Fisheries Research 168 (2015) 6–19

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Aging and life history traits of the longnose spiny dogfish in the Mediterranean Sea: New insights into conservation and management needs

Vasiliki Kousteni, Persefoni Megalofonou *

Faculty of Biology, Department of Zoology-Marine Biology, University of Athens, Panepistimiopolis, Ilisia, 15784 Athens, Greece

ARTICLE INFO

Article history:
Received 26 May 2014
Received in revised form 9 March 2015
Accepted 16 March 2015
Handling editor: B. Morales-Nin
Available online 11 April 2015

Keywords:
Squalus blainville
Fin spine morphometry
Age
Growth
Condition factor
Age at maturity

ABSTRACT

Aging chondrichthyans has been characterized as a slow and difficult process, but at the same time it is considered of fundamental importance for the holistic management and conservation of their populations. This study aims to assess the age and growth of the longnose spurdog *S. blainville*, to correlate the results to the species' biological features and to compare them with those reported in previous studies that used different aging methods. By counting the growth bands on the enamel surface of the dorsal fin spines, age was estimated in 569 out of 810 individuals that were taken as by-catch from commercial fisheries in the Mediterranean Sea during an 8-year period. Spine morphometrics revealed sexual dimorphism as far as spine length, spine base width and spine weight are concerned. The between-sex differences were also reflected in the length-weight relationships, in the gonadosomatic (GSI) and hepatosomatic (HSI) indices, and in the condition factor (K). All three somatic indices differed significantly among maturity stages, seasons or age classes. The reproducibility of the age readings was considered high based on the estimated CV and APE precision indices. Age bias plots also indicated no significant intra- and small inter-reader variation. The estimated VBGF parameters were: $L_\infty = 1097.3$ mm, $k = 0.03$ yr^{-1} and $t_0 = -5.58$ yrs for females, and $L_\infty = 665.5$ mm, $k = 0.08$ yr^{-1} and $t_0 = -3.35$ yrs for males. Likelihood ratio tests showed that all growth parameters were statistically significantly different between sexes ($\chi^2 = 38.26$, $df = 3$, $P < 0.001$). Females reached higher longevity (28 yrs) than males (22 yrs) and attained maturity at higher age and larger size ($T_{50} = 17$ yrs and $L_{50} = 568.1$ mm) than males did ($T_{50} = 11.3$ yrs and $L_{50} = 460.6$ mm). *S. blainville* seems to be a long-lived shark of slow growth and late maturity, a combination of traits indicating a species of great vulnerability to fishing pressure that can only sustain a low harvest rate.

1. Introduction

Assessing growth parameters is important not only for the prediction of growth rate evolution, identification of cohorts and evaluation of population dynamics, but also for the definition of strategies for sustainable fisheries (Rochet and Trenkel, 2003). Considering the current concern over the shark catches in the Mediterranean Sea (Dulvy et al., 2014) in conjunction with their inherent life history traits (Musick, 1999; Kyne and Simpfendorfer, 2007) that make them vulnerable to overexploitation (Stevens et al., 2000), it is of high importance to implement integrated management measures for their population stocks that include, among others, species-specific information on their demographic characteristics.

Age and growth studies in chondrichthyans are based on vertebrae, dorsal fin spines, caudal thorns and neural arches, since they lack the hard parts that teleosts have, such as otoliths, scales and bones (Cailliet and Goldman, 2004). Spines, which are present in the three extant orders of Squaliformes, Heterodontiformes and Chimaeriformes (Maisey, 1979), are considered useful for aging species baring large enamel caps and most notably squalid sharks (Cailliet and Goldman, 2004), in contrast to other species having either a thin enamel layer on the anterior external surface of the spine or none at all (Cotton et al., 2014). In some cases, the spines appear to offer the only means of age estimation, for example in sharks whose vertebral centra, despite their wide use in aging chondrichthyans (Cailliet, 1990), did not prove useful for this purpose even after applying band enhancing techniques (Clarke et al., 2002a; Irvine et al., 2006a; Coelho and Erzini, 2007, 2008;

* Corresponding author. Tel.: +30 2107274620; fax: +30 2107274620.
E-mail address: pmegalo@biol.uoa.gr (P. Megalofonou).

http://dx.doi.org/10.1016/j.fishres.2015.03.014
0165-7836/

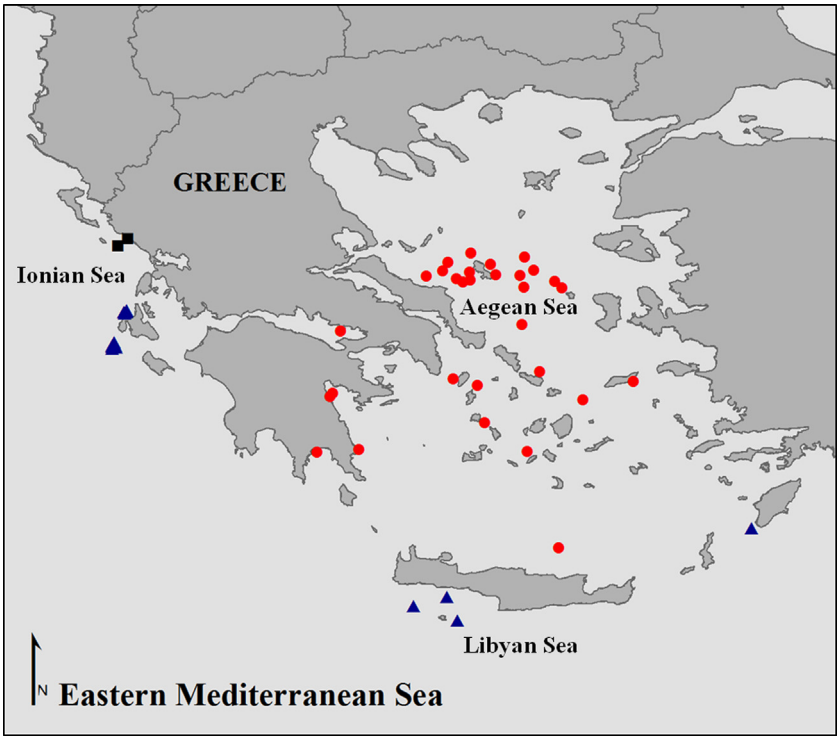

Fig. 1. Map of the study area indicating the sampling locations of 810 individuals of *Squalus blainville* caught by trawls (circles), longlines (triangles) and gillnets (squares) in the eastern Mediterranean Sea.

Cotton et al., 2011). The most common squalid shark whose spines were examined externally in aging studies is the piked dogfish *Squalus acanthias* (e.g. Kaganovskaia, 1933; Holden and Meadows, 1962; Jensen, 1965; Ketchen, 1975; Soldat, 1982; Saunders and McFarlane, 1993; Tribuzio et al., 2010; Orlov et al., 2011; Bubley et al., 2012).

The longnose spurdog *Squalus blainville* (Risso, 1826) is a demersal shark inhabiting the continental shelves and upper slopes of the Atlantic, Pacific, and Indian Oceans, including the Mediterranean and Black Seas (Compagno, 1984). Although its occurrence in the Mediterranean Sea has been recorded since the early 80s (Ondrias, 1971), few studies have been focused on its life history traits. Specifically, till present it has become known that *S. blainville* is an ovoviviparous shark that is involved in the production of few embryos and in a continuous reproductive activity during the year (Cannizaro et al., 1995; Sion et al., 2003; Kousteni and Megalofonou, 2011). Its feeding is based mainly on crustaceans, teleosts, molluscs, polychaetes, echinoderms and sipunculids (Capapé, 1975; Kabasakal, 2002; Martinho et al., 2012). Little knowledge exists about the species' age and growth delivered by counting the growth bands in sections of either vertebrae (Cannizaro et al., 1995) or spines (Marouani et al., 2012). Although the presence of bands on the external enamel surface of the dorsal fin spines has long been reported in the co-generic species *S. acanthias* (Holden and Meadows, 1962), they have not been examined in *S. blainville* till present.

In the Mediterranean Sea where *S. blainville* is a commercial bycatch species, official records of its landings are not available, and thus the IUCN categorize it as Data Deficient (DD) (IUCN, 2014). The main objectives of this study are: (a) to estimate the age of *S. blainville* using for the first time the external surface of the dorsal fin spines, (b) to analyze spine morphometrics, (c) to evaluate the precision of the aging method and compare the results with those found in previous studies using different methods, and (d) to evaluate the basic life history traits of the species, such as growth parameters, longevity, age and size at first maturity. All the above information is considered of high importance for management decision making that could contribute to the species' conservation in the Mediterranean Sea.

2. Materials and methods

2.1. Sampling

Between December 2004 and March 2012 a total of 810 longnose spurdogs were incidentally caught by the commercial fishing vessels using three types of gears (trawls, longlines and gillnets) in the eastern Mediterranean Sea (Fig. 1). All samples from the Aegean Sea ($N = 584$) were collected on board during seasonal fishing operations, while those from the Ionian ($N = 174$) and Libyan Seas ($N = 52$) were obtained at landings. All specimens were initially preserved in ice and later frozen until dissection. Sex was determined by direct examination of the presence or absence of the claspers and overall sex ratio (females:males) was calculated. Total length (TL) was measured to the nearest millimeter (mm), while total weight (TW) and eviscerated weight (EW) were measured to the nearest gram (g). The number and sex of embryos occupying the oviducts of gravid females were also recorded along with their TL and TW without the yolk sac weight.

2.2. Spine preparation and morphometry

Both first and second dorsal fin spines were removed, when present, by cutting at the base of the dorsal fins toward the vertebral column. Care was taken to include the delicate base portion. Spines were dipped for few minutes in boiled water in order to facilitate the removal of the excess tissue. Afterwards they were washed, air-dried and finally stored in labeled paper envelopes.

Spine morphometrics (Fig. 2A, Table 1) were recorded only in the second dorsal fin spine, which was mainly considered in the