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Discards of elasmobranchs in a trammel net fishery targeting cuttlefish, *Sepia officinalis* Linnaeus, 1758, along the coast of Sicily (central Mediterranean Sea)

Francesco Tiralongo [a,b,*], Giuseppina Messina [b], Bianca Maria Lombardo [b]

[a] *Ente Fauna Marina Mediterranea, 96012 Avola (SR), Italy*
[b] *University of Catania, Department of Biological, Geological and Environmental Science, 95124 Catania, Italy*

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ABSTRACT

Several species of elasmobranchs are commonly found as bycatch or discard in both artisanal and industrial fisheries. In particular, in the Mediterranean Sea, only few studies are available about bycatch and discards of elasmobranchs in artisanal coastal fisheries. In this study, we focus our attention on elasmobranch catches in a trammel net fishery targeting cuttlefish (*Sepia officinalis*) in the southeastern Ionian coast of Sicily (central Mediterranean Sea). In 2017, during the peak *S. officinalis* fishing season (February–May), four species of the infraclass Batoidea (*Raja radula*, *Dasyatis pastinaca*, *Torpedo marmorata* and *Torpedo torpedo*) constituted the total elasmobranch catches of the 16 survey days. Catch per unit effort (CPUE) of *T. torpedo*, in both number of specimens and biomass terms, showed the highest value, accounting for about 50% of the total. Except for the three larger specimens of *R. radula* (1.7% of *R. radula* specimens caught), all elasmobranchs were discarded. An ANOVA showed significant differences ($P<0.05$) between monthly CPUE values of the four species; while, for each species, the chi-square test failed ($P>0.05$) to show a significant difference in monthly CPUE values. Average disc width of the specimens caught showed the overall presence of a large number of juveniles. Chi-square test for sex ratio showed a significant difference ($P<0.05$) only for *T. torpedo*. For *D. pastinaca*, survival rate was equal to 0. Local traditions play an essential role in fishermen's choice to discard or retain fishes. Monitoring the impact of fishing on populations of these vulnerable or potentially vulnerable species is of fundamental importance for the development of management strategies.

1. Introduction

Because of their low birth rate, late maturity and long life span, elasmobranchs are particularly vulnerable to over-exploitation (Stevens et al., 2000). They often represent a significant, sometimes dominant, portion of catches (Baeta et al., 2010; Cartamil et al., 2011; Coelho et al., 2005; Correia and Smith, 2003; Cross, 2015; Erzini et al., 2002; Machado et al., 2004), both in artisanal and industrial fisheries. Nevertheless, elasmobranch bycatch is generally not regulated, catches are generally unmanaged and little is known about elasmobranch population structure (Başusta et al., 2006).

Small-scale fisheries represent an important part, often a major part, of the fishing activity of many countries (Shester and Micheli, 2011). It is the most important part of the fishing sector in the Mediterranean Sea, both in terms of number of fishermen and boats involved, and in some countries, such as Spain, Portugal, France, Italy and Greece, it has a long tradition and a high socio-economic importance (COPEMED, 2003). Among these fisheries, trammel nets are widely used and usually practiced in the coastal zone, often in shallow waters close to shore. However, despite its importance, compared to industrial fishing, artisanal fishing is less studied (FAO, 2004).

In the Mediterranean Sea, the cuttlefish, *Sepia officinalis* Linnaeus, 1758, is one of the most important coastal fishery species (Belcari et al., 2002). In the southeastern coast of Sicily, from Avola to Marzamemi, this species is caught by trammel nets; the peak fishing season is from February to May. Traditional fishing vessels of this area are small and medium size and operate with trammel nets at close-range from the mooring points, in very shallow waters along the coast. This kind of fishery is relatively size selective; however, it can catch a considerable number of non-target species (Stergiou et al., 2006; Batista et al., 2009).

In the area, there are limited data about elasmobranch bycatch and discards associated to this fishery and management or monitoring programs are absent. Hence the need to quantify and identify discards in order to better understand the impact of this fishery

* Corresponding author at: Ente Fauna Marina Mediterranea, 96012 Avola (SR), Italy
E-mail address: fra.tiralongo@hotmail.it (F. Tiralongo).

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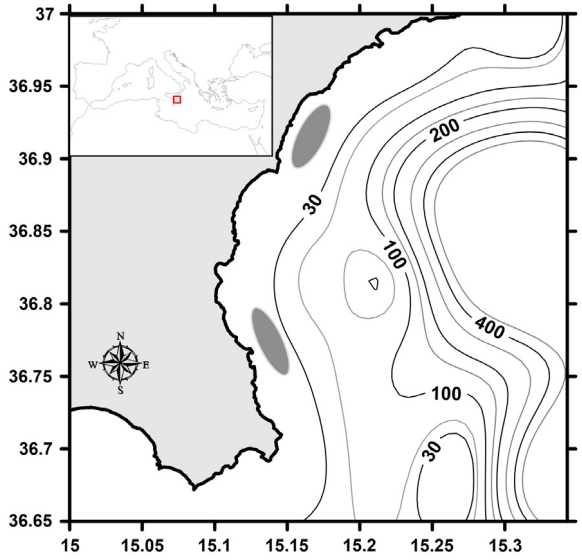

Fig. 1. (Insert) Location of the southeastern coast of Sicily in the central Mediterranean Sea; (Main map) Study area along the Ionian coast of the southeastern Sicily. The two fishing areas are marked with gray color.

on populations and community structure of coastal elasmobranchs (Hall et al., 2000; Borges et al., 2001; Kelleher, 2005).

This study provides the first data concerning discards of elasmobranchs along the southeastern coast of Sicily (central Mediterranean Sea). We also examined the reasons leading fishermen to consider elasmobranchs as discards and not as bycatch; other considerations have been provided on the survival rates of fishes discarded.

2. Materials and methods

The study area is located in the southeastern coast of Sicily, Ionian Sea (Fig. 1). A total of 34 vessels, all targeting *S. officinalis* using trammel nets with a length between 2600 and 4000 m about, have operated in this area during the study period. Almost all the vessels had an overall length of less than 9 m and an engine power less than 90 hp.

Sampling was conducted at approximately weekly intervals aboard two of these fishing vessels that operated in shallow waters between Avola and Marzamemi, from February to May 2017, during the fishing season of *Sepia officinalis*, the target species. The mean length of the trammel nets used per vessel was 3000 m (length range 2800–3200 m) with a height of about 1.8 m and conventional mesh size of 50 mm (inner panel). The soak time of the net was of 10–12 h, from 1–2 h before sunset to 1–2 h before sunrise (start time of retrieval). Elasmobranch catch data were collected for a total of 96 km of trammel net, equally distributed between the two areas, and 16 survey days (4 per months at each location), within the bathymetric range of 2–18 m. The nature of the sea bottom of the two fishing grounds in the area was very similar: the net was set on a mixed bottom of sand and rocks, near *Posidonia oceanica* (Linnaeus) Delile meadows or patches.

All the elasmobranch specimens were identified, sexed, weighed to the nearest gram and measured (disc width) to the nearest mm, mainly at the time of the landing. Live specimens were released near the landing point. For those specimens which can be easily freed from the net (they were mostly small specimens), all data were taken aboard and, immediately after, they have been released back to the sea. Statistical differences between monthly catch per unit effort (CPUE) values, specimens/1000 m of net, of the species, were analyzed by one-way ANOVA ($\alpha = 0.05$); while, differences in monthly CPUE values of each species were tested by chi-square ($\alpha = 0.05$). Sex ratio (M:F) for each species was tested by chi-square ($\alpha = 0.05$).

3. Results

A total of 541 elasmobranch specimens belonging to 4 species, 3 orders (Myliobatiformes, Rajiformes and Torpediniformes) and 3 families (Dasyatidae, Rajidae and Torpedinidae), were caught during the study period (Table 1). The dominant species in catches was *T. torpedo*, with 256 specimens and a total biomass of 120.36 kg (47.32% and 50.89% respectively of the total), followed by *R. radula*, *D. pastinaca* and *T. marmorata* (Table 1). The monthly CPUE ranged from 1.21 to 1.46 specimens/1000 m net for *T. torpedo* and was the highest recorded in the study, followed by *R. radula* (0.79 to 1.08 specimens/1000 m), *D. pastinaca* (0.44 to 0.66 specimens/1000 m) and *T. marmorata* (0.02 to 0.06 specimens/1000 m); monthly averages of CPUE are reported in Table 1.

ANOVA analysis showed significant differences ($P < 0.05$) between monthly CPUE values of the four species (Fig. 2); while, for each species, the chi-square test failed ($P > 0.05$) to show a significant difference in monthly CPUE values. Chi-square test for sex ratio showed a significant difference ($P < 0.05$) only for *T. torpedo*, with sex ratio of 2.12 (Table 1). Average disc width and weight of *D. pastinaca, R. radula, T. marmorata* and *T. torpedo* were, respectively, 24.94 cm and 733 g, 19.07 cm and 197 g, 22.69 cm and 949 g and 17.28 cm and 380 g (Table 2).

4. Discussion

The results of this study showed that discards of elasmobranchs per vessel in trammel net fishery targeting *Sepia officinalis* were high. Taking into account that 34 vessels operated in the research area, the overall impact of this activity on elasmobranchs is considerable. Furthermore, traditional fishing of *S. officinalis* using trammel net is widespread in Italy, especially in the southern part, and in other Mediterranean countries (Stergiou et al., 2006). This fishing method impacts on shallow water species of elasmobranchs that, instead, are caught in smaller quantities (or generally absent from catches) with trawl nets (Tsagarakis et al., 2014), which usually operate in deeper waters (>50 m).

Except for the three larger specimens (>600 g) of *R. radula*, which were sold to local fish markets, cartilaginous fishes were all discarded since they have no commercial value. Furthermore, concerning *D. pastinaca* survival rate, it was equal to 0, because the specimens caught were freed from the net only after landing (with the exception of the rare cases in which the specimens can be easily freed from the net aboard and immediately released) and because of their defensive behavior, dangerous for fishermen, that forces them to kill the stingrays, with the aim of avoiding injuries from the venomous sting. The choice of the fishermen to retain or discard catches is closely connected with local traditions and market demand. In the case of *D. pastinaca* and *T. marmorata*, the situation was totally different from the one of the west coast of Portugal (Baeta et al., 2010), where the species were always retained. These differences are evident not only in different countries, but also in different areas of the same country. Indeed, in nearby areas to the south of the study area, such as Portopalo of Capo Passero and Scoglitti, fishermen retained, for their own consumption or for sale, large-sized specimens of *T. marmorata* and *T. torpedo*; while, in the investigated area, *D. pastinaca*, *T. marmorata* and *T. torpedo* were always discarded, regardless of the size and only the larger specimens of *R. radula* were retained for sale.

Most of the specimens of *T. torpedo* were male and chi-square test for sex ratio (2.12) showed a significant difference ($P < 0.05$)