Distribution, abundance and biological features of picarel (*Spicara flexuosa*), Mediterranean (*Trachurus mediterraneus*) and Atlantic (*T. trachurus*) horse mackerel based on experimental bottom-trawl data (MEDITS, 1994–2002) in the Strait of Sicily

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Abstract

Information was gathered during the international experimental bottom-trawl survey programme MEDITS. Nine years of data (1994–2002), collected during the spring–summer seasons, were analysed in order to determine the horizontal distribution, depth preference, index of abundance and the basic biological features (length composition, sex ratio and size at maturity for females). All the three investigated species showed a marked preference for the continental shelf; they had a wide though not time-oriented, variability in abundance and in the biological features considered. The bulk of the samples were represented by immature or maturing specimens. Given its wider distribution and higher abundance, *Trachurus trachurus* was the most relevant species in respect of its possible interaction with the small pelagic species (*Engraulis encrasicolus* and *Sardina pilchardus*) targeted by the purse-seiners in the Strait of Sicily.

1. Introduction

The small epipelagic neritic species, *Spicara flexuosa*, *Trachurus mediterraneus* and *T. trachurus*, represent a common by-catch of coastal fisheries in the Mediterranean, especially those operating bottom trawlers. These species, although of low commercial value, play an important role at the ecosystem level being either a food source or important predators of other important commercially (Froese and Pauly, 2003).

In particular, the blotched picarel (*Spicara flexuosa* Rafinesque, 1810) is a protogynous hermaphrodite necto-bentonic fish occurring down to 130 m depth (but specimens move regularly in the water column). It is distributed in the eastern Atlantic, the Mediterranean and the Black Sea. In the Mediterranean, individuals of this species reach a maximum size (total length, TL) of 180 mm, for females, and 210 mm, for males; they have a longevity of 4–5 years. Individuals up to 160 mm are generally females, although even primary (small) males and large females can be found in the populations (Relini *et al*., 1999). Spawning occurs mainly in March–April, whereas recruitment is mainly in September. The growth is very fast and the picarel completes half of its potential growth span within the first five months. It feeds on small benthic invertebrates (preferably crustaceans).

The Mediterranean horse mackerel (*Trachurus mediterraneus* Steindachner, 1868) is a pelagic migratory (in large schools) oceanodromous fish occurring between 40 and 500 m depth, though usually near the bottom, but at times also in surface waters. It is distributed in the eastern Atlantic and the Mediterranean Sea, and in the southern and western parts of the Azov

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Sea. In the Mediterranean, this species reaches a maximum size of 400–600 mm and and age of 10–12 years (Stergiou *et al*., 1997; Relini *et al*., 1999). The main spawning and recruitment periods are summer and autumn, respectively. It feeds on other fishes, either larval or adult (especially sardines and anchovies), and small crustaceans.

The Atlantic horse mackerel (*Trachurus trachurus* L., 1758) is a pelagic oceanodromous fish occurring down to 600 m depth (especially in winter), although it prefers coastal areas with sandy substrate, where large schools can be found. It has a wide geographical distribution: eastern and western Atlantic Ocean, Indian Ocean, western Pacific Ocean and the Mediterranean Sea (including the Sea of Marmara and the Black Sea). In the Mediterranean, this species attains a maximum size of 300–600 mm and an age of 11 years. Females are batch spawners, with an extended spawning period, though with a peak in spring (Tsangridis and Filippousis, 1991; Campillo, 1992; Stergiou *et al*., 1997). Recruits concentrate mainly in spring and summer. The growth is very fast and the Atlantic horse mackerel completes half of it potential growth span within the first year of life (Campillo, 1992). The feeding habit of this species is similar to that of its congener *T. mediterraneus*.

In this paper, information on the distribution, abundance and basic biological features of the populations off the southern coast of Sicily are reported, with a view to obtaining, for the first time, an overall picture of the general characteristics of these stocks. Comparison is made with the homologous data for the northern Mediterranean populations within the framework of the SAMED programme (SAMED, 2002).

2. Materials and methods

Data were gathered during nine (from 1994 to 2002) spring–summer experimental trawl surveys carried out under the international programme MEDITS; in particular, a common protocol was adopted and the demersal resources of a large part of the Mediterranean (from the Alboran Sea to the water around Crete) was monitored (Abello *et al*., 2002). An *ad hoc* (GOC 73) trawl was utilized; it was only slightly modified after the 1994 and 1995 surveys, by reducing its vertical opening from 3 to 2.5 m; Fiorentini *et al.*, 1999). In the Strait of Sicily, the same trawler (F.V. "S. Anna") was employed to perform half-hour (shelf) and one-hour (slope) hauls; methodological details and further information on the MEDITS programme can be found at http://www.sibm.unige.it/.

Data were elaborated following the methodological framework developed within the international programme SAMED (SAMED, 2002). First, the frequency of occurrence (% of positive hauls), mean abundance indexes by number (DI, N/km^2) and by weight (BI, kg/km^2), and the corresponding coefficient of variation (CV%) were estimated for the shelf (10–200 m depth) and slope (201–800 m depth) strata. The average individual weight (g, grams) was obtained as the BI/DI ratio. For successive analyses, the whole sample was considered instead. Overall and by sex (males, females and unsexed) median length, sex ratio (Sr=F/sexed animals), and mean size of females by maturity stages (1, immature; 2, maturing; 3, mature; 4, spent) were hence computed. Thereafter, the length–frequency distribution (LFD) for females and for males was obtained, after having distributed the unsexed specimens according the average Sr value of the first three classes with representative (>30) sexed specimens. To allow a proper comparison, the LFD were standardized to an arbitrary surface of 10 km^2.

All computations were implemented with a specific software (SEA-TrIM) developed by MaLiRA Group.

3. Results

Spicara flexuosa

Apart from a handful of specimens found in deep water, this species was caught almost exclusively on the shelf (Figure. 1) indicating a more restricted preferential depth range of 50–100 m (Figure. 2). Considering only the shelf data, the positive hauls ranged between 62 and 82%, without any temporal trend.

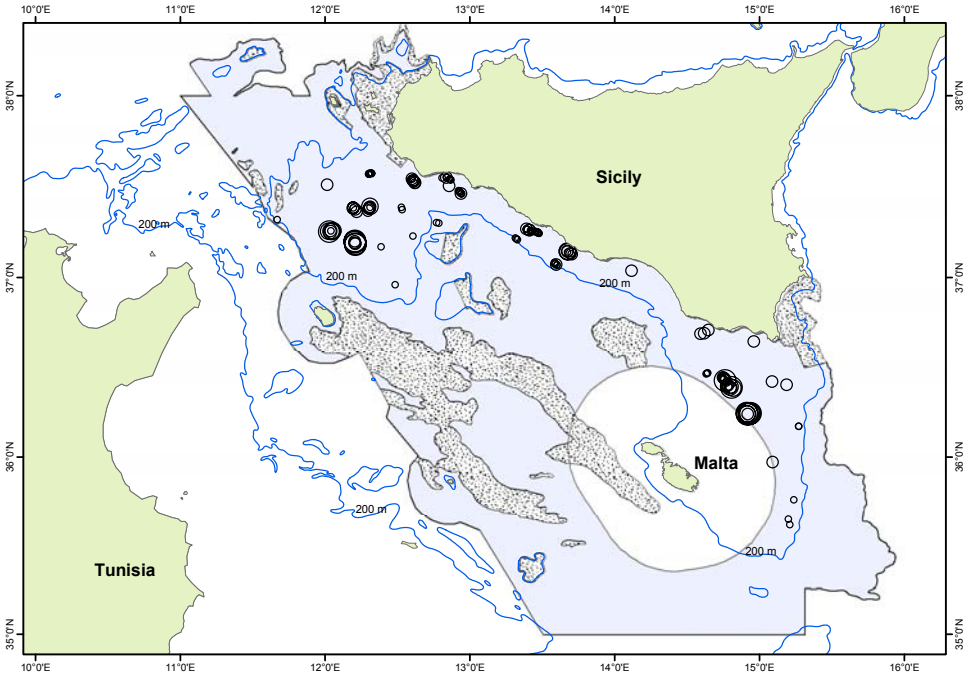

Figure 1. Density (DI=N/km^2) distribution for *Spicara flexuosa* (1994–2002, average) in the Strait of Sicily.

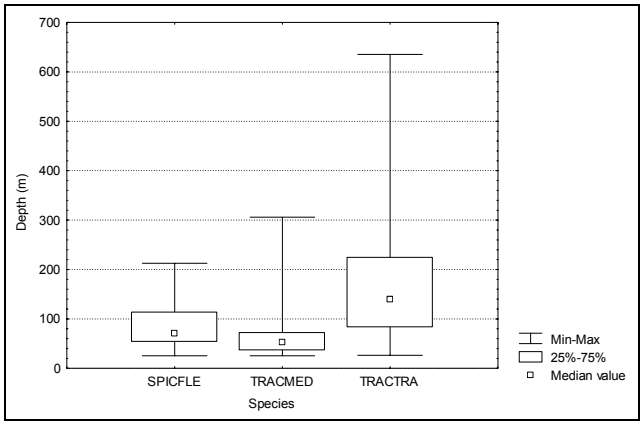

Figure 2. Depth occurrence of *Spicara flexuosa*, *Trachurus mediterraneus* and *T. trachurus* in the Strait of Sicily.

The DI (Figure. 3a) ranged from 830 to 5,907; the highest values were observed in 1994 (DI=5,907) and 2000 (DI=4,795); the CV range was 24–71%. The mean BI ranged between 21.2 and 87.0 (Figure. 3b), whereas the corresponding CV range was 21.2–54.3. A decreasing, though not significant, temporal trend was observed for both DI and BI. The range of mean weight was 12–27 g, with no trend (Figure. 3c).

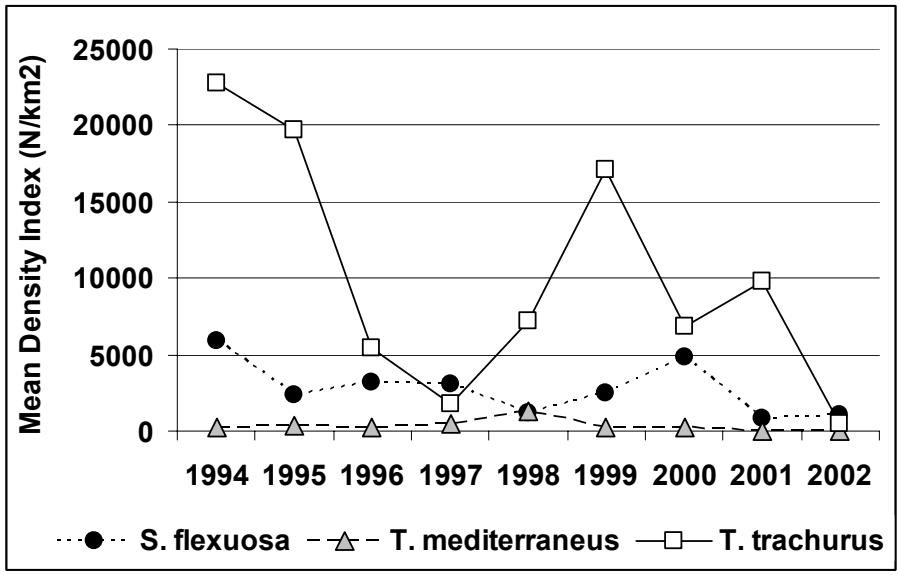

Figure 3a. Mean density index (DI=N/km^2) of *Spicara flexuosa*, *Trachurus mediterraneus* and *T. trachurus* in the Strait of Sicily (shelf).

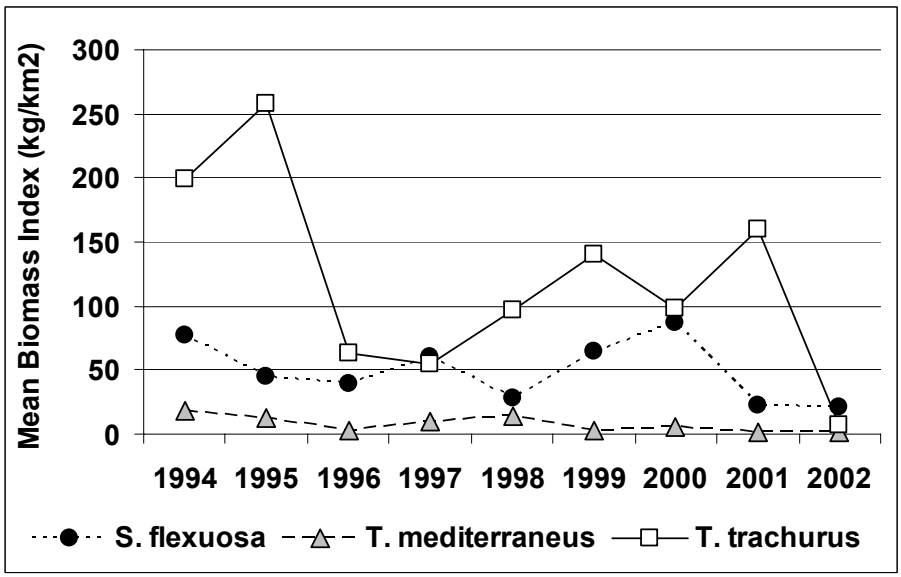

Figure 3b. Mean biomass index (kg/km^2) of *Spicara flexuosa*, *Trachurus mediterraneus* and *T. trachurus* in the Strait of Sicily (shelf).

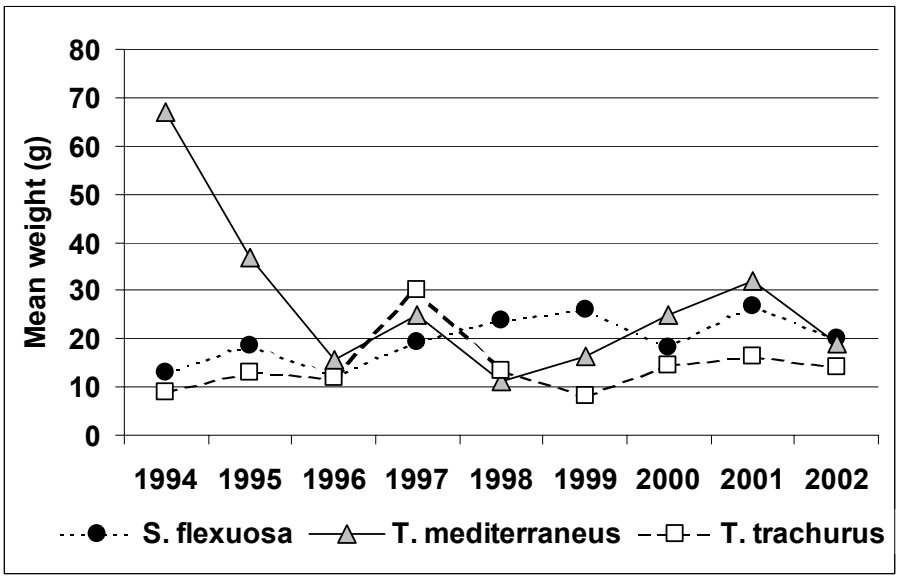

Figure 3c. Mean weight (in grams) of *Spicara flexuosa*, *Trachurus mediterraneus* and *T. trachurus* in the Strait of Sicily (shelf).

Overall, 19,955 specimens were examined, resulting in a yearly median length between 90 and 130 mm. The sex of 41.5% (8,282) of the specimens could not be determined (i.e. unsexed). Males showed a higher median length than females (140 versus 110 mm), although the maximum sizes were very similar (210 versus 200 mm).

The overall Sr was 0.80, without any trend. The Sr by size-class showed a significant (r^2=0.94) increase in the proportion of males above a length of 80 mm; these results are consistent with the sexual characteristics of this species (proterogynous hermaphrodite), since females are generally found up to 160 mm length (Relini *et al*., 1999).
All the four maturity stages were always irregularly represented, although the stages 3 and 4 comprised only a few females (171 and 8 specimens, respectively). The bulk of the sample was represented by immature (14,462 in stage 1) and maturing (1,263 in stage 2) individuals. The maturity stages were poorly discriminated by the corresponding size structures; the mean size of the females at stage 3 (140 mm) was slightly above the corresponding value in the literature (~120 mm; in Relini *et al*., 1999).

The length–frequency distributions (LFD) were very variable in the period studied (Figure. 4), without any particular temporal pattern. Male and female LFDs showed the same basic typology: skewed (right-tailed) with a platycurtic (flattened) peak, with variable modal length between years. In 1994 and 1995, the LFDs of the two sexes overlapped (peak at about 100 mm), whereas, in the other years, male LFDs were biassed towards the large size-class (modal length around 110–120 mm and 130–170 mm in females and males, respectively). The maximum displacement was detected in 2002, when the modal length was 120 and 170 mm for females and males, respectively.

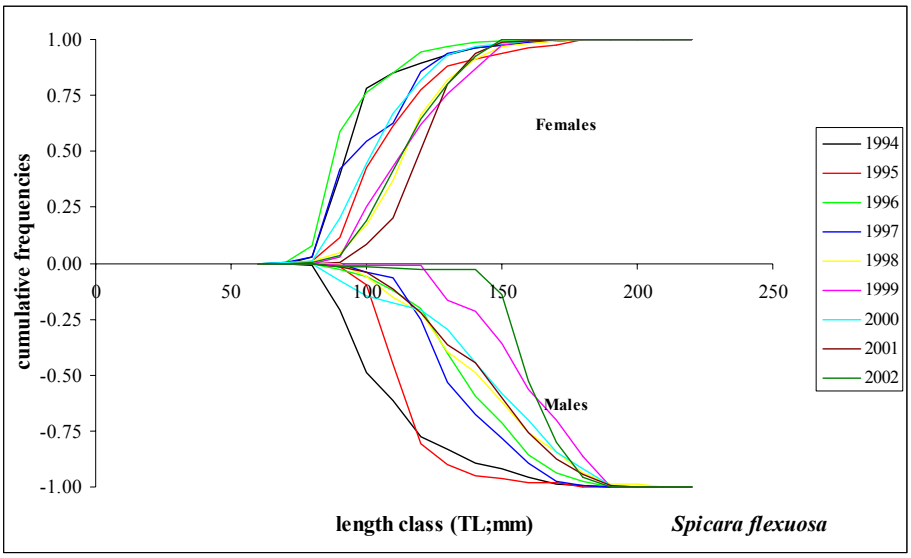

Figure 4. Relative length–frequency distribution by year for females and males of *Spicara flexuosa*

Trachurus mediterraneus

Although captures were scanty in the upper part of the slope (down to 300 m depth), it was caught on the shelf over practically all the investigated area (Figure. 5), though with a narrower preferential depth range (20–80 m) (see Figure. 2), which is close to the preferential depth reported by Relini *et al*. (1999). Frequency of occurrence oscillated around 30% of the hauls (range: 22–35%).

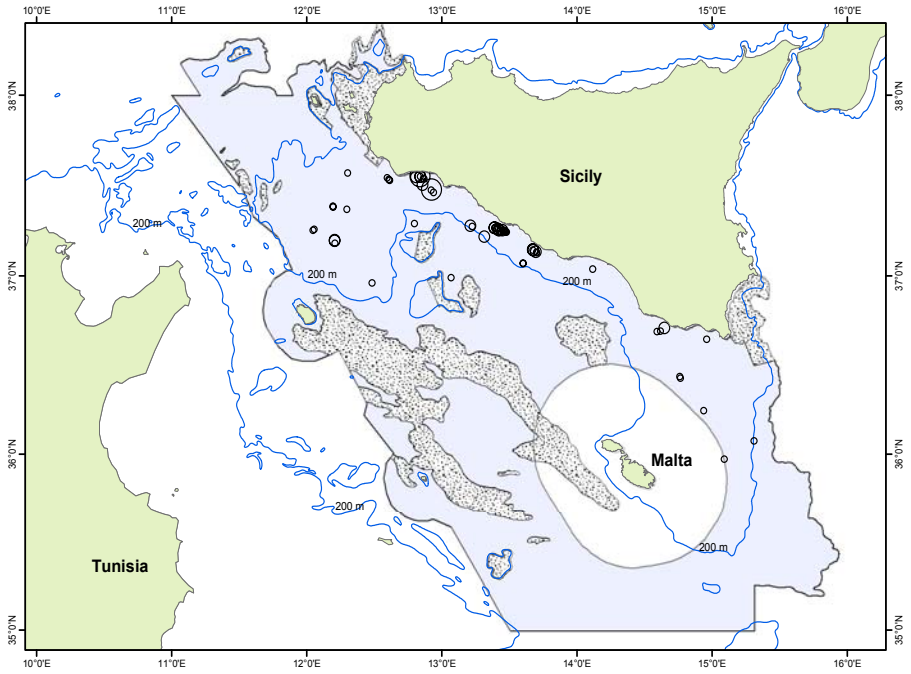

Figure 5. Density (DI=N/km^2) distribution for *Trachurus mediterraneus* (1994–2002, average) in the Strait of Sicily.

The mean DI (see Figure. 3a) ranged irregularly between 203 and 415, with the exception of 1998 (DI=1,282) and 2001–2002 (DI=47–50); the CV varied from 44 to 62%. The mean BI (see Figure. 3b) went from 1.0 (CV=38%), in 2002, to 18.2 (CV=68.0%), in 1994. An irregular decreasing, though not significant, trend characterized the BI. Excluding the 1994 value (65 g), the range of mean weight was 11–35 g, with no trend (Figure. 3c).

Overall, 3,417 specimens were examined, giving a median length by year between 80 and 160 mm; the sex of 57.8% (1,976) of the specimens could not be determined (i.e. unsexed). Although the maximum size was higher in females (430) than in males (390 mm), the latter were almost as large as females (130 versus 140 mm, median length); the largest specimens (>350 mm) were observed only in the first survey (1994).

The mean overall Sr was 0.39, with a very irregular evolution over the years (0.20–0.72). Considering the sex ratio by size-class (up to 140 mm), males were more abundant than females (about 65%); thereafter, the latter become more abundant (Sr 67% at 220 mm).

As regards maturity, the first three stages occurred in each year, with some variability, but only the first two were consistently represented. Maturity stages were characterized by different length structures (136, 211 and 207 mm for stages 1, 2 and 3, respectively). The mean size of mature females (207 mm) fell at the lower limit of the range reported in the literature (200–230 mm; Campillo, 1992; Stergiou *et al*., 1997; Relini *et al*., 1999).

Length–frequency distribution (LFD) showed high variability (Figure. 6), but without any temporal pattern. Male and female LFDs showed the same basic typology: two main components with a modal length between 120–130 and 170–220 mm, depending on the year. A scanty component of large female specimens (380 mm) was observed in 1994, whereas a "juvenile" (80 mm) peak was clearly detected in 1997. Hence, three components characterized the LFD of males and females, the latter showing the possible presence of a fourth component.

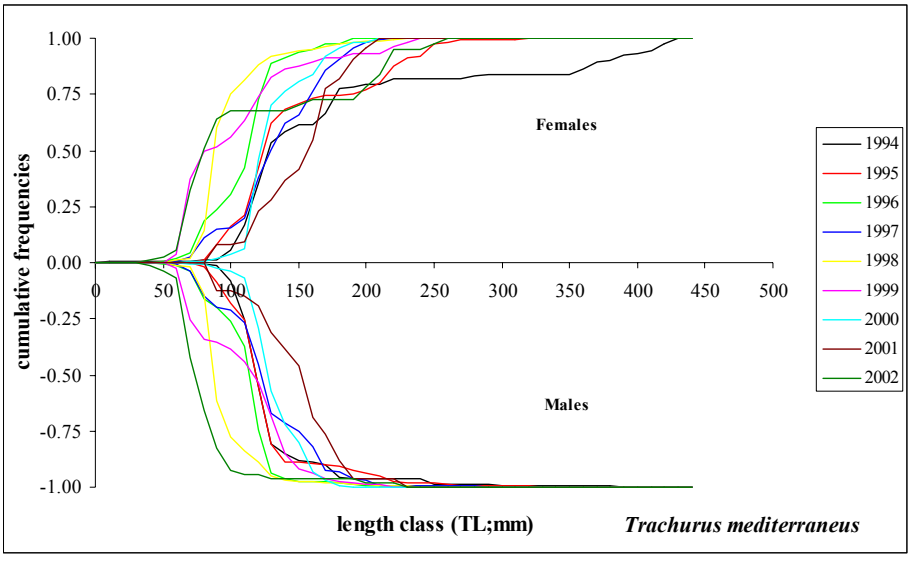

Figure 6. Relative length–frequency distributions by year for females and males of *Trachurus mediterraneus*.

Trachurus trachurus

Some catch of this species was recorded also in deep water (down to 600 m depth or more), especially in the first two years. Overall, it occurred exclusively on the shelf (see Figure. 2), showing a preference for the external edge (100–200 m) off the southern coast of Sicily (Figure. 7).

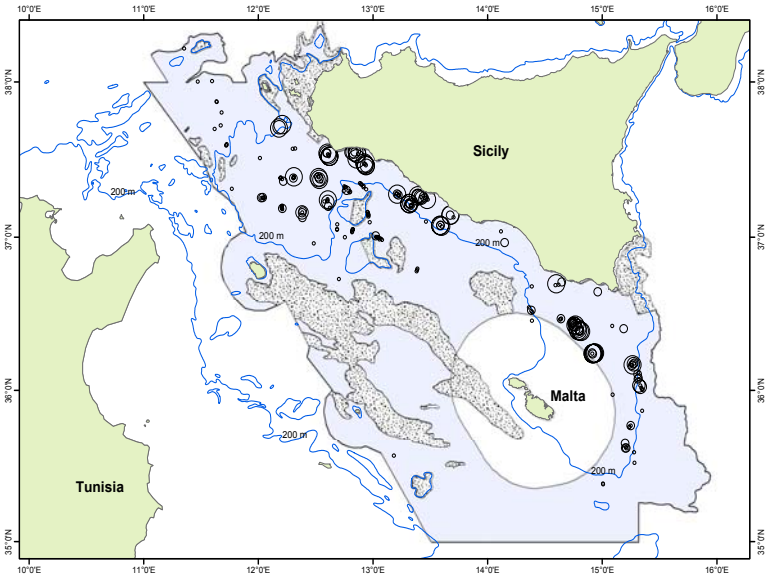

Figure 7. Density (DI=N/km^2) distribution for *Trachurus trachurus* (1994–2002, average) in the Strait of Sicily.

A temporal discontinuity was evident in the frequency of occurrence; on the shelf, it went from 96–100% in 1994–95 to 74-87% thereafter. A similar pattern was observed also on the slope: from 40–36% in 1994–95 to 21–32% between 1995 and 2001, and a minimum of 10% in 2002.

A sharp negative trend characterized the slope abundance; the mean DI went from 2,045–2,989 in 1994–95, to a few hundred (in 1996–97) and to few (in 1998–2002) specimens. The CV was very high (43–93%), especially in the years of high abundance (93–79%).

Considering the shelf (see Figure. 3a), the mean DI peaked in 1994 (DI=22,702; CV=28%), 1995 (19,657; CV=25%) and 1999 (17,049; CV=63%), whereas the values ranged between 1,813 and 9,768 (CV=42–55%) in the other years, except 2002, when the minimum DI (502; CV=22%) was observed.

A similar pattern also resulted for the abundance in weight. On the slope, the mean BI went from 94.4–129.3 in 1994–95 to 16.1–15.5 (in 1996–97) and about 2 (in 1998–2002). As expected, the minimum BI (0.5) was observed in 2002. The CV was very high (35–92%).

Considering the shelf, the highest mean BI (199.0–257.6 kg/km^2) was detected in 1994–95 (see Figure 3b). Intermediate values (140.0–159.7) occurred in 1999–2001, whereas low values characterized the other years (with a minimum of 7.1 in 2002). The CV was very high

(43–93%). The range of mean weight (considering only the shelf) was 8–30 g, with no trend (see Figure 3c).

Overall, 118,447 specimens were examined, producing median lengths from 90 to 150 mm, depending on the year; the sex of 74.1% (87,783) of the specimens could not be determined (unsexed). Although the maximum size was higher in females (430 mm) than in males (410 mm), the latter were as large as the former (160 mm) in terms of median length. The mean overall Sr was 0.60, with a very irregular evolution over the years (0.38–0.78). No size effect was detected.

As regards maturity, all the four stages occurred irregularly in each year, but only the first two were consistently represented. Maturity stages 1, 2 and 3 overlapped, showing a similar mean (155, 166 and 185 mm) length. The mean size of the females at stage 3 (185 mm) was lower than the available literature data on this species (210–230 mm; Campillo, 1992; Stergiou *et al*., 1997).

The length–frequency distributions (Figure. 8) were very variable over the study period, without any particular temporal pattern; the LFD of 1997, however, showed some particular feature as a consequence of the reduced presence of small-sized specimens. Also for this species, males and females showed the same basic LFD typology: two main components with modal length between 80–100 and 160–180 mm in different years. In some years, a secondary pulse, with a peak at about 70 mm, was detectable in the first component.

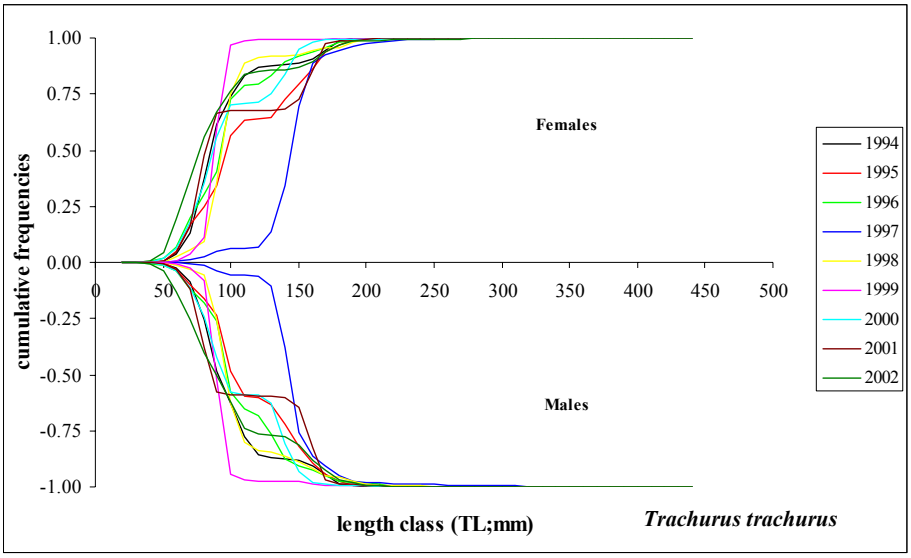

Figure 8. Relative length–frequency distribution by year for females and males of *Trachurus trachurus*.

4. Discussion

In spite of a common preference for the shelf, present results highlight a patchy distribution of the investigated species in the Strait of Sicily. *T. trachurus* was the most frequent and abundant species, which likely reflects both a higher efficiency of the MEDITS gear for *T. trachurus* (Fiorentini *et al*., 1999) and true biological effects, such as a habitat preference in *S. flexuosa* and different behaviour in *T. mediterraneus* (Relini *et al*., 1999).

Another evident common feature observed was the highly irregular temporal development of almost all the parameters considered, as expected for short-lived (*S. flexuosa*) and highly oceanodromous (*Trachurus* spp.) fishes; the abrupt decline in both the abundance and the mean weight of *T. trachurus* does not, in fact, reflect a true negative trend, but the reduction of the vertical opening of the MEDITS gear after 1995 (Fiorentini *et al*., 1999). Considering that large fish were caught only before this reduction, it is highly probable that these specimens are able to avoid capture, representing a safety valve for stock maintainance.

As concerns a comparison over a wider area of the Mediterranean than the Strait of Sicily, no comparable data were available, since these species are seldom or never the object of systematic and regular monitoring. Moreover, data are often reported as "mixed" (for example, *Trachurus* spp.; Campillo, 1992). Practically, the only comparable data are those in the SAMED report (SAMED, 2002), which are summarized in Tables 1, 2 and 3 for areas in which the species were more abundant.
Spicara flexuosa (Table 1) - the relevant SAMED data confirm this species' almost exclusive preference for the shelf; small captures on the upper slope were, in fact, recorded only in the Ionian Sea. Only this macrostratum will be considered hereafter. The percentage of positive hauls in the Strait of Sicily (62–82%) was among the highest in the Mediterranean Sea. Comparable frequency of occurrence was observed in Corsican (60–80%) and Sardinian (48–84%) waters, northern Sicily (71–93%) and Cretan waters (67–100%).

Table 1. Main biological information, by area, of *Spicara flexuosa* (%=percentage of positive hauls; *DI* density index in N/km^2; *BI* biomass index in kg/km^2; median length in mm: upper range is combined sexes, lower values are for females and males, respectively; *SR* sex ratio expressed as F/(F+M); size at maturity = mean length of mature females in mm ±1 standard deviation)

Areas	*Spicara flexuosa*					
	%	**DI**	**BI**	**Median length**	**SR**	**Size at maturity**
Spanish coast	27–60	89–368	2.1–10.9	110–140 120; 180	0.80–0.94	146.2±26.1
Corsica	60–80	751–2727	22.8–73.1	130–140 130; 140	0.57–0.96	135.5±10.7
Sardinia	48–84	575–1102	16.8–33.3	120–150 140; 150	0.58–0.68	134.0±10.8
Ligurian and Tyrrhenian	54–69	406–1095	5.3–12.7	90–120 110; 140	0.66–0.89	114.4±14.1
Northern Sicily	71–93	524–2192	13.7–65.6	120–140 130; 170	0.75–0.86	153.0±20.5
Western Ionian	57–63	475–1855	11.4–44.5	-	0.79–0.88	120.0±14.5
Eastern Ionian	32–55	263–1048	8.6–38.1	120–130 120; 140	0.47–0.74	n.a.
Aegean	38–49	541–855	12.9–23.4	130 130; 140	0.60–0.72	112±14.9
Crete	67–100	201–1935	4.5–37.2	100–120 110	0.63–0.90	n.a.

Present data are also in agreement with the irregular temporal pattern in the indexes of abundance: a decreasing, but not significant trend, was evidenced only in a few of the SAMED areas. Considering only the mean BI, and excluding the Adriatic and Alboran Seas, the maximum values were lower than those observed in the Strait of Sicily. As concerns length–frequency distribution, a high similarity was evident in all the SAMED areas. The overall (all specimens pooled) median length varied between 90 mm and 150 mm. Regarding sex, unsexed specimens were, overall, poorly represented in all areas, whereas females regularly outnumbered males.

Generally, females were slightly smaller than males. The maximum size (in millimetres) were in the range 170–230 mm for females (Aegean Sea, Spanish coast), and 190–240 mm for males (Crete, Greek continental coast).

As a rule, all the four maturity stages were irregularly present and not characterized by different length–frequency distributions; however, the bulk of examined specimens falls within the first two stages (one exception was found in Sardinia). The size at maturity (stage 3) ranged from 112 mm (Aegean) to 153 mm (northern Sicily), values which embraced the value (140 mm) obtained in the Strait of Sicily.

Trachurus mediterraneus (Table 2): Although some captures were recorded on the upper slope of many SAMED areas (off the Italian Tyrrhenian continental coast, Adriatic, Greek continental coast, Crete and Aegean), the bulk of this species was sampled on the shelf; consequently, only this macrostratum will be considered hereafter. The percentage of positive hauls of the Strait of Sicily (22–35%) was lower than that computed for most of the SAMED areas. Comparable frequency of occurrence were observed only in the Alboran (10–30%) and Ligurian and Tyrrhenian (32–48%) Seas.

Table 2. Main biological information, by area, for *Trachurus mediterraneus* (% = percentage of positive hauls; *DI* density index in N/km^2; *BI* biomass index in kg/km^2; median length in mm: upper ranges are for combined sexes, lower values, females and males; *SR* sex ratio expressed as F/(F+M); size at maturity = mean length of mature females in mm ±1 standard deviation).

Areas	*Trachurus mediterraneus*					
	%	**DI**	**BI**	**Median length**	**SR**	**Size at maturity**
Spanish coast	47–67	214–853	28.1–8.1	70–160 150	0.48–0.58	205.6±36.7
Gulf of Lions	30–64	57–268	1.5–10.3	130–190 190	0.46–0.62	224.5±30.7
Corsica	30–100	248–4181	24.2–73.9	110–220 150;140	0.35–0.47	188.7±43.0
Sardinia	22–50	32–264	0.8–7.5	110–140 170;140	0.25–0.52	180.1±28.2
Ligurian and Tyrrhenian	32–48	230–977	8.7–25.3	120–170 150	0.43–0.63	198.2±31.8
Western Ionian	26–65	46–1,264	2.1–31.9	120–160 130	0.41–0.61	175.0±30.7
Eastern Ionian	38–73	89–1,260	1.2–21.5	70–170 170;150	0.32–0.53	184.0±24.0
Aegean	34–55	48–2,305	1.4–40.8	90–170 160;150	0.33–0.66	171.0±24.7

As concerns the BI, the maximum values fall within the range 4.0 (Alboran Sea) and 73.9 (Corsican water); consequently, the estimate in the Strait of Sicily (18.2) is close to the lower limit. An increasing trend has been detected in three areas, the Tyrrhenian and Ionian Seas, and the Greek continental coast, but only the latter was significant (r2=0.72).

As concerns the length–frequency distribution and other biological features, no analysis was performed within the SAMED project for the Alboran, southern Tyrrhenian (northern Sicily), Adriatic Seas and Cretan water, given the weak and irregular presence of the species.

For the other areas, the overall (all specimens pooled) length–frequency distributions were not stable from year to year, showing a wide range of median length (70–170 mm), similar to that reported in the present paper (80–160 mm). Females and males showed the same or almost coincident median length, although with different values according to area.

Considering sex, with the exception of Sardinian water and the Ionian Sea, unsexed specimens were generally well represented. Females and males were in fairly equal number. The lowest values were observed in Sardinia.

Considering the sex ratio by size-class, no evident effect was generally found and only a slight increase in the number of females in the larger size-classes was found in few areas (for example, the Gulf of Lions).

The maximum size (in millimetres) were in the range 230–440 for females (Spanish coast, Crete), and 230–430 for males (Spanish coast, Tyrrhenian).

As regards maturity, all the four stages were present, but in most areas only the first three stages occurred consistently in each year. The maturity stages were characterized by slightly different length–frequency distributions. Attempts to fit a logistic curve gave heterogeneous results (from 144 mm, for Sardinian water, to 198 mm, in the Gulf of Lions. The size at stage 3 was lower than that reported in the present paper (207 mm) for the Strait of Sicily, in contrast to the value for the Gulf of Lions (224.5 mm).

Trachurus trachurus (Table 3): Although some captures were recorded on the upper slope of almost all the SAMED areas, both the highest frequency of occurrence and the abundance indexes were recorded for the shelf; consequently, only this macrostratum will be considered hereafter.

Table 3. Main biological information, by area, of *Trachurus trachurus* (% = percentage of positive hauls; *DI* density index in N/km^2; *BI* biomass index in kg/km^2; median length in mm: upper ranges are for combined sexes, lower values, females and males; *SR* sex ratio expressed as F/(F+M); size at maturity = mean length of mature females in mm ±1 standard deviation).

Areas	*Trachurus trachurus*					
	%	**DI**	**BI**	**Median length**	**SR**	**Size at maturity**
Alboran	50–90	195–4,390	6.2–118.1	75–150 160	0.24–0.65	262.1±60.8
Spanish coast	76–92	633–3,415	7.4–39.8	80–90 160;170	0.47–0.60	199.6±17.1
Gulf of Lions	71–98	983–10,646	10.1–98.7	70–100 190;180	0.25–0.52	332.2±74.2
Corsica	38–70	943–7,778	16.7–254.0	80–200 200	0.43–61	254.7±20.1
Sardinia	83–95	1804–5,728	11.6–40.3	60–90 150;160	0.47–0.89	236.7±72.0
Ligurian and Tyrrhenian	25–51	102–1,414	1.6–19.5	80–100 220	0.20–0.46	236.7±82.4
Northern Sicily	36–86	836–12,319	15.1–175.8	90–160 170;160	0.40–0.72	195.7±29.9
Western Ionian	58–96	800–7,981	18.3–55.0	n.a.	0.47–0.78	281.0±69.6
Southern Adriatic	87–100	1621–6,599	12.6–38.7	60–90 250;170	0.23–0.71	324.0±45.8
North-central Adriatic	65–90	189–2,153	3.3–13.3	80–120 180;170	0.26–0.62	277.0±76.0
Eastern Ionian	23–73	707–2,889	9.9–28.4	70–100 200	0.31–61	n.a.
Aegean	53–73	395–4,636	2.9–77.0	70–100 190;180	0.39–0.61	201.0±83.2

T. trachurus was widespread over almost all the shelf area covered by SAMED, with a range in the percentage of positive hauls similar to that observed in the Strait of Sicily (74–100%).

As concerns the BI, SAMED data confirm the general lack of any specific pattern; a negative, though not significant, trend was detected only in two areas (Alboran Sea and Corsican water). The maximum values fall within the range 13.3 (northern Adriatic) and 254 (Corsican); consequently, the highest estimates in the Strait of Sicily are higher than the upper limit of the SAMED values.

The overall (i.e. all specimens pooled) length–frequency distribution was generally not stable in the different areas, showing a wide fluctuation in median length (60–200 mm). Females and males showed the same or almost coincident median length, although with different values according to area.

Considering the sex, unsexed specimens were generally well represented. Females and males were in fairly equal number: the Sr went from 0.48 (Alboran) to 0.57 (Spanish coast). The lowest values were observed in Gulf of Lions and the Ligurian and Tyrrhenian Seas.

Considering the sex ratio by size-class (millimetres), there was a slight predominance of females, but in variable length ranges: in the Gulf of Lions (120–280 mm), Tyrrhenian (120–160 mm), Ionian (100–220 mm), southern Adriatic (240 mm) and Aegean Sea (200 mm).

Maximum size (millimetres) was in the range 310–460 mm for females and 220–480 mm for males; the minimum and maximum values were observed in Cretan water and the Aegean Sea, respectively.

All four stages of maturity were identified, with high irregularity within years, owing to the low number of females examined. The size at stage 3 ranged from 200 mm (Spanish coast) to 324 mm (southern Adriatic), values larger than those reported in the present paper (185 mm) for the Strait of Sicily.

5. Conclusions

Present results are the first systematic source of information for these three species, which share an ecological and overall potential commercial interest. Although some variability hampered a detailed interpretation of the collected information, it is evident that at least part of this variation does reflect the true adaptability to the variable (environmental and man-made) conditions in the different areas. If this hypothesis is confirmed, a meta-analysis, including also the growth and mortality assessment, might help in improving knowledge of these species. For the epipelagic resources of the Strait of Sicily, meanwhile, the likely influence of *Trachurus trachurus* may be noted; this species showed the capability to produce a standing stock accessible to the MEDITS gear at a level of thousands of tons, considering only the shelf (about 19,500 km^2). In fact, although not fully quantifiable, an impressive fraction of the catch (Andaloro, 1996; Tsimenides *et al*., 2000) is discarded at sea, enhancing the scavenger food chain at the bottom; on the other hand, this stock represents a food source for mankind and a predator for other commercially important species, such as the pilchard and the anchovy. There are, consequently, many reasons to consider *Trachurus trachurus* in the ecosystemic analysis of the epipelagic domain, with a view to attain a basic understanding of the dynamics of such a complex system.

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