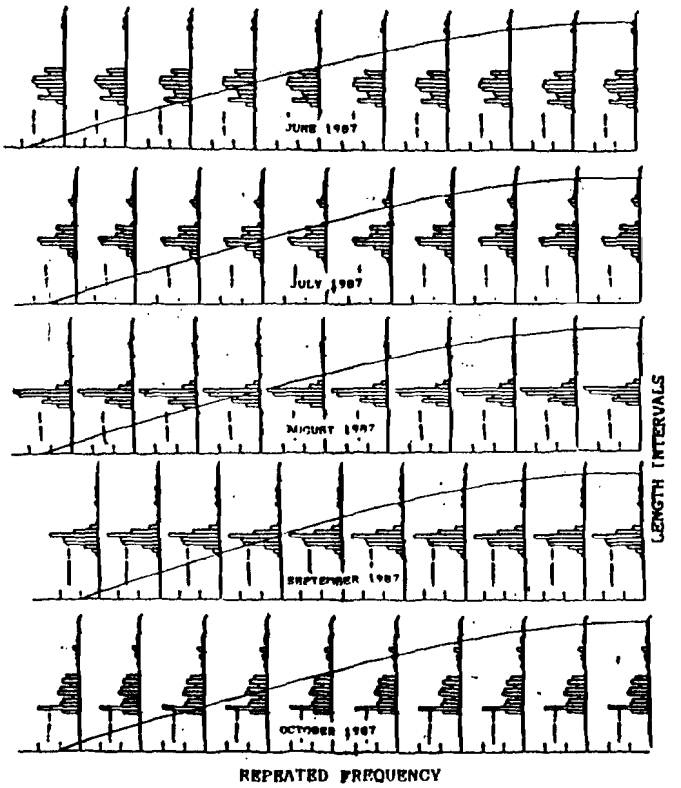

FIG. 2-A

Curve fitting for the integrated method on the monthly length frequency distribution of **Lethrinus nebulosus** of Qatar waters as obtained from the bottom trawling during June 1987 to October 1987.

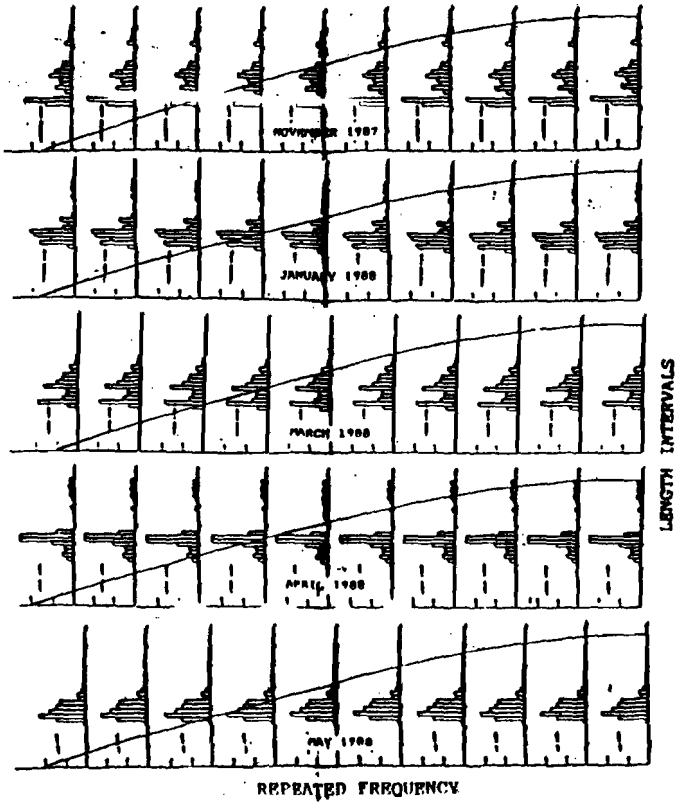

FIG. 2-B

Curve fitting for the integrated method on the monthly length frequency distribution of **Lethrinus nebulosus** of Qatar waters as obtained from the bottom trawling during November 1987 to May 1988. (December 1987 and February 1988 samples were not valid for analysis).

The growth parameters obtained are as follows:

Body-scale Methods:	K = 0.134	t_o = 0.50 years	L_∞ = 89.4 cm
Intergrated Method :	K = 0.154	t_o = 0.44 years	L_∞ = 83.8 cm
Average of Above	: K = 0.145	t_o = 0.74 years	L_∞ = 58.8cm

Using the above mentioned parameters in fitting the VBGF, the calculated lengths at-age are shown in Table 2.

TABLE 1
Length (mm) at-age (years) of Lethrinus nebulosus
of Qatar waters as estimated from observed scales measurements
and curve fitting of the integrated method.

Methods	Age in Year									
	1	2	3	4	5	6	7	8	9	10
Scales	97	172	252	328	409	492	557	613	632	641
Integrated	53	153	243	331	415	495	558	607	626	634
Average	66	163	248	330	412	494	558	610	629	638

TABLE 2
Calculated length (mm) at-age (years) of Lethrinus nebulosus
of Qatar waters as obtained by fitting VBGF on observed scales measurements,
curve fitting of the integrated method and the average of both.

Methods	K	t	L_∞	Age in Year										
				1	2	3	4	5	6	7	8	9	10	11
Scales	0.134	0.50	894	58	163	254	335	405	466	520	567	608	644	675
Integrated	0.154	0.44	838	69	179	273	354	423	482	533	576	614	646	673
Average	0.145	0.47	858	63	171	263	344	413	473	525	570	609	643	672

3-Cassie Probability-Paper Method:

All attempts of applying Cassie's (1954) method in the analysis of size frequency distribution to determine the age of L. nebulosus were not successful. This could be attributed to the presenece of more than ten age-groups in the fish landings, beside the rarity of some age groups. This situation leads to a great interference and truncation, even with samples having two distinct populations separated by a missing size-group. The method proved unsuccessful in this respect due to small numbers representing the older age-groups. Hence, this method was not considered in the analysis of much fish species.

Growth Rates:

Beased on Table 2, and applying the functional regression of the length-weight relationship as 2.89; the average length at-age was used to calculate the different types of growth rates as follows and the results are shown in Table 3.

Absolute increase (increment) in a given year =

$$L_2 - L_1 \quad \text{or} \quad W_2 - W_1$$

Relative rate of increase =

$$(L_2 - L_1) / L_1 \quad \text{or} \quad (W_2 - W_1) / W_1$$

Intstantaneous rate of increase =

$$\text{Log}_e L_2 - \text{Log}_e L_1 \quad \text{or} \quad \text{Log}_e W_2 - \text{Log}_e W_1$$

Table 3 indicates that this species reaches about 17 cm in total length after a period of about two years. It seems that the increment in length is somewhat higher than expected. The reason may be due to the lack of age group (0) that enters the calculations, and/or in determining the true annulus of age group 1.

With respect to the age groups vulnerable to fishing activities, it appeared that increment was at its maximum between the first and third years of age with an average of about 10 cm/year. There was a steady rate of decrease of about 1 cm/year between the third and seventh years of age. The increments in these groups were; 108, 92, 81, 69, 60 and 52 mm/year respectively. The minimum increments were during the ages 7 to 10 years, where they were 45, 39 and 34 mm/year respectively.

With respect to absolute increase in weight, it appeared that the minimum increase was in age groups 1 and 2 with an increment of about 69 gm/fish /year. On the other hand, the maximum increase was about 500 gm/fish/ year at age groups 6 to 9, then the rate was decreasing again. This finding suggests that fishing activity should be directed towards catching the older rather than the younger fish. This suggestion could be implemented through controlling the mesh size of both the bottom trawls and the fishing traps operating in the deeper and shallower waters respectively.

Spawning Habits:

Ibrahim, et al (in press) indicated that spawning of this species takes place during April-May, with the first spawning activity taking place at the fourth years of age. Based on the observation that, size groups from 40 to 52 cm were missing from the trawling grounds and were predominant in the trap fishery; it couldd be stated that this size group spawns in rocky and reef areas. Hence, protective measures should be taken into consideration to protect the spawners in the mentioned areas to give the fish a chance to spawn at least once at about 35 cm in total length.

TABLE 3

Different growth rates of both length and weight, of the different age groups of Lethrinus nebulosus of Qatar waters.

Age Intervals (Year)	Length intervals (mm)	Weight intervals (gm)	Absolute Increase in length (L.)	Absolute Increase in weight (W)	Relative rate of increase in (W)	Relative rate of increase in (W)	Instantaneous rate of increase in (L)	Instantaneous rate of increase in (W)
1- 2	63-171	4- 73	108	69	171%	1692%	1.00	2.89
2- 3	171-263	73- 254	92	181	54%	247%	0.43	1.24
3- 4	263-344	254- 552	81	198	31%	117%	0.27	0.78
4- 5	344-413	552- 936	69	384	20%	70%	0.18	0.53
5- 6	413-473	936-1385	60	499	15%	48%	0.14	0.39
6- 7	473-525	1385-1872	52	487	11%	35%	0.10	0.30
7- 8	525-570	1872-2374	45	502	9%	27%	0.08	0.24
8- 9	570-609	2374-2875	39	500	7%	21%	0.07	0.19
9-10	609-643	2875-3363	34	489	6%	17%	0.05	0.16
10-11	643-672	3363-3821	29	457	5%	14%	0.04	0.13

CONCLUSION

Family Lethrinidae is represented in Qatar waters by four species. In terms of abundance, **Lethrinus nebulosus** is represented by 45-50%, **L. lentjan** by 30-45%, **L. kallopterus** by 4-15% and **L. miniatus** by 5-6%.

Age determination via scale reading was confusing to some extent due to the presence of a confusing annulus between each two successive annuli. This dictates that caution to be taken in this regard with repeated reading especially in case of old-age fish. The use of the "integrated method" in age determination proved superior, giving that length frequency sampling is representative of the catch.

It was proven that sizes from 40 to 52 cm of **L. nebulosus** were rarely represented in the trawling grounds, but predominant in the trap and reef areas. This indicates that this species moves to such areas for spawning. The spawning takes place for the first time at 3-4 years of age at about 35 cm in total length durink the months of April-May.

Growth rates indicated that maximum increment in length is during the age grops 1-3 years with an average of 10 cm/year, then it decreases by one cm/ year during the ages of 3-7 years. The minimum increment is during the ages of 7 years and up with an average of about 4 cm/year. This means that the fish can reach a length of 64 cm in about 9-10 years. With respect to increment in weight; it is about 69 gm/year for the age groups 1-2, increasing to reach a maximum of 500 gm/year between 5 and 9 years, then decreasing again thereafter. These figures indicate that the same amount of increment (in weight) from certain number of fish in any particular age group could be obtained by half of that number in the next age group.

The overally results of this study recommend the use of the "integrated method", with proper length-frequency sampling, in determining the age of **L. nebulosus**. Also fishing activity on such species should be directed towards older age groups of more than 3 years of age. This can be achieved by controlling the mesh size of both fish traps and trawling nets, as well as protecting this fish in their spawning groups in the shallow and reef areas through trap fishery management.

REFERENCES

Cassi, R.M., 1954. Some uses of probability paper in the analysis of size frequency distribution. **Aus. J. Mar. Freshw. Res.**, Vol. 5: 13-22.

Hashem. M.T. and A.A. Shakour, 1981. Age determination and growth studies of **Lethrinus mahsena** and **L. xanthochilus**. **Jed. Jour. Mar. Res.**, Vol. 1: 11-21.

Ibrahim, M.A; K.A. El-Bary and J.A. Al-Khayat, 1989. Impact of bottom trawling on the demersal fishes in Qatar waters, Arabian Gulf. **Qatar Univ. Sci. Bull.**, Vol. 9 (in press).

Jones, R., 1956. The analysis of trawl haul statistics with particular reference to the estimation of survival rates. **Rapp. P. V. Reun. Cons. Perm. Int. Explor.**

Mer., Vol. 140: 30-39.
Niklosky, G.V., 1963. **The ecology of fishes.** Academic Press, London.
Pauly, D., 1983. **Some simple methods for assessment of tropical fish stocks.** FAO Fisheries Technical Paper No.234.
Ricker, W.E., 1969. Effects of size-selective mortality and sampling bias on estimation of growth, mortality, production and yield. **J. Fish. Res. Board , Can.** Vol. 26: 479-541.
Ricker, W.E., 1978. Computation and interpretation of biological statistics of fish populations. **Bull. Fish. Board Can.** Vol. 191.
Sivasubramaniam. K. and M.A. Ibrahim, 1982. A. **Common Fishes of Qatar.** Scientific Atlas of Qatar., Vol. 1.
Sivasubramaniam, K. and M.A. Ibrahim, 1982 B. Demersal fish resources around Qatar. **Qatar Univ. Sci. Bull.,** Vol. 2: 305-352.
Snedecor, G.W., 1956. **Statistical methods.** 5th end., Iowa State College Press.
VanOosten. J., 1953. A modification in technique of computing average lengths from the scale of fishes. **Prog. Fish Cult.,** Vol. 15 (2).