

Fishery, growth and mortality of the threadfin bream, *Nemipterus japonicus* (Bloch, 1791) (Pisces: Nemipteridae) from the southern Sudanese waters, Red Sea

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Abstract

The fishery, growth and mortality of the threadfin bream, *Nemipterus japonicus* (Nemipteridae) from the southern region of the Sudanese Red Sea was assessed. Fishes were collected from the Tawkar fishing region, south Sawakin, by trawl net during 2003-2004. The total fish caught during the experiment period was 33,000 kg, of this 3,586 kg where threadfin bream. The species constituted 10.8% of the total catch. The average total catch per unit of effort was 83.3 kg/hr and for the threadfin bream was 9.0 kg/hr. Length-weight relationship was calculated and yields the following equation: $W=0.021 L^{2.85}$ for fish ranged from 12-19 cm. The relative condition factor of the species ranged from 0.90 to 1.04 (mean \pm S.D 0.976 \pm 0.0468). The population parameters estimated for the threadfin bream were $L_{\infty}= 22.8\text{cm}$, $K= 0.36$ and $t_0= 1.374$. The growth performance index (ϕ) of the species was computed as 2.27. Total mortality rate (Z) was computed as 0.939, natural mortality rate (M) as 0.763, fishing mortality rate (F) as 0.176 and the exploitation ratio was 0.187, indicating that the threadfin bream stock in Sudanese Red Sea is under exploitation.

Introduction

The Red Sea is considered as a tropical water course with a prevailing desert and semi-desert climate. The Sudanese Red Sea coast is approximately 750 km long, extending from 18°N at the Eritrean border to 22°N at the Egyptian border, with a shelf area of 22300 km². Sudan territorial waters are generally characterized by weak currents, lack of upwelling phenomenon, weak tide (1-2 feet), high water temperature (20°C in February and 33°C in August), high salinity, (39-45‰) lack of permanent

rivers and freshwater runoff except the freshwater reaching the sea seasonally from Baraka River forming Delta Tawkar in the south and rain water that influx through valleys and ephemeral khors such as Arbaat in the north and Kilab, Moug, Hoshiery Valley and Nawarat south of Port Sudan (8).

Nemipteridae is represented by three genera (*Nemipterus*, *Scolopsis* and *Parascolopsis*) and 20 species in the Western Indian Ocean (Fishing Area 51), small to moderate-sized, slightly compressed fishes, mostly living in shallow coastal waters. The threadfin bream (Bassi), *Nemipterus japonicus* (Bloch, 1791) is belonging to the genus *Nemipterus* with eight other species in the Western Indian Ocean (10). The threadfin bream is widely distributed throughout the Indo-West Pacific, including Red Sea and Arabian Gulf (10; 16; 28), and recently been reported from the Mediterranean Sea (13). The species is very abundant in coastal waters, found on mud or sand bottoms in 5 to 80 m, usually in schools (28). The diet of this species consists of benthic organisms; include crabs, fishes, mollusks, shrimps and worms (7). This species exhibited year-around spawning, with peak from November to May and concentrated at times of the year when winds are weakest in the Jizan Region of the Red Sea (4).

Some aspects of fishery biology of the threadfin bream studied in various regions of the world in addition to its fisheries (17; 20; 23; 22; 21); biology (17; 15; 12; 13; 1; 19), population dynamics and stock assessment (20; 6; 2). However, no information is available on the fishery, growth and mortality of this species from the Sudanese waters.

The objective of this study therefore is to provide some information on the fishery, growth and mortality of the threadfin bream from the southern region of the Sudanese waters, Red Sea.

Materials and methods

The data used in this study were collected from the shallow waters of Tawkar (37° 19' to 37° 58' E, 18° 20' to 18° 42' N), south Sawakin, within the southern region of the Sudanese waters, Red Sea (Fig. 1). The average water temperature in the region was 26 C° and the general profile of the substratum is muddy. The fishing operations were undertaken during October 2003 - May 2004 fishing season and by a commercial fishing trawler (23m long, 850H.P. main engine, with a capacity of 58 gross tonnages), supplemented by trawl net measured 200m long and 50m on the head rope. Experimental trawl fishing was made at 3 – 4 trips per season (for

22 days), each trip took seven days and the haul lasted for 2-3 hours at the speed of about 2.5 knots, i.e. 7-9 hauls or 18 hours were executed per day. The total fishing area, and total swept- area by the trawler were measured. After each haul, total catch and catch of each fish species were taken. Random samples of the brushtooth lizardfish were collected from the catches during the study period for biological study. Catch per unit of effort (CPUE) was determined, using the information about total catch per day, duration of haul and number of hauls per day, and expressed as fish biomass caught per hour (kg/hr). Species identification was confirmed from the FAO manuals for Eastern Indian Ocean (10).

The total length (mm) and total weight (g) were taken for each individual of the brushtooth lizardfish. The relation between the total length (L) and total weight (W) was computed according to (18). The relative condition factor (Kn) was calculated from the formula ($Kn = W/W'$), where W= the observed weight and W'= the calculated weight (3). The fish age was determined from opercular bones. Opercular bone was removed from left side of fish by cutting around the anterior-posterior edge using a scalpel and then twisting with fingers. The bone from each fish was then stored in a labeled paper envelope. (11) method was applied for treatment of opercular bones. The von Bertalanffy growth curve $L_t = L_{\infty} [1 - e^{-k(t-t_0)}]$ was fitted using the method of Beverton (27), where L_t = the expected length at age t years; L_{∞} = the asymptotic maximum length; K = the von Bertalanffy growth constant; and t_0 = the theoretical age at zero length. The growth performance index (ϕ) was computed according to the formula of (24) as: $\phi = \log_{10} K + 2\log_{10} L_{\infty}$.

The Beverton and Holt model (30) was applied to estimate the total mortality coefficient (Z): $Z = K \cdot (L_{\infty} - L'') / (L'' - L')$, where L_{∞} and K are growth parameters, L' = cut-off length and L'' = mean length above L' . Natural mortality rate (M) in the population was calculated by the following equation (24):

$M = 0.8 * \text{EXP} [- 0.0152 - 0.279 * \ln L_{\infty} + 0.6543 * \ln K + 0.463 * \ln T]$
where the annual water temperature of the study area (T) entered was 26 °C. The fishing mortality coefficient (F) was calculated as: $F = Z - M$. The exploitation rate (E) was calculated using the formula of (14) as: $E = F/Z$.

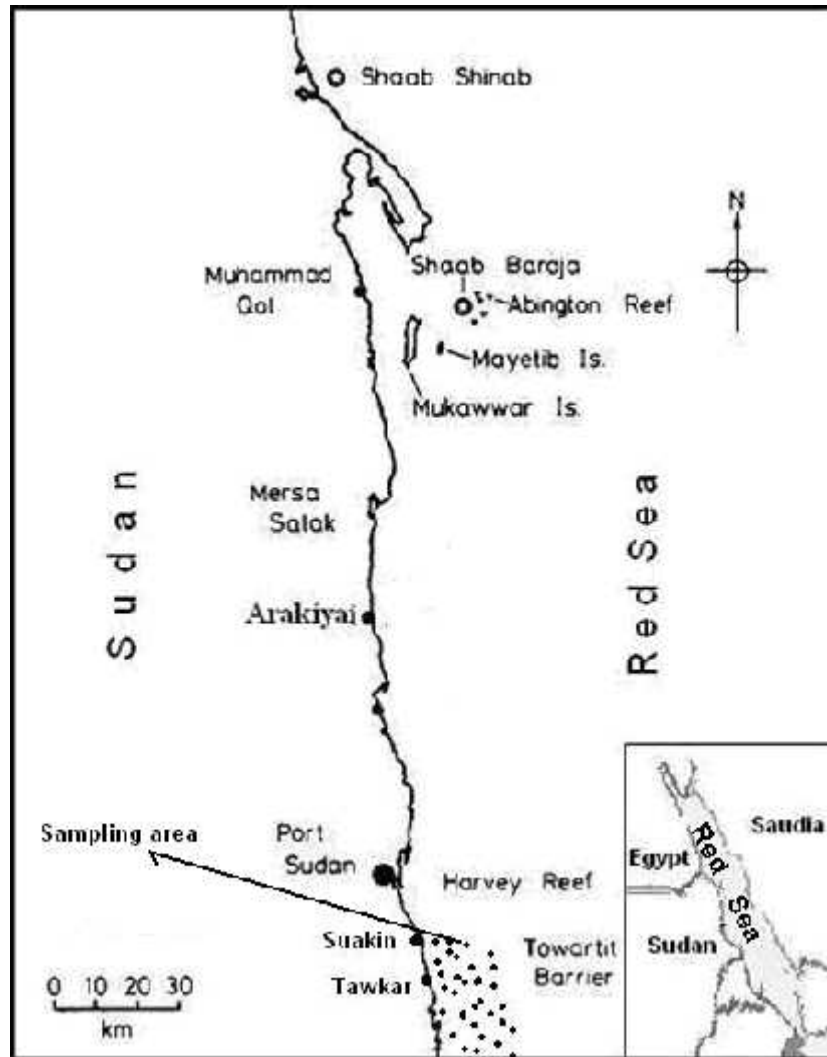


Fig. 1. Map of the Sudanese coast, Red Sea showing sampling location

Results

Information about the catches and fishing efforts in the experimental trawl fishing of the Sudanese Red Sea are summarized in Table 1. A total of 396 trawling hours through 154-198 hauls were executed at 22 days during 2003 - 2004 fishing season. The total fish caught during the experiment period was 33,000 kg, of this 3,586 kg of *N. japonicus* and 29,414 kg of other fish species including *Saurida undosquamis*, *Mulloidés vonicolensis*, *Terapon theraps*, *Gerres oyena*, *Pelates quadrilineatus*, *Leiognathus virgatus*, *Pamadasys maculatus* and *Mulloidés flovolineatus*. The threadfin bream constituted 10.8% of the total catch. The average total catch per unit of effort was 83.3 kg/hr (188 kg/haul and 1500 kg/day) and for the threadfin bream was 9.0 kg/hr.

The length frequency of the threadfin bream ranged from 12 to 19 cm TL was analyzed (Fig. 2). The major peak was at length 13cm and formed 24% from the species catch. Fish <12cm were not appeared in the catch. The relationship between length and weight for 132 specimens (12–19 cm TL, 28 to 87 g total weight) of the species was $W=0.021 L^{2.85}$ ($r^2 =0.990$). It was statistically significant difference from the value 3 ($t= 3.37$, $P >0.05$), which means an allometric growth pattern. The relative condition factor was ranged from 0.90 for length group 18-19cm to 1.04 for length group 13-14cm, (mean \pm S.D 0.976 ± 0.0468) (Table 2).

Estimated ages of 100 individuals (12–19 cm TL) ranged from 1 year to 4 years. Fish of two years old was the highest contribution (36%) in the sample (Fig. 3). The obtained results revealed that the growth of the lizardfish during the first four years of its life was 13.0, 16.0, 18.0 and 19.5 cm, respectively. During the first two years of life, the species grew rapidly in length, with average increases of 13.0, 3.0, 2.0 and 1.5 cm during the first four years of its life. The estimated von Bertalanffy growth parameters for the species were $L_{\infty}= 22.8$ cm, $K= 0.36/\text{yr}$, and $t_0= 1.374$ yr. The growth performance index (ϕ) of the species was computed as 2.27.

The annual total mortality rate (Z) of the species was estimated to be 0.939 and the natural mortality rate (M) was 0.763. Consequently, the fishing mortality rate (F) was 0.176; hence the exploitation rate (E) was 0.187.

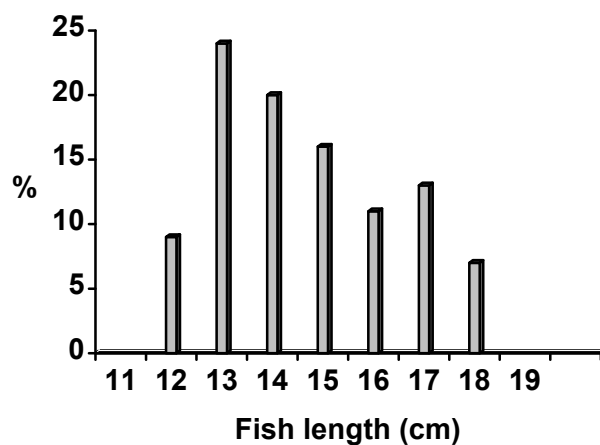


Fig. 2 Length–frequency distribution of the threadfin bream in the southern Sudanese waters, Red Sea

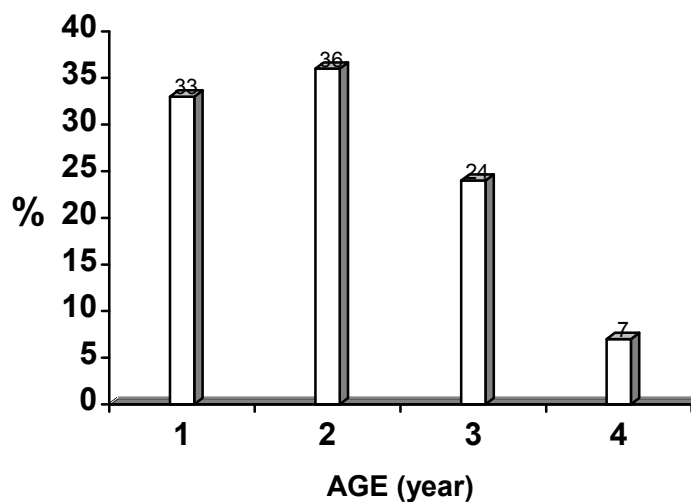


Fig. 3. Age distribution of the threadfin bream in the Sudanese waters, Red Sea

Table 1. The fishing efforts in the experimental trawl of the Sudanese waters, Red Sea.

| | Total catch (kg) | Catch (kg) per unit effort (CPUE) | | | % |
|---|------------------|-----------------------------------|------|------|------|
| | | Haul | Day | Hour | |
| Total catch | 33,000 | 188 | 1500 | 83.3 | 100 |
| <i>Nemipterus japonicus</i> | 3,586 | 20 | 163 | 9.0 | 10.8 |
| <i>Saurida undosquamis</i> | 20,592 | 145 | 936 | 52.0 | 47.5 |
| <i>Mulloides vonicolensis</i> , <i>Terapon theraps</i> , <i>Gerres oyena</i> , <i>Pelates quadrilineatus</i> , <i>Leiognathus virgatus</i> , <i>Pamadasys maculates</i> and <i>Mulloides flovolineatus</i> | 8,822 | 23 | 401 | 22.3 | 41.7 |

Table 2. Relative condition factor of the threadfin bream in the Sudanese waters, Red Sea.

| Length group (cm) | No. of fish | Mean Length (cm) | Mean weight (g) | Calculated weight (g) | Relative condition factor (Kn) |
|-------------------|-------------|------------------|-----------------|-----------------------|--------------------------------|
| 12-13 | 9 | 12.7 | 28.9 | 29.4 | 0.98 |
| 13-14 | 24 | 14.0 | 40.5 | 38.8 | 1.04 |
| 14-15 | 20 | 14.9 | 46.6 | 46.3 | 1.01 |
| 15-16 | 16 | 15.8 | 51.8 | 54.8 | 0.95 |
| 16-17 | 11 | 16.8 | 64.9 | 65.2 | 1.00 |
| 17-18 | 13 | 17.9 | 74.8 | 78.1 | 0.96 |
| 18-19 | 7 | 18.8 | 80.8 | 89.9 | 0.90 |

Discussion

Trawling is in the hands of a limited number of small-sized, commissioned or contracted, trawlers in confined areas in the southern and northern parts of the Sudanese Red Sea, and operate mainly seasonally, targeting shrimp, lizard fish, goat fish and threadfin bream. The irregular seabed limits trawling operations to an area of 71 000 ha in Delta Toaker (29 500 ha), Gulf of Agieg (6 500 ha), Mersa Mogadam (3 000 ha), Khor Nawarat (2 000 ha) and a few other small areas. The number of trawlers and total production reported catch for in 2005 from Marine Fisheries Administration were 32 and 1314 tons, respectively (5; 9).

Subsequent to the discovery of a shrimp resource off the Toakar delta there has been intermittent trawling by licensed foreign vessels, such as the Italian trawler F/V Omarazo Torzo was operated on these grounds during 1981 (29), and in the early 1990s an industrial fleet of trawlers operated under Egyptian-Sudan joint venture arrangements. However most joint venture trawlers have ceased operations because shrimp catches, the major target group, were considered too low. Only Egyptian trawlers have remained in the area fishing for lizardfish for the Egyptian market (26).

The brushtooth lizard fish dominated the bottom trawl catch (47.5%) in the Sudanese Red Sea followed by the threadfin bream constituted 10.8%. The same findings in the other areas of the Red Sea such as in the Ethiopian Red Sea coast (31). However, the threadfin bream constituted 2.8% of by-catch species in north Arabian Gulf, Kuwait (20), 8.6% of the trawl catch in the coast of Pakistan (21) and 7.0% of the trawl catch in the Gulf of Suez (9). The rates of total catch of fish (83.3 kg/hr) and for threadfin bream (9.0 kg/hr) in the present study are close to the values recorded in the Jizan Region of the Saudi Red Sea for overall catch rate (80.3kg/h) and for threadfin bream which ranged from 0.47 to 21.88 kg/hr with averaged at 8.22 kg/h during October 1985 to November 1986 (23).

The parameter estimates of the threadfin bream obtained in the present study were compared with the status of this species in the other regions (Table 3). The length range of threadfin bream in Sudanese waters is lower than those recorded for the same species in the other waters (23; 1). However, the exponential value (b) of the length-weight relationship of the species in Sudanese waters is better than those recorded in the other areas

(Table 3). The growth parameters obtained in our study (L_{∞} , K and \emptyset) fall within the lower values recorded for the same species in other studies. These different data from different regions may be related to the environmental conditions.

The values of the mortality and exploitation rates of the threadfin bream obtained in the present study are lower than those recorded for the same species in the Arabian Gulf, Kuwaiti waters (20) and in the Bay of Bengal, Bangladesh (2). (14) reported that the optimum exploitation rate of any exploited stock is about 0.5. It could be concluded that the threadfin bream stock in the Sudanese coast is now underexploitation ($E= 0.187$) and to exploit this valuable fish resource, the exploitation rate should be increased to the optimum value by increasing fishing pressure on stock of this species. No significant stock assessment has been conducted in Sudan's waters. However, work by United Kingdom Overseas Development Administration (ODA) indicated a total MSY of around 35,000 metric tons. In comparison to current annual total national catch of around 1,400 metric tons. Sudan considers its marine fish resources to be lightly exploited. The effect of illegal fishing on Sudan's fish stocks is not known (26).

Table 3. Comparison population parameters of the threadfin bream, *N. japonicus* in the Sudanese Red Sea and other regions.

| Region | Fish length (cm/L) | Length-weight relationship | | L _∞ (cm) | K | t ₀ | σ | Z | F | M | E | Sources |
|------------------------------|--------------------|----------------------------|-------------|---------------------|-------|----------------|------|-------|-------|-------|-------|---------------------------------|
| | | a | b | | | | | | | | | |
| Jizan Region, Saudi Red Sea | 3.5-22.0 | 0.3138-0.3399 | 2.469-2.428 | - | - | - | - | - | - | - | - | Oakley and Baksh (1989) |
| Coast of Karnataka, India | 9.5 -30.8 | 0.039 | 2.664 | - | - | - | - | - | - | - | - | Abdurahiman <i>et al</i> (2004) |
| Arabian Gulf, Kuwaiti waters | - | 0.0245 | 2.790 | 33.0 | 0.54 | - | - | 1.7 | - | 1.32 | 0.39 | Mathews and Samuel (1989) |
| Bay of Bengal, Bangladesh | - | - | - | 27.2 | 0.92 | - | - | 2.25 | 0.51 | 1.74 | 0.23 | Amin <i>et al</i> 2006 |
| Java Sea, Indonesia | - | - | - | - | - | - | 2.59 | - | - | - | - | Sinoda and Intong (1978) |
| Gulf of Aden, Yemen | 8.8-23.5 | 0.059 | 2.664 | 29.1 (FL) | 0.310 | 0.05 | 2.42 | - | - | - | - | FishBase |
| Arabian Gulf, Kuwait waters | - | - | - | 30.3 | 0.54 | 0.19 | 2.70 | - | - | - | - | FishBase |
| Mumbai coast, India | - | - | - | 35.0 | 0.83 | - | 3.01 | - | - | 1.52 | - | FishBase |
| Andhra-Orissa Coast, India | - | - | - | 20.9 | 0.65 | - | 2.45 | - | - | - | - | FishBase |
| South China Sea, Hong Kong | - | - | - | 38.0 | 0.13 | - | 2.27 | - | - | - | - | FishBase |
| Sudanese Red Sea | 12.0-19.0 | 0.0210 | 2.850 | 22.8 | 0.36 | 1.374 | 2.27 | 0.939 | 0.176 | 0.763 | 0.187 | Present study |

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مصائد ونمو ونفوق اسماك ألباسي الياباني (*Nemipterus japonicus* (Bloch, 1791) في
الجزء الجنوبي من المياه السودانية في البحر الأحمر

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الخلاصة

وصفت مصائد ونمو ونفوق اسماك ألباسي الياباني threadfin bream, *Nemipterus japonicus* (Bloch, 1791) في الجزء الجنوبي من المياه السودانية في البحر الأحمر. جمعت عينات الأسماك من منطقة مصائد Tawkar جنوب السواقيين بواسطة شبكة الجر خلال موسم 2003-2004. بلغت كمية الصيد الكلية خلال مدة الدراسة 33000 كغم، منها 3586 كغم من اسماك ألباسي الياباني. شكلت أفراد النوع 10.8% من المصيد الكلي وكانت كمية الصيد الكلية لوحدة الجهد 83.3% كغم/ساعة ولأسماك ألباسي 9.0 كغم/ساعة. كانت علاقة الطول بالوزن للأسماك $W=0.021 L^{2.85}$ لأطوال 12 إلى 19 سم. تراوحت قيم معامل الحالة النسبي بين 0.90 - 1.04 وبمعدل 0.976 ± 0.0468 (SD). كانت قيم مقاييس النمو كالتالي: $L_{\infty}=22.8$ سم، $K=0.36$ و $t_0=1.374$. بلغ دليل كفاءة النمو (\emptyset) للنوع 2.27. ان قيم النفوق الكلي (Z) 0.939 والطبيعي (M) 0.763 والصيد (F) 0.176 ومعدل الاستغلال 0.187، مما يشير إلى إن مخزون اسماك ألباسي الياباني في المياه السودانية تحت مستوى الاستغلال المثالي وان هناك إمكانية لزيادة معدل الاستغلال لهذا النوع من الأسماك.