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Studies on Age Determination and Growth Pattern of the Red (Blackspot) Seabream [*Pagellus bogaraveo* (Brünnich, 1768)] from the Strait of Gibraltar (ICES IXa/SW Spain): Application to the Species Migratory Pattern

by

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Abstract

Red (blackspot) seabream (*Pagellus bogaraveo*) is considered the main target species in the fishery carried out in the Strait of Gibraltar waters. This study analyzed the growth pattern of the species. The determination of age was done by observing and analysing whole otoliths (sagitta), thereby obtaining the mean lengths at age for males and females in the year 1998 (from 11 - 54 cm TL and 0 - 8 years for the whole population). Additionally, the growth parameters in both sexes were obtained according to the von Bertalanffy equation: L_∞ = 58 cm (constrained using as reference the largest individual observed from commercial length distribution samples), K = 0.169 and t_0 = -0.668 that would be compared with those obtained by other authors in other areas of distribution of the species. Through the interpretation of the otolith and its edge, a sequence of annual rapid and slow growth rings was observed, otoliths with the opaque edge (rapid growth) showing the highest percentages in the period from June to September. Otolith total diameters, from valid readings, were measured and seems to follow an allometric model: $TL=aOD^b$ (a= 24.25, b = 1.12 and r^2=0.82). These results were related with those obtained from tagging surveys in the area in order to describe the movements along the life cycle o f the species.

Introduction

The Red (blackspot) seabream (*Pagellus bogaraveo*) is an sparid with a great commercial interest for the Andalusian artisanal fleet. Their fishery is carried out in the Strait of Gibraltar area with local mechanized hand lines gears ("*voracera*") during the turnover of the tides. In this work we present aspects of age and growth of the species that could be used to understand life story events. Results were related with those obtained from the tagging surveys recaptures to describe the species movements along its life.

Materials and Methods

Growth was studied throughout monthly samples from landings of artisanal fleet ("*voracera*"), 1997-1999, in the fishing ports of Tarifa and Algeciras (Cádiz, SW Spain). The total body length in millimeters

(TL) were measured in each fish sampled the and later otoliths were collected. Whole otoliths (*sagitta*) were read under a ligth microscope for recording the number of rings and their edge type. 1st of January was assigned as the birthdate. From at least three agree readings was created the ALK. The Von Bertalanffy growth function (VBGF) was fitted to the data, by means of FISHPARM software (taking the L_∞ value, 58 cm, from the largest total length of the monthly length distribution samples) to estimate growth parameters and model the growth pattern too.

$$L_t = L_\infty(1-e^{-k(t-t0)})$$

Those have been compared with those obtained in other distribution areas using the *"Phi-prime Test"* (Munro & Pauly, 1983) that contrasts the different growth global yield indexes (f') obtained according to:

$$f' = \log_{10}k + 2\log_{10}L_\infty$$

Otolith maximum diameters were measured by Optical Pattern Recognition System sofware (OPRS, Biosonics). Measures were only carried out in those otoliths with three agree readings. Significative, or not, differences between left and right otoliths measures were tested by means of a t-test (Zar, 1984). The pair of values, Total Length (mm) vs. Otolith Measurement (mm), from each sample have been fitted to an allometric model:

$$TL = aOM^b$$

Migration patterns is studied by Tagging Surveys in the Spanish South Mediterranean region and the Strait of Gibraltar. Trap gears were utilised to catch Red seabream juveniles (Mediterranean Sea) and adults in the commercial fishery area were catched with the *"voracera"* gear. A T-bar type external mark was used, on the mid dorsal side, to identify individuals. Tagged samples were released after recording their total length. Also an informative survey was developed to announce the experience in those areas where the recaptures can be done later.

Results and Considerations

Age and growth

Generally, rapid growth rings (opaque) are formed in summer-autumnn and slow ones (traslucent) in winter-spring (Morales-Nin, 1987). In this study is clear the alternation in the deposition, bigger or smaller, of organic matter that confirms the annual rhythm of the growth rings (Figure 1). Thus, the ring formation pattern is clearly apparent in the whole otolith with one opaque and one tralucent zone being laid down every year.

Table I shows mean length at age obtained from the ALK. From these was estimated the growth parameters represented in Table II with those obtained by other authors. The phi-prime test estimations provide an indication of the reability of estimates since it is suggested that values are similar for the same species and genera. The values ranged from 2.47 to 2.75 with a mean of 2.65. Our value is similar for other distribution areas of the species, mainly with Sánchez study for the Cantabrian Sea population.

The comparison between left and rigth otolith measurements yielded no significant differences ($p>0.05$) and its proposed an allometric relationship: $TL=24.25aOM^{1.12}$ with a $R^2=0.82$ (Figure 3).

Movements

The size of the tagged individuals seems to be related with the depth which were captured (Table III).Total number of recaptures is 160 until the present day (August 2001). Most of them (77) shared to the sport fisherman notifications from closest but more deeper areas than the juveniles tagging surveys. Furthermore, the notification of far away recaptures gives an idea of the species mobility (Figure 4).The most remain in the sea sample is one fished by the Tarifa´s *"voracera"* fleet (October 1999) more than two years after the tagging. Bigger displacement was recaptured in Cabo de Gata (Almeria, SE Spain) after 416 days. After a breeding period juveniles mainly goes to the Strait of Gibraltar and the vicinity of Ceuta where the fishery is carried out. Also, in a minor way, trhee samples moves towards the Mediterranean reflecting a displacement of the species to other areas. Recaptures from matures tagging do not reflect important movements so far. All the recaptures come from the Strait of Gibraltar and was notified by the "*voracera"* fleet.

A brief journey through the species vital history could be: Later the spawning season, currents moves eggs and larvae to both sides of the Strait of Gibraltar. Spends its early years in coastal areas (bays, breakwaters and even inside ports). Later, ventured to move away from these shelter areas. Once recluted to the fishery (since three years) it seems to remain in the Strait of Gibraltar area continuing their growth and taking place other life events as: maturation, sexual investment, spawning.....In this area cohabit different ages that originate the distribution of the capture in four commercial categories (as a function of the individuals weight).

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TABLE I. *P. bogaraveo*. Mean length, St. Deviation and Coeficient of variation at age.

Age (years)	0	1	2	3	4	5	6	7	8
Mean length (cm)	12.4	17.3	22.4	28.7	33.1	35.3	40.9	44.0	49.9
St. Deviation	0.73	1.20	1.35	2.49	2.23	3.14	2.33	3.91	3.54
C. V.	0.06	0.07	0.06	0.09	0.07	0.09	0.06	0.09	0.07

TABLE II. *P. bogaraveo*. Growth parameters and phi-prime values by author and study area.

Author	Study area	Method	t_0	k	L_∞	Phi (f')
Ramos (1967)	Cantabrian Sea	Direct	-1.02	0.127	53.86	2.57
Gueguen (1969)	Cantabrian Sea	Direct	-2.92	0.092	56.80	2.47
Sánchez (1983)	Cantabrian Sea	Direct	-0.53	0.209	51.56	2.74
Krug (1982-1984)	Azores Islands	Direct	-1.46	0.124	61.40	2.67
Krug (1982-1984)	Azores Islands	Indirect	-0.75	0.115	61.89	2.64
Krug (1982-1985)	Azores Islands	Direct	-0.91	0.118	58.89	2.61
Krug (1982-1985)	Azores Islands	Indirect	-0.75	0.144	51.21	2.58
Krug (1987-1991)	Azores Islands	Direct	-0.39	0.121	64.18	2.70
Krug (1987-1991)	Azores Islands	Indirect	-0.34	0.154	55.70	2.68
Krug (1997/2000)	Azores Islands	Direct	-1.83	0.127	54.90	2.58
Gil & Sobrino (2001)	Strait of Gibraltar	Direct	-0.67	0.169	58.00	2.75

TABLE III. Red (blackspot) seabream tagging surveys features.

Tagging Survey	Date	Gear	Depth range (m)	Tags	Range (cm)	Mean length (cm)	Recaptures
Estepona97	Aug´1997	Traps	43-103	1590	13-28	20	108
Sotogrande98	Aug´1998	Traps	43-103	1428	12-27	18	17
Tarifa01	Mar´2001	Voracera	179-485	979	21-52	34	35

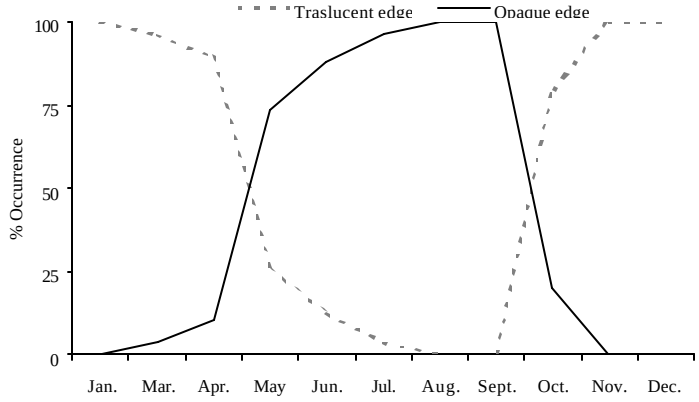

FIGURE 1. *P. bogaraveo*. Otoliths edge type monthly percentage of occurrence.

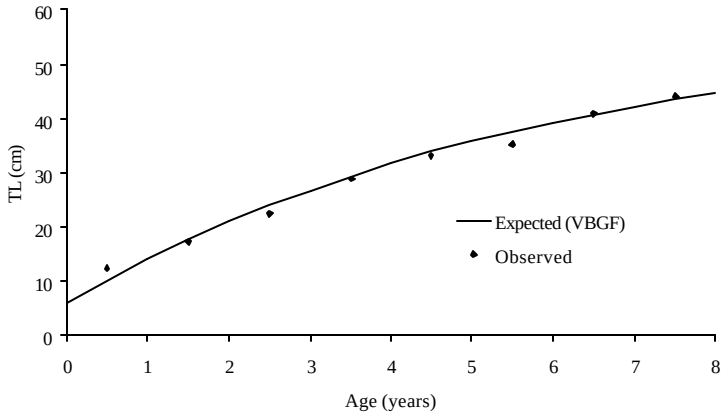

FIGURE 2. *P. bogaraveo*. Growth curve and its parameters.

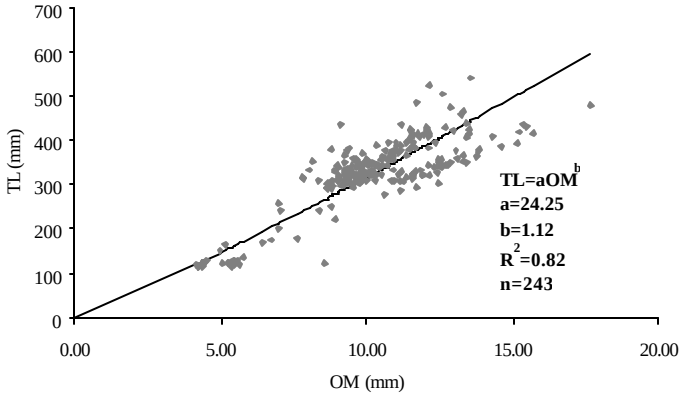

FIGURE 3. *P. bogaraveo*. Total length vs. Otolith maximum diameter relationship.

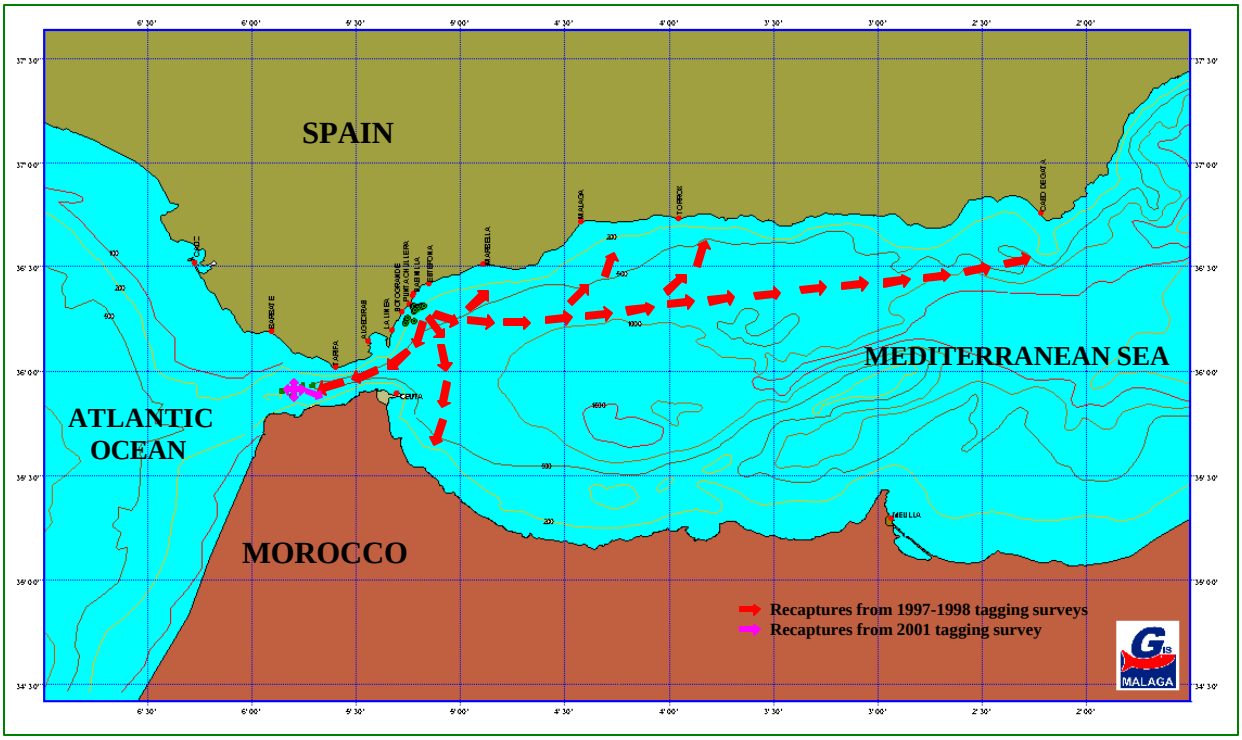

FIGURE 4. Location and movements from the Red (blackspot) seabream tagged samples.