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Some Aspects of the Biology of Red Snapper *Lutjanus campechanus* (Rivas, 1966) from the Red Sea

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Abstract

Distribution and biology of red snapper *Lutjanus campechanus* (Rivas, 1966) were investigated in the Red Sea along the coast off Jizan between 16°45-17°47 E and 41°48-42°38 N. The juvenile and immature fish were distributed at a depth range of 6-27 m (winter 15-21, summer 6-27 m) and mature fish from 27 to 59 m (winter 29-35, summer 27-59 m). Of the 153 specimens, the male to female sex ratio was 1:0.9. Females dominated in the months of January, April and July. Size at first maturity was 440 mm total body length or TL (female) and 500 mm TL (male). Spawning period was July-August. Mean fecundity of seven fish, 3-6 years old, was 169,000 eggs. Annual rings appeared on scales mostly in July. Length was back-calculated by TL = 67.3 + 4.42 scale diameter (R=0.99). The commercial catch was dominated by age group III+ fish. Weight-length and girth-length relations were determined. Mean values of condi-tion "K" and relative condition factor "Kn" of fish in combined sexes are 1.45°0.13 and 0.98°0.03, respectively. Planktonic crustaceans, fish eggs and fish larvae were preferred by juvenile and immature fish, while larger crustaceans, molluscs and fish were pre-ferred by mature fish as their diet.

Introduction

The family Lutjanidae, comprising tropical demersal and coral reef fishes (Edwards 1983), is the dominant family in Saudi waters of the Red Sea and in the Arabian Gulf. It is represented by *Lutjanus fulviflammus*, *L. bohar*, *L. monstigma*, *L. kasmira* and *L. campechanus* (Tortonese 1983). The red snapper, *L. campechanus*, is found in abundance along the coast of the Red Sea off the Jizan region. It is a large fish found all year-round and is economically important.

Although the literature on red snapper is voluminous, few studies deal with the life history, fishery, age, growth and mortality of *L. campechanus* (Bradley and Bryan 1975; Futch and Bruger 1976; Stephen et al. 1980; Nelson and Manooch 1982; Hanafi 1986). The present paper deals with some aspects of its biology and distribution along the Jizan coast in the Red Sea.

Materials and Methods

A sample of 1,117 fish was collected between the latitudes 16°45-17°47 N and longitudes 41°48-42°38 E, at a depth range of 6-59 m, with a trawl net on a vessel belonging to Saudi Fisheries Company at Jizan, from November 1982 to December 1983.

Fish were measured to the nearest mm from the tip of the snout to the end of the longest caudal fin rays, weighed to the nearest mg and sexed. The girth was measured as circumference of the body just in front of the dorsal fin. The whole alimentary canal was removed and preserved in 5% formalin. Stomach contents were identified to generic level where possible and quantitatively analyzed using the frequency occurrence method (Laevastu 1965). The gonads were removed and weighed after removing the extra moisture and preserved in 5% formalin. Fecundity was estimated by the gravimetric method (Laevastu 1965) and its relationship with fish length, weight and girth was determined. Age was determined using annual rings on scales taken from 70 fishes belonging to different size groups in different months. About 5-10 scales adjacent to the pectoral fins were taken, immersed in 5% ammonia solution for 1 minute, cleaned and mounted dry between two glass slides. Annual rings were counted under a binocular stereomicroscope at a magnification of x 10.

Length-weight and length-girth relationships, condition factor "K" and relative condition factor "Kn" were calculated as follows using STATGRAPHICS statistical package:

$$\text{Log } W = a + b \text{ Log } L \quad ...1)$$

$$\text{Log } G = a + b \text{ Log } L \quad ...2)$$

$$K = W \times 100/L3 \quad ...3)$$

$$Kn = W/\hat{W} \quad ...4)$$

where L=length, W=observed weight, G = girth a and b constants and $\hat{W}$ calculated weight from aL^b.

Results

Seasonal Distribution

Mature, immature, juveniles and larval stages were distributed at different depths according to the season, in the range investigated, 6-59 m. During the winter, juvenile and immature stages (99-350 mm total body length or TL) were abundant and were distributed at the depth range of 15-21 m at latitudes 16°45-16°52 N and longitudes 41°48-42°31 E, but during summer they were caught from the depth range of 6-27 m at 17°10-17°47 N latitudes and 41°44-41°12 E longitudes. The mature fish were distributed at the depth range of 29-35 m between the latitudes 16°45 to 16°53 N and 42°30 to 42°31 E during winter, but in summer they were caught at the depth range of 22-59 m between 17°02 to 17°47 N latitudes and 41°48 to 42°38 E longitudes.

Sex Ratio

Out of 156 fish sexed, 80 were males and 76 were females giving a male to female ratio of 1:0.9, which was not significantly different from 1:1 (X^2=0.32, P<0.05). The ratios for different size classes suggested a dominance of males in smaller fish (Table 1).

Table 1. Sex ratio in different size classes of *L. campechanus*.

Length range (mm)	M	F	No. fish	Ratio M:F
360-400	16	9	25	1:0.60
>400-450	16	10	26	1:0.63
>450-500	15	12	27	1:0.80
>500-550	16	20	36	1:1.30
>550-600	7	11	18	1:1.60
>600-650	6	6	12	1:1
>650-700	4	2	6	1:0.5
>700	-	6	6	-
Total	80	76	156	1:0.95

Age Determination

The scales of *L. campechanus* are ctenoid. Concentric ridges or circuli are arranged around the focus. Seasonal differences in spacing of circuli indicate periods of fast and slow growth. The wider spacing was found typically at the beginning of each new period of growth, indicating fast winter growth. In the majority of fish, the annulus appeared in July. By counting the number of annuli present on the scale, the age of the fish was determined and expressed as 0^+, I^+, II^+, III^+, etc. The data were not separated according to sex.

Age-frequency data are plotted in Fig. 1. The commercial catch was dominated by fish of age group III^+ which constituted about 34.4% of the total catch, while 29% of the catch belonged to the age groups of IV^+, V^+ and VI^+. The rest were immature fish of age 0^+, I^+ and II^+.

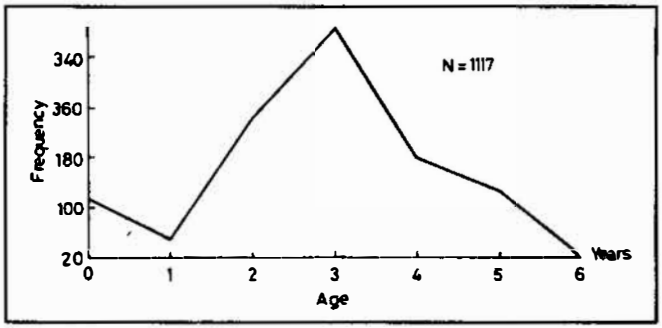

Fig. 1. Age-frequency curve for *L. campechanus*.

Monthly fluctuations in age composition (Fig. 2) indicate that age groups 0^+ and I^+ were present in the catch in almost all months. Age group II^+ was present in an appreciable amount during June-August and formed 21% of the total catch, whereas 52.2% of the total catch belonged to age groups III^+, IV^+, V^+ and VI^+.

Growth Rate

A linear relationship between the scale diameter (S) and total body length (TL) was found (TL = 67.3 + 4.42S, R=0.993) (Fig. 3).

The lengths of fish at different ages were back-calculated (Table 2, Fig. 4). The back-calculated lengths were almost the same as those recorded directly. The maximum growth in length was recorded during the first year and thereafter it decreased gradually.

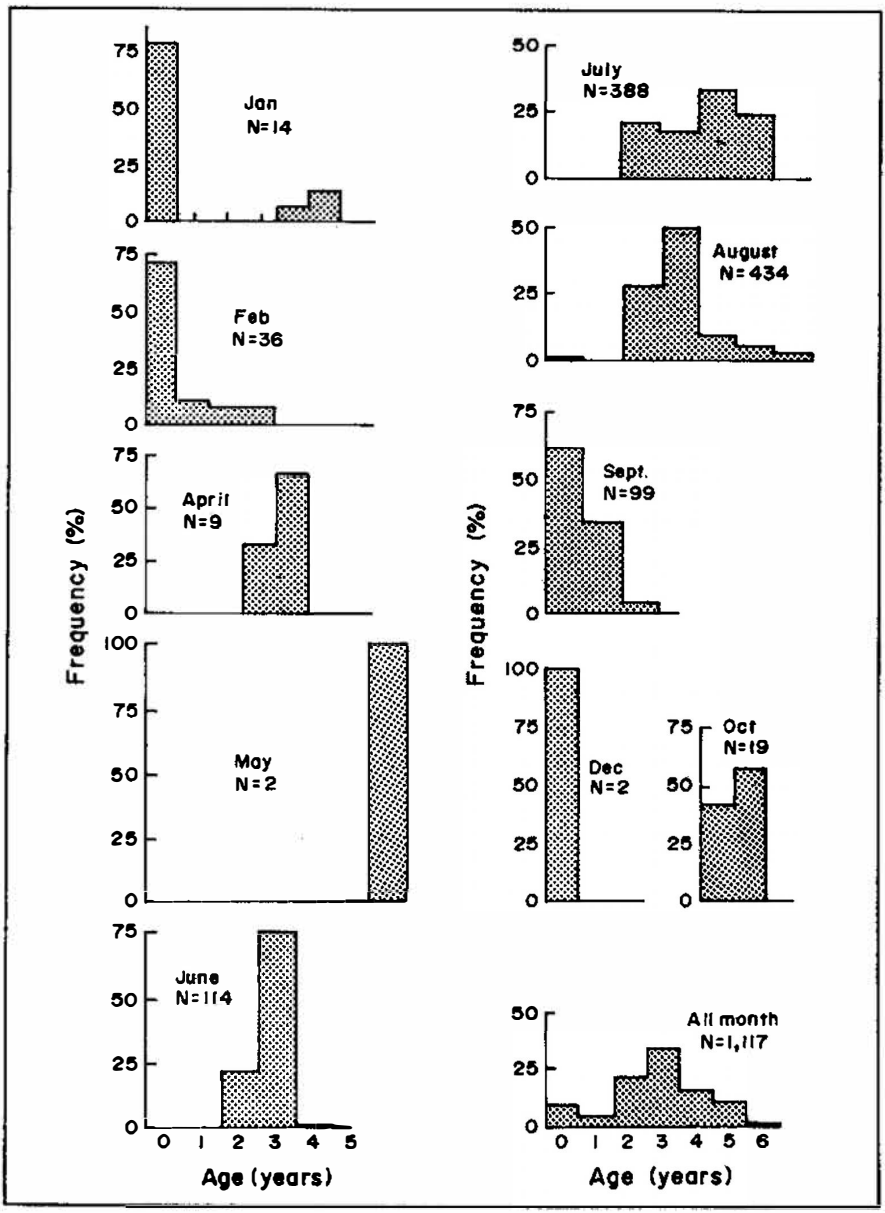

Fig. 2. Seasonal fluctuation in age composition for *L. campechanus*.

Table 2. Reconstructed length growth and weight of *L. campechanus*.

Age group	Mean length and weight (observed)	Frequency	Back-calculated lengths (Italics,mm) and weights (g) at the time of annulus formation (TL, mm)						Total
			I+	II+	III+	IV+	V+	VI+	
I+	222.00 *174.78*	20	224.20 *180.12*						
II+	375.00 *696.35*	16	235.30 *204.58*	359.00 *620.57*					
III+	482.00 *1,348.59*	13	227.30 *186.80*	361.20 *631.96*	464.20 *1,223.89*				
IV+	590.00 *2,299.47*	8	229.10 *190.22*	367.90 *663.37*	478.80 *1,324.30*	576.50 *2,164.20*			
V+	681.00 *3,348.92*	9	233.10 *199.70*	374.50 *692.14*	487.60 *1,390.10*	584.40 *2,244.40*	671.09 *3,299.30*		
VI+	700.00 *3,601.69*	4	238.80 *212.16*	367.30 *659.37*	486.30 *1,381.70*	588.80 *2,285.60*	679.50 *3,328.70*	712.60 *3,780.07*	
Mean	-	-	231.30 *195.60*	366.00 *653.48*	479.20 *1,330.00*	582.90 *2,231.40*	675.70 *3,278.90*	712.60 *3,780.70*	
Increment	-	-	-	134.70 *457.89*	113.20 *676.50*	103.70 *901.38*	92.80 *1,047.60*	36.90 *501.07*	481.30 *3,585.08*
% increase	-			28.00 *12.77*	23.50 *18.87*	21.55 *25.14*	19.28 *29.22*	7.67 *14.0*	

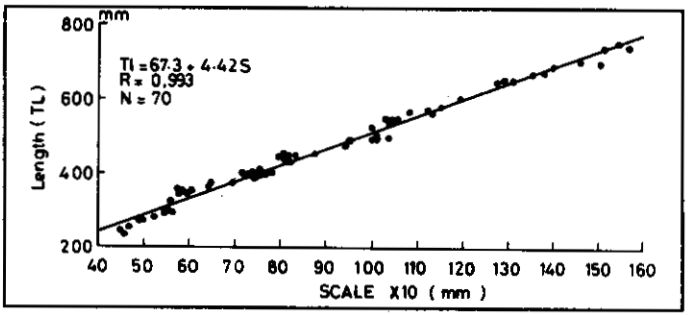

Fig. 3. Relationship between total length and scale radius in *L. campechanus*.

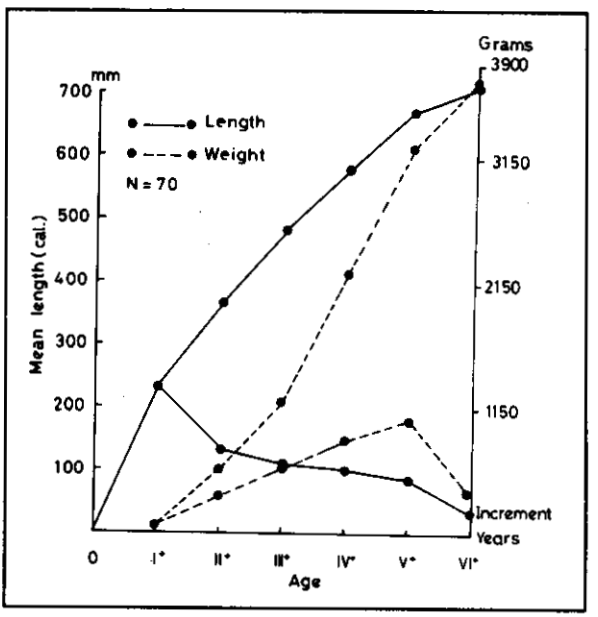

Fig. 4. Growth in length and weight with age and annual increment in *L. campechanus*. Upper lines are cumulative figures; lower lines show annual increments. Data based on back-calculated size at age.

Maturation and Spawning

Gonads in female *L. campechanus* started to mature when fish attained a TL of 400 mm and most of the females were sexually mature at 450-500 mm length.

Data on monthly spawning activity (Table 3) suggest that, although a few mature fish were present in January, a relatively higher proportion of females are sexually mature by May-June which spawn in July-August.

Table 3. Monthly spawning activity of *L. campechanus*, 1983.

Development stages	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Total
III (Developing early <400 mm)	-	-	-	3	-	2	1	2	8
IV (Developing late 400-500 mm)	-	1	-	2	-	4	8	7	22
V (Gravid 500-550 mm)	-	-	-	-	-	1	11	8	20
IV (Spawning 550-650 mm)	3	-	-	-	-	-	5	7	15
VII (Spawning, spent 650-700 mm)	-	-	-	-	1	-	-	1	2
VIII (Spent 700-700^{+} mm)	-	-	-				3	3	6
Total	3	1	-	5	1	7	28	28	73

Length-Weight and Length-Girth Relationships

Length-weight and length-girth relationships of 153 fishes, 80 male and 73 female, are expressed by the following equations:

Log W= -1.3023+2.6335 Log TL (sexes combined). (R=0.9)
Log W= -1.5059+2.751 Log TL (female). (R=0.9)
Log W= -1.4425+2.7240 Log TL (male). (R=0.9)
Log G = -0.09+1.005 Log TL (R=0.9)

Condition "K" and Relative Condition Factor "Kn"

The values of K and Kn in combined sexes ranged from 1.03 to 2.59 (mean 1.45±0.13) and 0.83 to 1.18 (mean 0.98±0.03), respectively. K was high (mean 1.64±0.21) in immature fish (99-380 mm TL), lower (mean 1.25±0.06) in mature fish and spawners (410-700 mm TL), and 1.03±0.03 in the largest size group, 710-750 mm TL. The relative condition factor "Kn" value did not vary significantly with age of the fish (Fig. 5).

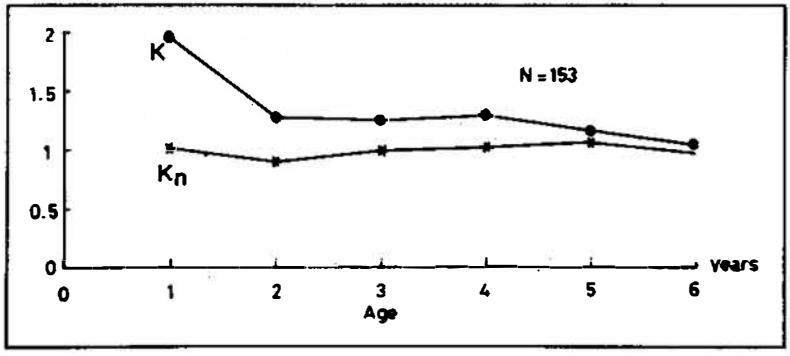

Fig. 5. Coefficient of condition (K) and relative condition (Kn) factor with respect to age in *L. campechanus*.

Fecundity

Fecundity of seven fish with 450-700 mm TL, varied from 10,000 to 230,000 eggs with a mean value of 169,000.

Food and Feeding Habits

Out of the 209 fish examined, ranging from 122 to 740 mm TL, 142 (68.0%) were juveniles and immature fish (122-370 mm length) and the rest were adult and mature (400-740 mm length). Forty-six (32.4%) juveniles and immature fish contained food in their stomach; the rest had empty stomachs. From 67 mature fish, 52 (77.6%) had food in their stomach. Stomach eversion of snappers from deeper waters accounted for some of the empty stomachs.

Average percentage composition of various constituents of stomach contents is given in Table 4. The planktonic crustaceans, fish eggs and fish larvae were the main items of diet of juveniles and immature fish, while mature fish preferred molluscs, adult crustaceans and fish. The planktonic crustaceans ingested were predominantly copepods, decapods (Anomura and Brachyura), mysids, amphipods, isopods, malacostracans. Fragments of crustacean cuticles and fish scales were abundant. Postlarval stages of Penaeidae and Alphaeidae, juveniles and immature stages of *Penaeus* and *Metapenaeus*, *Plectorhynchus schotal*, *L. campechanus*, *Epinephelus* spp., *Gnathanodon* spp. and *Lethrinus* spp. were also recorded. Fragments of gastropod shells, foraminiferous shells, young octopus and squids were common in the diet.

Discussion

The present study demonstrates that juveniles and immature stages of *L. campechanus* occur along the entire coast of Jizan and that their distribution and abundance varies with seasons. In summer, they occupied a depth of 6-27 m, while in winter they occurred at 15-21 m. The juveniles and immature fishes disappeared from the catch during the summer months (April-August), but were captured during the late summer (September-October) and continued as the season progressed to winter. This observation agrees with the

Table 4. Occurrence of different food items in the stomachs of *L. campechanus*.

Food items	Winter* Mean number	Winter* Frequency occurrence in fish	Winter* Frequency %	Summer** Mean number	Summer** Frequency occurrence in fish	Summer** Frequency %
Debris and mud	-	34	72.3	-	11	15.5
Crustacean plankton						
Decapods	37	34	72.3	23	10	14.1
Copepods and Calanoids	23	29	61.7	32	10	14.1
Malacostraca	18	24	51.1	21	7	9.9
Isopods and Amphipods	42	26	55.3	35	4	5.6
Adinida	11	25	53.2	24	8	11.3
Rhizopods	13	17	36.2	36	6	8.4
Penaeidae and Alphaeidae (larvae and juveniles)	-	-	-	7	19	26.8
Penaeus, Metapenaeus (immature stages)	3	10	21.3	1	9	12.7
Anamura/Brachyura (larvae and immature stages)	1	8	17.0	1	19	26.8
Fragments of crustacean cuticles		34	72.3	-	32	47.8
Fish						
Eggs	48	30	63.8	22	5	7.0
Larvae	21	34	72.3	9	9	12.7
Juveniles	-	-	-	3	14	21.2
Immature	2	12	25.5	39	39	54.0
Molluscs						
Squid	2	9	19.1	3	27	38.0
Octopus	1	5	10.6	-	-	-
Gastropod shell (fragments)	-	8	17.0	-	14	21.2
Foraminiferan shell (fragments)	-	5	10.0	-	10	14.1

*47 fish were examined.
**71 fish were examined.

suggestion of Camber (1955), Moseley (1966) and Beaumariage and Bulleck (1976) that as snapper grow they move to offshore deeper water. Wright et al. (1986) describe a definite relationship between fish length and water depth, which shows the migration of large individuals away from shallow water.

Mature snapper were few (1.33%) and restricted in distribution during winter (29-35 m) between latitude 16°45-16°53 N and longitude 40°23 to 42°31 E, but they were greater in number and widely distributed in summer (22-59 m) between latitude 17°02 to 17°47 N and longitude 41°48 to 42°38 E. This seasonal distribution may be due to physicochemical and biological conditions. *L. campechanus* might move about to seek a range of temperature that is suitable for its survival and growth.

The present results indicate that juvenile snappers demonstrate a seasonal inshore and offshore movement. It is very likely that mature snappers move inshore from reef areas during the warmer months (June-August) to spawn and then move back to deeper water in winter. This would explain the poor representation of mature fish in the catch during winter.

Snappers caught in the present study were aged using the scale methods and monthly fluctuations in age were found. But in the majority of fishes the annulus appeared in June-July just before spawning when most of the food reserve goes into the development of gonads. It is also suggested that snappers do not feed during their spawning period, which causes the formation of growth rings (Camber 1955).

The growth increment in length in red snappers was highest during the first year. However, the annual growth in weight had an opposite trend. It increased from the second year through the fifth year and then dropped. The mean rate of length growth per year was 96 mm which is comparable with that reported for the same species by Bradley and Bryan (1975).

The young and immature fish of 0^+ and I^+ age were found in almost all months along the entire coast of Jizan. The highest catch of young fish was made during September. This represents the recruitment of young fish.

L. campechanus probably mature during the III^+ year of life after they attain a length of 450 mm TL. The smallest mature female recorded was 440 mm TL and male, 500 mm TL. These observations agree with the observations of Talbot (1960) who found the smallest mature female at 48.6 cm FL (fork length) and male at 49.0 cm FL in *L. bohar* along the African Coast. In the closely related species *L. purpureus*, the maturity and first spawning was reported at an age of II^+ (Menezes and Gesteira 1974). Gross examination of gonadal condition and the presence of spent ovaries indicate that *L. campechanus* spawn during July and August in the Red Sea off Jizan coast. Bradley and Bryan (1975) also observed most ripening ovaries in the months of June and July off the Texas coast. Camber (1955), Moseley (1966), Futch and Bruger (1976) and Beaumariage and Bulleck (1976) agree that snappers spawn during summer months with a peak in August.

The weight-length study reveals that the weight of this species in the Red Sea exhibits allometric growth, i.e., does not follow the

cubic law, as the value of exponent "n" is less than 3 (2.6, sexes combined, females 2.75, and males 2.72). Futch and Bruger (1976) recorded the value of n as 3.03, 3.00 and 2.99 for female, male and combined sexes, respectively, for the same species from Florida waters.

Stomach analysis indicated that *L. campechanus* is polyphagous and opportunistic. Adults are piscivorous primarily, although they ate a variety of invertebrates (crustaceans and molluscs) which shows inshore and coral feeding habits. They probably feed throughout the water column on pelagic and demersal fish and invertebrates. The diet of juveniles, mostly zooplankton, agrees with the findings of Camber (1955) and Moseley (1966). Generally, it seems that the juveniles and immature fish depend almost exclusively upon invertebrates for food and then there is a gradual increase in dependency upon vertebrates as the fish grow (Bradley and Bryan 1975).

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References

Beaumariage, D.S. and L.H. Bulleck. 1976. Biological research on snappers and groupers, as related to fishery management requirements, p. 86-91. *In* H.R. Bullis, Jr. and A.C. Jones (eds.) Proceedings: colloquium on snapper-grouper fishery resources of the western central Atlantic Ocean. Mississipi-Alabama Sea Grant Consortium, Rep. 17.

Bradley, E. and C.F. Bryan III. 1975. Life history and fishery of the red snapper (*Lutjanus campechanus*) in the northwestern Gulf of Mexico: 1970-1974. Proc. Gulf Caribb. Fish. Inst. 27:77-106.

Camber, C.I. 1955. A survey of the red snapper fishery of the Gulf of Mexico, with special reference to the Campeche Banks. Florida Board of Conservation, Marine Research Laboratory Technical Series 12:1-64.

Edwards, R.R.C. 1983. The Taiwanese pair trawler fishery in tropical Australian water. Fish. Res. 2:47-60.

Futch, R.B. and J.E. Bruger. 1976. Age, growth and reproduction of red snapper in Florida waters, p. 165-184. *In* H.R. Bullis, Jr. and A.C. Jones (eds.) Proceedings: colloquium on snapper-grouper fishery resources of the western central Atlantic Ocean. Mississippi-Alabama Sea Grant Consortium, Rep. 17.

Hanafi, N.A.A.S. 1986. Some aspects of biology and ecology of the red snapper *Lutjanus campechanus* (Rivas, 1966). King Saud University, Saudi Arabia. 52 p. M.S. thesis.

Laevastu, T. 1965. Manual of methods in fisheries biology. FAO Man. Fish. Sci. 1(9):41-45.

Menezes, M.F. and T.C.V. Gesteira. 1974. Idade e crescimento do pargo, *Lutjanus purpureus* Poey, do norte e nordeste do Brasil. Arq. Cienc. Mar. 14(2):81-85.

Moseley, F.N. 1966. Biology of the red snapper, *Lutjanus aya* Bloch, of the northwestern Gulf of Mexico. Publ. Inst. Mar. Sci. Univ. Texas 11:90-101.

Nelson, R.S. and C.S. Manooch III. 1982. Growth and mortality of red snappers in the west-central Atlantic Ocean and northern Gulf of Mexico. Trans. Am. Fish. Soc. 111:465-475.

Stephen, A., S.A. Bortone and L. Charles. 1980. Ageing red snapper *L. campechanus*, with otoliths, scales and vertebrae. Northeast Gulf Sci. 4:60-63.

Talbot, F.H. 1960. Notes on the biology of the *Lutjanidae* (Pisces) of the East African coast, with special reference to *L. bohar* (Forsskal). Ann. Afr. Mus. XLV:549-579.

Tortonese, E. 1983. List of fishes observed near Jeddah (Saudi Arabia). J. Fac. Mar. Sci. Jeddah 3:1-5.

Wright, A., P.J. Dalzell and A.H. Richards. 1986. Some aspects of the biology of the red bass, *Lutjanus bohar* (Forsskal), from the Tigak Islands, Papua New Guinea. J. Fish Biol. 28:533-544.

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