Juvenile fish populations in two areas of the Sicilian coast

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Abstract. The qualitative and quantitative composition of juvenile stages of fish caught by bottom trawl in 2009, during the period authorized by Sicilian Region, was studied in two areas of Sicilian coasts. The species *Sardinella aurita* appeared more abundant at beginning, but it was gradually substituted over time by *Sardina pilchardus* and *Engraulis encrasicolus*.

Keywords: Strait of Sicily; Tyrrhenian Sea; juvenile fish; qualitative and quantitative composition; fisheries sector.

INTRODUCTION

The first studies on larval fish dates more than one hundred years ago. Raffaele (1887 a, b) was the first to describe the eggs and larvae of more than thirty species. Subsequently similar studies were conducted by Agassiz (1882).

Hensen (1883), McIntosh (1896) and Prince (1890). Then, Lo Bianco (1899) from the Zoological Station of Naples published a paper on the morpho-anatomical changes and physiological growth of larval and juvenile stages.

In subsequent years, eggs and larvae and juvenile fish received very little attention, except for some work on developing larvae from Myctophiphormes (Cavaliere & Berdar, 1976). Today only a few investigators cope with this topic. During the past fifteen years, some studies have been conducted on the qualitative composition of juvenile fishing (Lo Piano et al., 1992, Relini et al., 1996; Costa, 1999; Cefali et al., 1997; Romanelli & Giovanardi, 1993). But studies on this field are to be encouraged; because the juvenile stages of marine organisms have a great significance in the marine food chain.

The guidelines adopted for this study are those proposed in 2006 by the Italian Society of Marine Biology "Checklist della fauna marina italiana" (G. Relini publisher), which states that the term "juvenile" refers to the juvenile stages of fish with length less than seven centimetres at the time of capture (Lo Bianco, 1910). The name of Bianchetto ("whitish") refers to organisms that are diaphanous and devoid of pigmentation. Only when they reach the length of 4-5 cm the pigmentation appears.

Fishing for juvenile fish is made with a bottom trawl, formed by two long wings and a small mesh (1-2 mm) bag. In this fishing system, used for over a century, the net is being launched as soon as the swarms of juvenile fish are spotted, while at the same time the boat makes a wide curve around.

The European Community, which regulates fishing in all Mediterranean Sea (EEC Reg-

ulation 850/1998; Reg EC 1967/2006, EU Reg 23/2010) granted in its directives, power to authorize the opening of fishing juveniles in suitable periods. The Sicily Region (Region with special status) has used this authorization until 2010 establishing the periods of fishing juveniles with appropriate Regional Decrees yearly. The year in which we conduct this study (2009), the fishing season for juveniles were fixed between on 12/01/2009 and on 12/03/2009 (Regional Decree 01/Pesca, 09/01/2009) with an extension up to 22/03/2009 (Regional Decree 03/Pesca, 12/03/2009).

Two areas were selected to conduct the study: the Gulf of Patti, that is part of the northern coast of Sicily, overlooking the southern Tyrrhenian Sea, and the Gulf of Sciacca, along the southern coast of Sicily on the Strait of Sicily.

The waters of the southern Tyrrhenian Sea are influenced by Atlantic water, flowing from the Straits of Sardinia along the northern coast of Sicily. In fact, the average salinity is around 37.6 ‰, with temperatures around 18° C (Sparnocchia et al., 2009; Astraldi et al., 2002; Sanfilippo et al., 2009). Instead, the waters of the Strait of Sicily on which overlooks the Gulf of Sciacca, are affected by ionic water flowing westward along the southern coast of Sicily. The presence of Levantine waters, moving from the eastern Mediterranean basin to the west, produces an average salinity of around 38.5 ‰ and temperatures around 14° C (Gasparini et al., 2005). Along the southern coast of Sicily, the flow of water produces Levantine coastal upwelling that affect the values of salinity and temperature in these areas.

MATERIALS AND METHODS

Study areas

The study was carried out on two Sicilian coastal areas, the Gulf of Patti (Eastern Tyrrhenian coast) and the Gulf of Sciacca (Strait of Sicily) (Fig. 1).

Sampling and analytical methods

The samples were collected from fishing by local fishermen during the period of permission to fish for juveniles. The fishing system utilized was the bottom trawl for juvenile fishes.

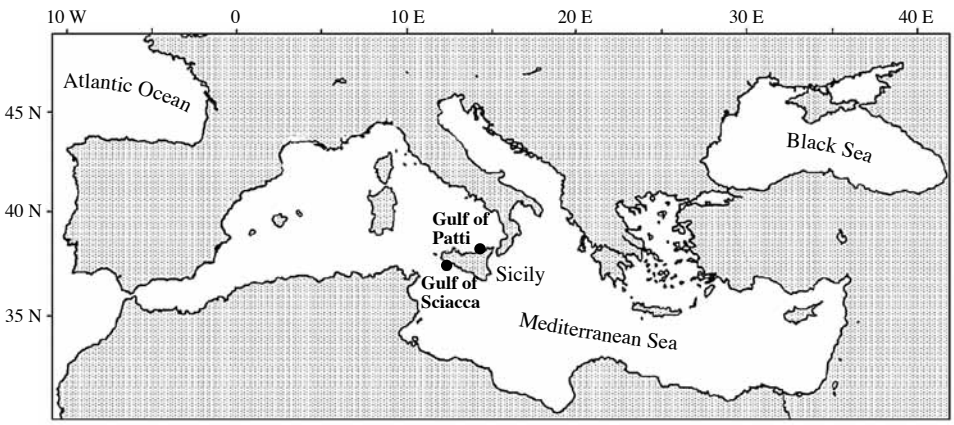

Fig. 1 – Sampling areas (indicated with black points).

The samples on the catch of juveniles were made on nine dates between January and March 2009 for the Gulf of Patti and four dates between February and March 2009 for the Gulf of Sciacca. In the period between January and February it was not possible to carry out sampling in the Gulf of Sciacca due to the adverse weather conditions that prevented the fishing. Therefore we have no data for Sciacca until February 3rd.

A sample of juveniles with an average weight of 120 g, were divided into sub-samples (6-7).

The fishes were gently washed using a sieve. Later they were observed under a stereomicroscope and then photographed. On these, except for injured animals, were made the determinations with the qualitative diagnosis of the species detected, that were listed and expressed as a percentage. Then the fishes were fixed in 70% alcohol.

The data were analyzed statistically with regard to the variability, with both parametric and non-parametric tests (i.e., one-way ANOVA, Spearman test), using WinSTAT (2007.1).

RESULTS

The identified species and their relative abundance in each of the two areas, expressed as a percentage, are reported in Tables 1 and 2.

Sardinella aurita, *Sardina pilchardus* and *Engraulis encrasicolus* are the prevailing species in the samples examined. *Gymnammodites cicerelus* and *Aphia minuta* were found in significant percentages (respectively around 17.24% and 9.19%) only once (12/02/09). Other species were found only sporadically and incidentally.

The three main species were found in similar percentages (around 30%) during the months of February and March in both areas. Instead, in January, *S. aurita* reached 60% of the sample (14 January) and *S. pilchardus* 45% (26 January), while *E. encrasicolus*, in general, did not exceed 20%.

The temporal variation of the three main species is represented in Figure 2 (Gulf of Patti) and Figure 3 (Gulf of Sciacca), as number of individuals detected.

Tab. 1 – Identified species and their percentage distribution in the Gulf of Patti.

	14.01.09	**26.01.09**	**29.01.09**	**05.02.09**	**12.02.09**	**16.02.09**	**23.02.09**	**10.03.09**	**20.03.09**
Sardinella aurita	61.02	32.05	44.05	34.15	27.19	35.50	35.27	34.79	33.70
Sardina pilchardus	16.27	44.89	33.82	32.43	25.36	38.09	36.15	34.83	36.15
Engraulis encrasicolus	22.71	19.97	22.06	29.07	21.02	26.25	28.36	30.31	30.14
Aphia minuta	0.00	2.77	0.00	0.00	9.19	0.00	0.00	0.00	0.00
Crystallogobius linearis	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Blennius ocellaris	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Gymnammodytes cicerellus	0.00	0.00	0.03	2.16	17.24	0.09	0.18	0.00	0.00
Liza aurata	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.00	0.00
Pagellus erythrinus	0.00	0.00	0.00	0.94	0.00	0.03	0,00	0.00	0.00
Pagellus acarne	0.00	0.00	0.00	0.50	0.00	0.00	0.04	0.00	0.00
Scomber scombrus	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Sarpa salpa	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00
Diplodus vulgaris	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00

Tab. 2 – Identified species and their percentage distribution in the Gulf of Sciacca.

	05.02.09	12.02.09	23.02.09	20.03.09
Sardinella aurita	38.81	36.26	38.02	35.42
Sardina pilchardus	35.69	30.30	33.42	27.43
Engraulis encrasicolus	23.99	19.21	28.32	27.43
Gymnammodytes cicerellus	1.51	4.55	0.18	0.00
Aphia minuta	0.00	3.33	0.00	0.00
Liza aurata	0.00	2.87	0.00	0.00
Pagellus acarne	0.00	3.49	0.03	0.00
Pagellus erythrinus	0.00	0.00	0.03	0.00

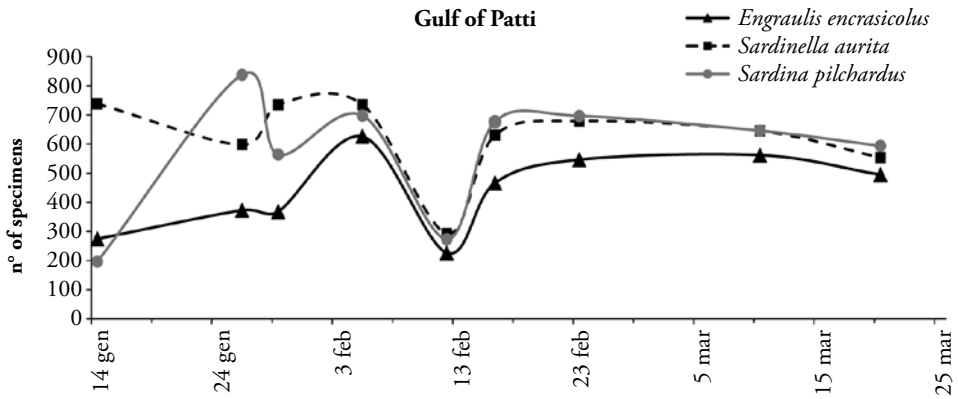

Fig. 2 – Distribution of species (as number of individuals per 100 grams of samples) detected in the Gulf of Patti.

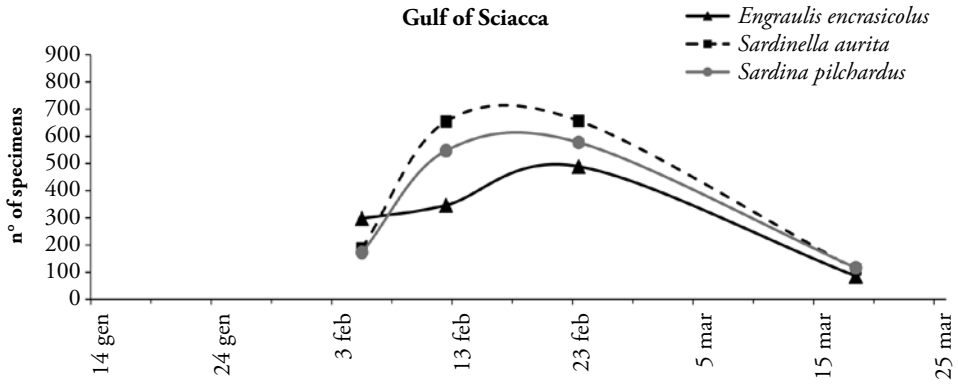

Fig. 3 – Distribution of species (as number of individuals per 100 grams of samples) detected in the Gulf of Sciacca.

As already referred in other papers (Sabatés et al., 2006; Ungaro et al., 1994), despite the incidence of the mortality during the juvenile stage (La Mesa et al., 2009; Sogard, 1997), also in our samplings, *S. aurita* decreased sharply in time till February. Subsequently, the population grows rapidly reaching a nearly constant level of about 600 specimens per 100 grams of sample (Fig. 2). A similar trend was observed in the Gulf of Sciacca (Fig. 3) for the same species during the month of February. After, the population decreased significantly (till to <200 specimens per 100 grams of sample) *S. pilchardus* had a pattern very similar to *S. aurita* in both areas.

Our attention was focused on *E. encrasicolus*, species of great commercial value in the adult stage, analyzing the results obtained. The trend of this species in the two areas was similar to that of *S. aurita* and *S. pilchardus*, from February onwards, keeping values lower than those of the other two species. In previous months, the abundance of *Engraulis* was significantly smaller than the other two species.

To compare the relative abundance of the three species, expressed as a percentage, we

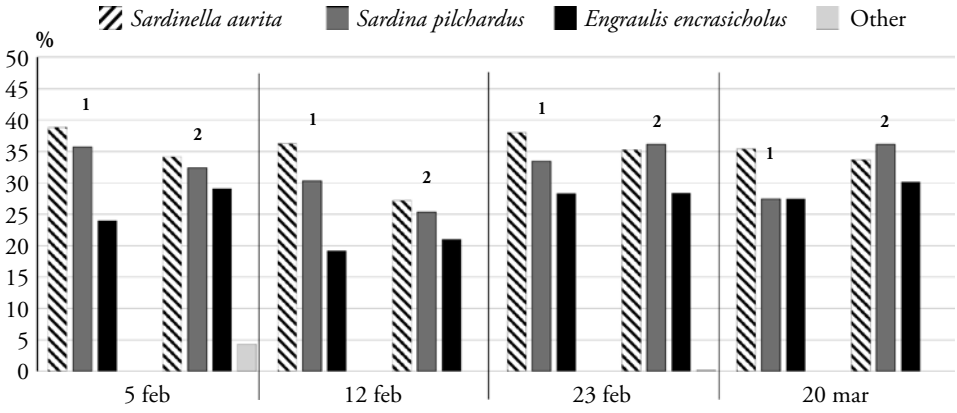

Fig. 4 – Comparison between species found in the Gulf of Sciacca (1) and in the Gulf of Patti (2) in the same dates.

Tab. 3 – Statistical evaluations. μ = mean value; σ = standard deviation; VC = variability coefficient; *n* = number of samples.

		Engraulis encrasicolus	*Sardina pilchardus*	*Sardinella aurita*	Other species
Gulf of Patti	μ	437.51	575.85	623.06	49.44
	σ	135.56	208.76	139.76	94.46
	VC	0.31	0.36	0.22	1.91
	n	9	9	9	9
Gulf of Sciacca	μ	304.80	353.35	402.52	67.08
	σ	167.14	242.57	294.00	126.59
	VC	0.55	0.69	0.73	1.89
	n	4	4	4	4

considered the same dates of sampling in both areas (Fig. 4). The abundance of *Engraulis* than other species becomes similar only at the end of February onwards. Previously, *S. aurita* and *S. pilchardus* prevail for more than 60% of the total.

These differences in populations and between areas, were reported by the statistical evaluations (Tab. 3). In fact, the area of Patti presented higher amounts of total catch. The differences between the two areas can be ascribed to different oceanographic conditions set out in the introduction.

DISCUSSION AND CONCLUSIONS

Results coming from the two fishing areas are quite similar, despite different oceanographic characteristics (Basilone et al., 2004; Cefali et al., 1997). In fact, the waters of the southern Tyrrhenian Sea are influenced by Atlantic water, flowing from the Straits of Sardinia along the northern coast of Sicily. So, the average salinity is around 37.6 PSU, with temperatures is around 18° C (Sparnocchia et al., 2009; Astraldi et al., 2002). The waters of the Strait of Sicily, on which overlooks the Gulf of Sciacca, are instead affected by the flow of ionic water flowing westward along the southern coast of Sicily (Gasparini et al., 2005). This produces an average salinity of around 38.5 PSU and temperatures around 14° C (Sanfilippo et al., 2009).

The percentage of juvenile fish species are almost similar and this may suggest that these are homogeneously distributed along all Sicilian coasts, and probably along all the coasts of the Mediterranean (Somarakis et al., 2002; Stergiou et al., 2002; Lleonart & Maynou, 2003; Bariche et al., 2006; La Mesa et al., 2009; Somarakis & Nikolioudakis, 2007; Campo et al., 2006; Sabates et al., 2007). Still of particular interest, the last sampling in the Strait of Sicily (Gulf of Sciacca), in which, respecting the percentage of the three predominant species, the size of the bodies were significantly increased (up to 4-5 cm). This means that in the month of March, the species have already reached a size not legally fishery.

The European statistics on fishing in the Mediterranean (FAO, 2005) indicate that nominal catches in Area 37 increased from slightly over 0.7 million tons in 1950, to near 2 million tons between 1982 and 1988. Catches subsequently declined steeply to 1.3 million tons as a result of the collapse of the sprat and anchovy fishery in the Black Sea. Total catches have subsequently increased to 1.5 million tons in 2001 and 2002, after some small fluctuations (Lleonart & Maynou, 2003). Small pelagics account for approximately 50 percent of total Mediterranean catches. Anchovy (*Engraulis encrasicolus*) with 59 percent of small pelagic catch, and sardine (*Sardina pilchardus*) with 16 percent are the most abundant. Other small pelagic are sprat (*Sprattus sprattus*), sardinella (*Sardinella aurita*). Taking into account these data and on the basis of our results, it is our opinion that the opening of the fishing to juveniles granted in Sicily in 2009 for the periods previously indicated, had a negative impact on fish stocks of species of big commercial interest (such as anchovy). In fact it engraves just in its larval stages and interdicts the development to adulthood. This not only affects the marine food chain, of which the anchovy is an essential component, but also affects the entire economy of the fishing industry.

Based on data obtained from this study, our opinion is that it would be desirable that the fishing of juveniles will no longer be authorized. But, if this is not possible, it would be desirable to anticipate the opening of the fishery at least one month than that allowed for 2009. This would be benefit to species of greatest commercial interest (anchovy). In fact, prior to the

month of January, relative abundance of *Engraulis* is significantly lower. In contrast, the stock of *S. pilchardus* would be prevalent on the total fishable, because its breeding season begins earlier than that of *Engraulis*.

In 2011 the European Community has not granted exemptions for the opening of juveniles fishing, which was therefore prohibited. It would be desirable that the fishing of juveniles will no longer be authorized. However, if the European Community will decide to reauthorize this fishery, should take into account "Management Plans". This tool will allow, on the basis of studies like the present work, to suggest the best times for fishing not to affect the species of greatest commercial value.

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RIASSUNTO

Novellame di popolazioni ittiche in due aree della costa siciliana

Le ricerche sugli stadi larvali dei pesci sono cominciate dall'inizio del novecento. In seguito le uova, le larve ed i giovanili hanno ricevuto scarsa attenzione, tranne che per alcuni lavori sullo sviluppo di larve. Anche oggi questo settore è poco studiato, nonostante gli stadi giovanili degli organismi marini abbiano grande importanza nella catena alimentare. È stata analizzata la composizione qualitativa e quantitativa di stadi giovanili di pesci catturati durante il periodo di autorizzazione (alla pesca al novellame) in due aree della Sicilia, il Golfo di Patti (costa orientale del Mar Tirreno) ed il Golfo di Sciacca (Canale di Sicilia). Il sistema di pesca utilizzato è quello della sciabica da natante. I campionamenti sono stati effettuati in nove date, tra gennaio e marzo 2009, per il Golfo di Patti ed in quattro date, tra febbraio e marzo 2009, per il Golfo di Sciacca. I risultati di questo studio hanno mostrato un andamento analogo tra le due aree, sia per la composizione delle specie che per la loro incidenza percentuale. La specie più abbondante è risultata sempre *Sardinella aurita* con una diminuzione graduale nel tempo a favore di *Sardina pilchardus* ed *Engraulis encrasicolus*. Quest'ultima viene così colpita dalla pesca proprio nei suoi stadi giovanili, impedendone lo sviluppo fino allo stadio adulto. Essendo tale specie quella a valore commerciale più elevato, la sua cattura negli stadi giovanili provoca grande impatto non solo sulla catena alimentare marina, ma anche sull'economia dell'intera filiera pesca.

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