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Selective characteristics of a shark-excluding grid device in a Mediterranean trawl

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ABSTRACT

Galeus melastomus (blackmouth catshark) is often caught as bycatch in demersal trawls in the Mediterranean. In order to reduce bycatches of shark we tested an excluder grid with 90 mm bar spacing during experimental fishing in the Tyrrhenian Sea (Western Mediterranean). Data collected made it possible to simultaneously evaluate catch losses of two commercial species: *Nephrops norvegicus* (Norway lobster) and *Phycis blennoides* (greater forkbeard). The escape outlet ahead of the grid and the codend were both mounted with a cover in order to collect escaped fish ahead of the grid and through the codend meshes. We used a structural model to estimate the contribution of the individual selective processes consisting of the excluder grid and the size selective codend. The 90 mm excluder grid did not prove to be efficient in excluding *G. melastomus*, while it excuded more of *P. blennoides*. Catches of *N. norvegicus* were also affected by the presence of the grid, but not as much as the catches of other two species. The results obtained for the experimental grid + codend setup were then compared with the estimated selectivity for the "codend alone" setup. Furthermore, by way of explorative simulation with other grid bar spacing, we concluded that reducing the grid bar spacing to 70 mm would provide better compromise between the reduction of *G. melastomus* as bycatch and the catch rate of *P. blennoides* and *N. norvegicus*.

1. Introduction

Although, there is no trawl fishery that specifically targets sharks and other chondrichthyans in the Mediterranean, they are often caught as bycatch. Studies show that long tow duration and small mesh sizes affect shark bycatch most of which is then discarded at sea (Ragonese et al., 2000). Currently, in the Mediterranean, 42% of chondrichthyan fishes are considered threatened (Critically Endangered, Endangered or Vulnerable), where according to IUCN (International Union for Conservation of Nature), bycatch has been identified as one of the greatest threats to their extincion (Cavanagh and Gibson, 2007). Some of the 14% of chondrichthyans that are not considered to be under any threat of extinction now or in the foreseeable future are nevertheless often discarded at high rates in some profitable deep bottom shrimp trawl fisheries (Tsagarakis et al., 2013). *Galeus melastomus* (blackmouth catshark) is one of the species which is exposed to high fishing pressure and is often caught as bycatch (Carbonell et al., 2003). This species shows resilience to repeated trawling (Dimech et al., 2012), despite being regularly discarded (Carbonell and Mallol, 2012; Pennino et al., 2014). Fishermen are also convinced that large catches of *G. melastomus* may reduce quality of the shrimp captured, because they speculate that shrimp forced against the abrasive shark skin in the codend can easily get damaged. Choosing the appropriate size and shape of the mesh in trawl codend, might have some benefit in allowing neonate and small juvenile sharks to escape (Walker, 2005), but Ragonese et al. (2013) suggested that in order to protect demersal sharks, codend selectivity should not be pursued, at least not in the short term, because it is very difficult to convince fishermen to use diamond mesh sizes larger then 50 mm, knowing how difficult the previous transition from 40 mm diamond to 40 mm square mesh was.

Most of the selectivty studies carried out in the Mediterranean investigated the effect of mesh configuration and mesh size (Petrakis and Stergiou, 1997; Lucchetti, 2008; Sala et al., 2008, 2015; Tosunoğlu et al., 2009), twine material and twine thickness (Tokaç et al., 2004; Sala et al., 2007; Deval et al., 2009) and codend

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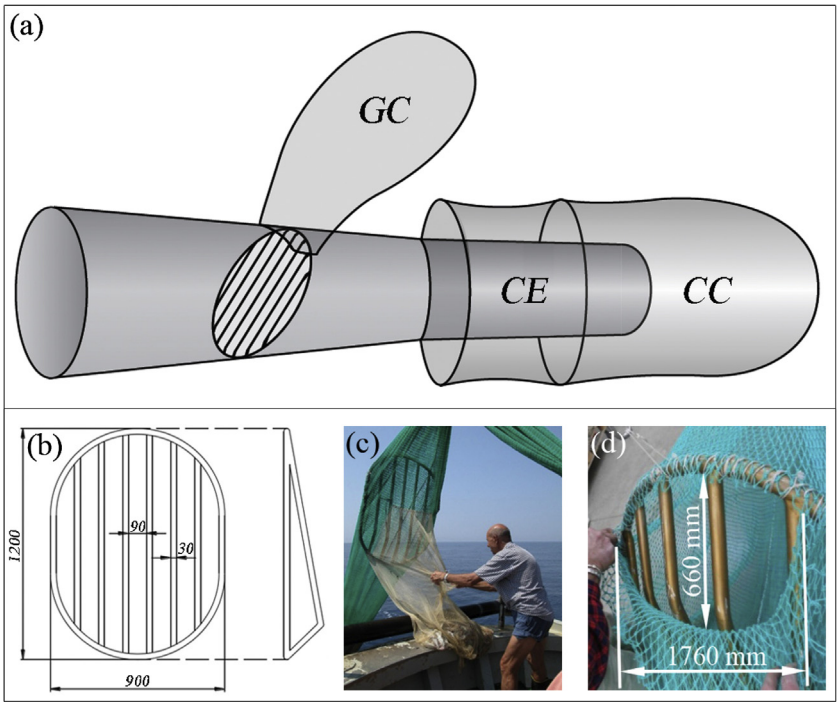

Fig. 1. (a): Conceptual drawing of a grid based dual selection system used in this study. Large fish (sharks) are intended to be excluded to escape through the outlet ahead of the grid to be collected by the grid cover (GC). Target species are intended to pass through the grid and enter the codend (CE), where further size selection takes place with some individuals escaping to be collected by the codend cover (CC); (b): technical specification of an aluminium grid "Super Shooter" used in the study; (c): photograph showing grid and grid cover (GC) mounted on the net; (d): photograph of the escape outlet ahead of the grid.

circumference (Sala and Lucchetti, 2010, 2011; Sala et al., 2006) on finfish selectivity, but none of these studies focused specifically on chondrichthyan selectivity.

Mediterranean commercial fishermen are very interested in testing TEDs because these devices can reduce the amount of debris, bycatch, damage to fish in codend, and also speed up the sorting time on deck (Lucchetti and Sala, 2010). Walker (2005) argued that trawls fitted with a turtle excluder device (TED) reduce shark catches and therefore similar devices, specifically designed to exclude sharks, might improve the reduction.

Studies that focused on the selectivity of sorting grid systems in the Mediterranean, usually applied simple logistic or the Richards model to their grid + codend selectivity analysis (Sardà et al., 2004, 2005, 2006; Bahamon et al., 2007; Aydın et al., 2008; Massutí et al., 2009; Aydın et al., 2011). Another approach to grid based selection system analysis is the use of so-called structural models (O'Neill and Herrmann, 2007). These models use arguments on the physical and biological mechanisms of gear selection and model each of the individual processes in the system. Thus, the structural modeling approach enables us to predict the overall selectivity of the combined system if an individual part of the system is varied (Herrmann et al., 2013).

The aim of the current study was to test the effect of excluder grid mounted ahead of the codend to avoid catching of *G. melastomus* without affecting the catch efficiency of other commercial species. We used structural models to investigate the size-selective properties of a system composed of an excluder grid with 90 mm grid bar spacing followed by a size-selective codend made of 50 mm diamond mesh netting. We compared the experimental grid + codend selectivity with a "codend alone" setup based on the modeling approach described above. In addition, we investigated whether majority of individuals escaped ahead of the grid or through the codend meshes. Finally, we predicted the effect on the combined selectivity by changing the bar spacing in the excluder grid.

2. Material and methods

2.1. Experimental design

The experimental fishing trials were conducted in the Tyrrhenian Sea (Western Mediterranean) over two days (03/04/2012 and 25/07/2012), on board the commercial fishing vessel "Angela Madre" (206 kW, length over all 22.65 m and 67 GT) with a typical Mediterranean bottom trawl named "Tartana" (Eigaard et al., 2011; Fiorentini et al., 1999, 2004) which had fishing circle, headline and foot-rope length of 59.4, 45 and 55 m, respectively. The last section of the belly (tapered section) where the codend was attached was constructed of 44 mm diamond netting with 280 meshes in circumference. The net was rigged with "Danese" type otterboards (1600 × 1000 mm, 190 kg), 230 m long sweeps, and was towed with 1600–1650 m long warps (depth dependent). All rigging components of the gear were identical with those commonly adopted in commercial practice in the Italian trawl fisheries (Dremière et al., 1999; Prat et al., 2008; Sala et al., 2009; Notti et al., 2013).

An aluminum grid "Super Shooter", commonly used in shrimp fisheries in several countries (Sala et al., 2011), was mounted in front of the codend of the trawl net (the distance between the grid and the beginning of the codend was 3.5 m). The grid dimensions were 1200 × 900 mm, with 90 mm spacing between the bars (Fig. 1). The angle of attack of the grid was measured with Star-Oddi minilog and was around 45°, with the top toward the aft (Eayrs, 2007). The codend was made of 50 mm (measured mesh size of 51.9 ± 0.3 mm) polyamide (PA) diamond mesh netting, 6 m long (120 meshes) with a circumference of 246 meshes. It was rigged to the extension piece constructed of 44 mm diamond PE netting with a circumference of 280 meshes. The mesh sizes were measured with an electronic OMEGA mesh gauge (Council Regulation (EC) No 517/2008) while the netting was wet. Throughout the duration of the experiment the net was monitored with the SIMRAD PI50 catch monitoring system. To ensure similar trawl geometry