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Annotated records of scombroid eggs and larvae distribution in northeastern Mediterranean waters

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Abstract

The distribution of eggs and larvae of scombroid fish in northeastern Greek waters were studied during the summer of three consecutive years(1992-1994) to determine spawning, time of spawning peaks, and the possible preferred spawning grounds. Among eggs only those of Xiphias gladius were successfully identified. Larvae of Thunnus alalunga, Euthynnus alleteratus, X. gladius and Auxis rochei were recorded, the latter species being encountered more frequently than the rest. Most scombroid larvae were collected in the Sporades Islands' basin and their abundance, particularly that of A. rochei, was relatively increased at the end of the summer, possibly suggesting increased spawning activities during that period.

Keywords: Eggs; Larvae; Scombroids; Aegean Sea.

Introduction

Ichthyoplankton data on large pelagics are of primary importance for delineating spawning grounds and seasons of these migratory species, contributing thus to improving knowledge of their biology and ecology. The distribution and abundance of the ichthyoplankton of several scombroids are presented in a number of studies conducted in various areas of the Pacific, as well as in the Atlantic. In the Mediterranean however, the available data refer to old records on *Xiphias gladius* and *Sarda sarda* (SELLA, 1911; SANZO, 1922; 1930; 1932; TAANING, 1955; DEMIR, 1957; DEMIR, 1970) as well as some information on the distribution of the larvae of certain tuna species in the western Mediterranean (PICCINETTI & MANFRIN, 1994; GARCIA, 2002; ORAY, 2005; ALEMANY, 2006; SABATES & RECASENS, 2001) while in eastern Mediterranean waters the only available data derive from fish larvae surveys in the north Aegean Sea (SOMARAKIS *et al.,* 2002; KOUTRAKIS *et al.,* 2004).

The objective of the present study is to report on the distribution of the eggs and larvae of scombroids in northeastern

Mediterranean/Aegean Sea waters, in order to determine which species spawn in the area, the time when spawning peaks, and the sites which may constitute spawning grounds.

Material and Methods

Ichthyoplankton samples were collected at a grid of 113 stations, covering north Aegean Sea waters (Fig. 1). The survey was conducted during a three-years period, from 1992 to 1994, in summer, from July through September, a period known to coincide with the spawning of scombroids in the Mediterranean (MEGALOFONOU *et al.,* 1995). Oblique tows were made from just above the sea bottom to surface (or to a maximum depth of 150 m whenever the sea bottom is deeper), using a 60 cm Bongo net outfitted with 300 and 500 μm mesh nets. In the Sporades basin (N.W. Aegean sea), known to be an important nursery ground for scombroids (MEGALOFONOU, 1990), additional data were gathered from horizontal surface tows using the Bongo nets and Methot trawl (3mm mesh size net) at depths near the thermocline (5-25 m) during the summer of 1992. All samples were preserved in 4% neutralized formalin.

In the laboratory all eggs and larvae

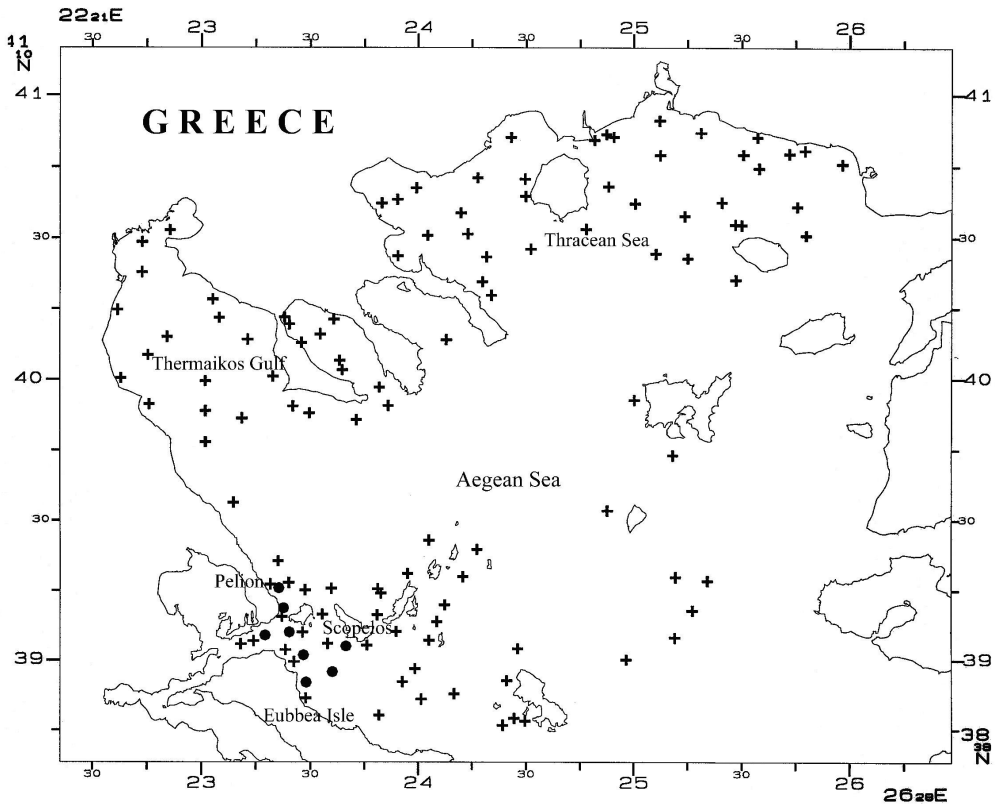

Fig. 1: Location of sampling stations.

were removed, identified to the lowest possible taxon, counted and measured (diameter for eggs and standard length (SL) for larvae). The absolute number of eggs and larvae per haul was recorded and the relative number per 100 m^3 filtered water was calculated.

Results

In all, 68 fish taxa were identified in the ichthyoplankton samples collected in the study area during the summers of 1992, 1993 and 1994. Scombroid larvae comprised 4.1% of all fish larvae collected.

59 *Xiphias gladius* eggs were collected during the three years of the survey, from early July till the end of August in the area appearing in Figure 2. 51 eggs were collected by Bongo nets during oblique tows and 8 were taken in the Methot trawl samples (Tables 1, 2). Egg abundance in the Bongo samplings peaked in the July - early August surveys (Table 2) and eggs were found in open-sea waters. The diameter of the eggs varied between 1.63 and 1.92 mm. Moreover, two postlarvae of the species were caught by the Methot trawl in August and September 1992 (Table 3). One post-larva (15.1mm SL) was caught in early August in a site relatively close to the shore; the second one (12.6 mm SL) was caught in an open sea area in mid-September.

Thunnus alalunga was represented by only one larva which was collected in late August 1992. The specimen (4.4 mm SL) was captured by Bongo during a horizontal tow conducted at a depth of 23 m (Table 3).

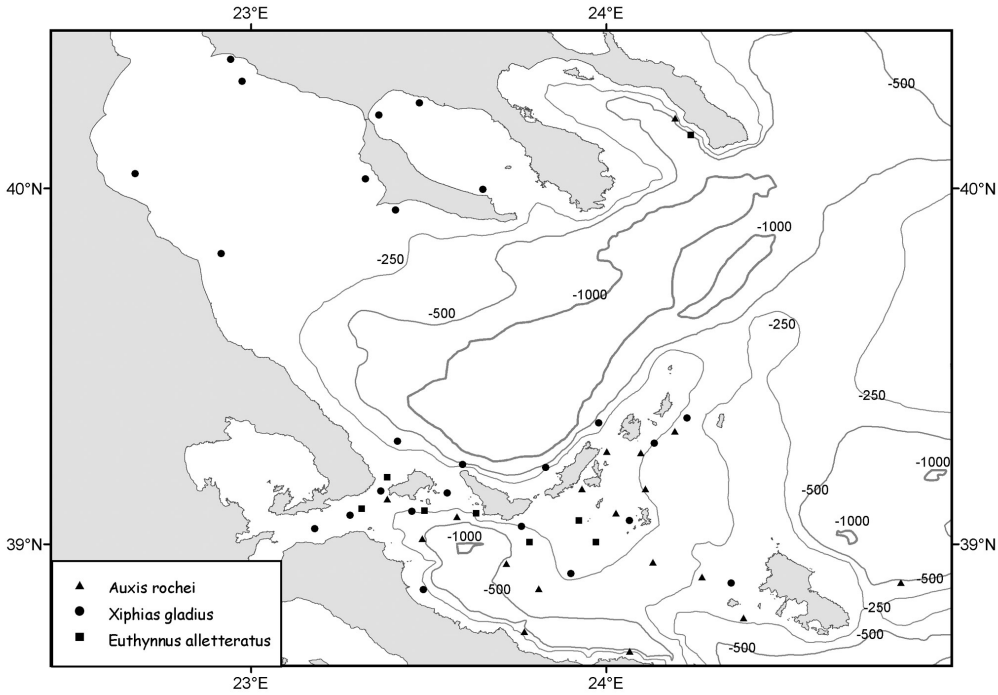

Fig. 2: Stations where eggs and larvae of scombroids were collected.

Table 1
Ichthyoplankton Methot-trawl sampling characteristics and egg and larvae abundance for all fish species (total) and for *A. rochei, E. alleteratus* and *X. gladius*.

Methot trawl				Total		*A. rochei*	*E. alleteratus*	*X. gladius*
Cruise	Number of stations	Type of towing	Sampling period	Number of larvae	Number of eggs	Number of larvae	Number of larvae	Number of eggs
1	9	horizontal	28 July - 4 August 92	761	115	13	4	5
2	5	horizontal	26 August - 22 September 92	870	72	7	0	3

Table 2
Ichthyoplankton Bongo-net sampling characteristics and egg abundance (absolute and relative) for all fish species (total) and for *X. gladius*.

Bongo net				Total		*X. gladius*	
Cruise	Number of stations	Type of towing	Sampling period	Number of eggs	Eggs per $100m^3$	Number of eggs	Eggs per $100m^3$
1	51	oblique	28 July - 4 August 92	7073	14145.0	6	9.4
2	57	oblique	26 August - 22 September 92	4174	8235.8	1	2.4
2	30	horizontal	26 August - 22 September 92	3126	935.7	2	0.8
3	46	oblique	1- 6 July 93	3928	4308.3	14	10.5
4	22	oblique	1- 4 Agust 93	3022	4211.3	9	11.1
5	58	oblique	15 July - 5 Agust 94	3423	5643.3	14	9.4
6	41	oblique	28 August - 2 September 94	1192	1198.8	5	4.9

Table 3
Sampling characteristics, number of larvae and body size (SL) of the species *E. alleteratus, T. alalunga, X. gladius* and *A. rochei* collected during the study.

Species	Sampling gear	Type of towing	Sampling period	Number of larvae	Body length interval (SL,mm)
E. alleteratus	Bongo net	oblique	July-Aug.	6	4.1-10.2
"	Bongo net	horizontal	September	6	5.2- 7.7
"	Methot-trawl	surface	August	4	5.7- 7.2
T. alalunga	Bongo net	horizontal	August	1	4.4
X. gladius	Methot-trawl	surface	Aug-Sept.	2	12.6-15.1
A. rochei	Bongo net	oblique	July-Aug.	198	2.2-10.5
"	Bongo net	horizontal	July-Aug.	136	3.8- 7.1
"	Methot-trawl	surface	July-Aug.	20	5.0-11.0

Euthynnus alletteratus numbered 16 larvae, measuring from 4.1mm (end of July) to 10.2 mm (end of August) (Table 3). Four of these were collected by Methot trawl (Table 1), six by Bongo, during horizontal tows in depths from the surface to 25 m, and six by Bongo, during oblique tows, five of which were conducted to a maximum depth of 23 m and one to a depth of 103 m (Table 4). The distribution area in which this species was collected is reported in Figure 2.

Auxis rochei larvae were encountered more frequently than all the other species. 354 specimens (334 by Bongo, with SL ranging from 2.2 to 10.5 mm, and 20 by Methot trawl, with SL from 5 to 11 mm) were collected during the survey (Tables 1, 3, 4). Most of these specimens were collected during oblique tows conducted till the depth of 20-25 m in the area appearing in Figure 2. Relative abundance values of *A. rochei* larvae peaked in the late August – mid September samplings (Table 4).

Discussion

Of the seven scombroids existing in Mediterranean waters (COLLETTE & NAUEN, 1983; GOLANI *et al.* 2002), we collected eggs and/or larvae of four species (i.e. *Thunnus alalunga, Euthynnus alleteratus, Auxis rochei* and *Xiphias gladius*). At this point it should be emphasized that the young stages of this family are considered difficult to identify to the species level. (RICHARDS *et al.,* 1990). In particular, their eggs resemble the vast majority of perciform eggs and are unknown except for a few species. In the present study, the identification of the larvae to the species level was successful, while in relation to eggs, only those of *X. gladius* were distinguished.

The 59 eggs of *X. gladius* were collect-

Table 4
Ichthyoplankton Bongo-net sampling characteristics and larvae abundance (absolute and relative) for all fish species (total) and for *A. rochei* and *E. alleteratus*.

Bongo net				Total		*A. rochei*		*E. alleteratus*	
Cruise	Number of stations	Type of towing	Sampling period	Number of larvae	Lavrae per 100 m^3	Number of larvae	Lavrae per 100 m^3	Number of eggs	Lavrae per 100 m^3
1	51	oblique	28 July - 4 August 92	4653	11519.0	6	7.5	2	0.2
2	57	oblique	26 August - 22 September 92	3218	5212.6	51	144.0	0	0.0
2	30	horizontal	26 August - 22 September 92	12313	2689.7	136	116.4	6	22.3
3	46	oblique	1- 6 July 93	6007	6454.6	0	0.0	0	0.0
4	22	oblique	1- 4 Agust 93	2953	3669.2	4	10.7	0	0.0
5	58	oblique	15 July - 5 Agust 94	6066	7077.0	32	27.6	3	3.2
6	41	oblique	28 August - 2 September 94	3443	3258.7	105	94.0	1	0.9

ed during the three years of the survey, from early July till the end of August, while the two post-larvae were caught respectively in early August and in mid-September 1992. The latter is in agreement with the findings of other studies on adult swordfish in the east Mediterranean, according to which spawning takes place between June and August, peaking in July (DE METRIO *et al.,* 1989; MEGALOFONOU *et al.,* 1995) and is closely connected to water temperature, the optimum being 23-26˚C (REY, 1988).

T. alalunga was represented by only one larva which was collected in an open sea location in late August 1992. TSUJI *et al.* (1997) have located *T. alalunga* larvae in the western and southern parts of Cyprus. A limited concentration of larvae of the latter species was also found in areas of the west Mediterranean in mid-summer (GARCIA *et al.,* 2002).

E. alletteratus numbered 16 larvae, caught between the end of July and the end of August. These findings are in agreement with other studies reporting the presence of E. alletteratus larvae both in the Aegean (SOMARAKIS *et al.,* 2002) and in the Levantine Sea ORAY *et al.* (2005) Moreover, ALEMANY *et al.* (2006) have found *E. alletteratus* larvae in waters off the Balearic Islands and this would suggest that the species spawns in both the western and eastern Mediterranean, while previously its spawning grounds were considered to be limited only to areas of the central Mediterranean (PICCINETI & MANFRIN, 1994).

A. rochei larvae were encountered more frequently than all the other species and were collected from June till September, with an increasing abundance from late August till mid-September, which possibly suggests that spawning activities in the Aegean peak at mid –to the end of summer. In the north Aegean Sea, SOMARAKIS *et al.* (2002) have found larvae of the species in early summertime, and KOUTRAKIS *et al.* (2004) in July and September. The latter season coincides with the period when *A. rochei* larvae appeared also in ichthyoplankton samples collected in west Mediterranean waters (SABATES & RECASENS, 2001).

Sarda sarda was not collected in the framework of the present study. *S. sarda* appears to migrate for spawning, from the Aegean to the Black Sea in April and returns to the Aegean in October (DEMIR, 1957), which could be the reason for no samples of this species being caught during this survey. In fact, there is a report on the collection of the species' eggs off the coast of Sebastopol in the Black Sea, during an ichthyoplankton survey, performed from May till September 1986 (KLIMOVA, 1990). On the other hand, according to SABATES and RECASENS (2001) a small abundance of the species' larvae was found in west Mediterranean waters (Catalan coast) in mid-summer; these authors suggest that there is a resident population off the Spanish coast, which, however, does not mix with that of the east Mediterranean.

Regarding *T. thynnus,* although no larvae of the species appeared in our samples, ORAY *et al.* (2005) found a few specimens in waters between Turkey and Cyprus and provided the first evidence that the east Mediterranean, and particularly the Levantine, constitutes a spawning ground for bluefin tuna. According to the latter findings the species spawns a month earlier (mid-late May) in eastern Mediterranean waters as compared to other spawning areas in central and western Mediterranean, and this was attributed to

the warmer seawater temperatures prevailing in the former area. Hence, if the species spawns in particular areas of the north Aegean Sea, and temperatures there reach optimal values earlier in the season (eg May), then tuna larvae might have been missed by the present samplings.

The seventh species of the family, *Scomberomorus commerson,* is an alien species known from the Levantine Sea since 1935 (GOLANI *et al.,* 2006). However, the species did not appear in the samples of the present study, but was recently captured in the south-east Aegean Sea (CORSINI-FOKA & KALOGIROU, current volume).

The present findings provide further evidence that the Sporades Islands' basin is a spawning ground for scombroids. High concentrations of scombroid larvae near islands were also established in the frame of other studies and were connected either to larval transport mechanisms (MILLER, 1979), or increased availability of food (LEIS *et al.,* 1991). ALEMANY *et al.* (2006) demonstrated that spatial distribution of the larvae of scombroids around the Balearic Islands is related to particular mesoscale hydrodynamic features. Moreover, according to ORAY & KARAKULAK (2005) abundance of tuna larvae is considered to be consistent with certain physical oceanographic features, because the main larval populations were found within cyclones. They also suggested that the tuna species spawning locality should be in the vicinity of these areas, since as the currents meander on the peripheries of the cyclonic and anticyclonic systems, they are not expected to carry eggs and larvae from other regions. During summer in the Sporades basin prominent eddies are formed (DURRIEU DE MADRON *et al.,* 1992; KOURAFALOU & BARBOPOULOS, 2003) which could influence the retention of the larvae there, also creating favourable feeding conditions, since certain studies indicated that biomass maxima appeared to be related to hydrographic structures which are known to act as fertilization mechanisms (THIBAULT *et al.,* 1994; ZERVOUDAKI *et al.,* 2007). The above underline the necessity to conduct larger scale spatio-temporal samplings, exploring at the same time the influence of physical environmental factors on the general pattern of the distribution of scombroid larvae in the waters of the northeastern Mediterranean.

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