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Avoidance within a changing assessment paradigm for Mediterranean Hake stocks

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Abstract

The Mediterranean hake Merluccius merluccius L., 1758, is the emblem of the so-called Mediterranean demersal fisheries paradox, showing a persistent, although stable, status of growth overexploitation and an impressive gap between current and any biological reference point. Almost full avoidance capability of large size females to bottom trawls, higher overall growth rates than previously believed and higher natural mortality in juveniles than adult, were considered among the most plausible explanation factors of such persistence. In the present note, arguments are illustrated to raise some concern about avoidance and highlight the important role of the other factors in improving assessments and launching a short term recovery plan for Mediterranean Hake stocks which is more acceptable to fishermen.

Keywords: *Merluccius merluccius;* avoidance; Short term management; Mediterranean Sea.

The Mediterranean hake (*Merluccius merluccius* L., 1758) is one amongst the most broadly exploited and investigated ground-fish species in the Mediterranean Sea (ORSI-RELINI *et al.,* 2002). Hake stocks can be also considered the emblem of the so-called Mediterranean demersal fisheries paradox (MESNIL, 1998), since their persistence and no clear sign of recruits decline (ABELLA et al, 1997), notwithstanding the general increase in fishing mortality, growth overfishing and depletion of the spawning stock continuously evidenced in both scientific Journals (ORSI-RELINI *et al.,* 2002) and General Fisheries Council for the Mediterranean reports (http://www.icm.csic.es/rec/projectes/scsa/documents).

Fishing mortality increase might be attributed to technology improvements (steel polyvalent otter board, GPS, more powerful engines etc) and spreading of the activities in countries belonging to the European Union (EU), and building up of fishing capacity in non-EU countries. Growth overfishing derives from the huge number of recruits and juveniles (0+ and 1+ age groups), up to 96% in some fisheries; ABELLA *et al.,* 1997), which are almost exclusively caught by trawlers (Fig. 1a). On

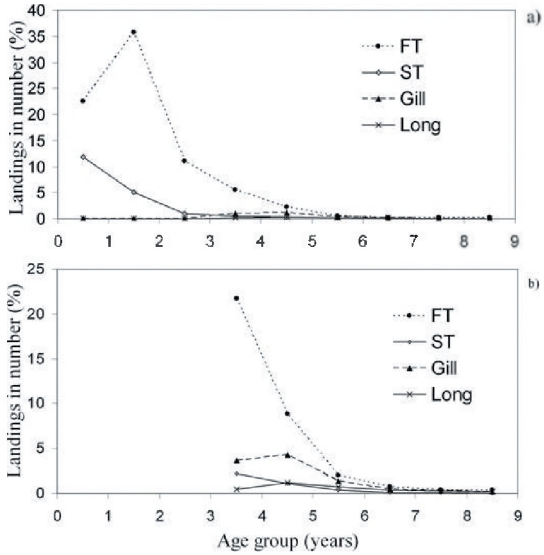

Fig. 1a, b: Mean landing (from 1988 to 1991) in number (%) of *Merluccius merluccius,* by gear and age group, in the Gulf of Lions. a) % refer to all age groups (0.5 step; N=12055000); b) % refer to adult groups. Legenda: FT = French Trawl, ST = Spanish trawl, Gill = Gill-net, Long = Long-lines (modified from ALDEBERT *et al.,* 1993; ALDEBERT & RECASENS, 1996).

the contrary (Fig. 1b), the spawning stock seems to be affected by both trawlers and set nets (ALDEBERT *et al.,* 1993; ALDEBERT & RECASENS, 1996).

Almost all the available assessments indicate a drastic reduction in fishing mortality to be achieved by increasing/changing the mesh size/type, establishing closed areas (mainly nurseries) and period (fishing ban), limiting catch and landing size, etc. These multiple options, however, seem not to have been properly applied and enforced by the administrative bodies and effectively implemented by the fishing industry, resulting in stationary or even a progressive general worsening of hake and other demersal resources (ROCHET *et al.,* 2005).

The dark side of hake assessments at hand consists in the difficulty in justifying the persistence of fisheries, which might have already collapsed according general fishing theory. Beside the possibility that an increasing productivity of Mediterranean might has enhanced recruitment success, it was only in the last decade that new scenarios were explored based on four main topics (ABELLA *et al.,* 1997; MESNIL, 1998; CADDY & SEIJO, 2002; GARCIA-RODRIGUEZ & ESTEBAN, 2002): avoidance capabilities of large size females, overall growth rate much higher than previously believed, growth and natural mortality much higher in recruits/juveniles than adults, and peak of the reproductive value of hake females at intermediate sizes/ages.

Translating all these topics into an assessment format, a more optimistic diagnosis and a harvesting strategy in which 'older juveniles and early mature age class' might represent the target of the fishery, if 'older spawner' can be considered partially or totally excluded from exploitation, would derive (CADDY & SEIJO, 2002).

Within a precautionary-risk-averse approach, however, the four topics previously described do not have the same management relevance; in particular, the assumption that hake stock persistence should reflect mainly an increase in trawl avoidance capability related to both spatial (not trawlable grounds) or physiological (swimming endurance and behaviour) *refugia* deserves more attention. First of all, the spatial aspect seems less relevant because large hakes are able to move from one area to another according to food or reproductive factors; hence, only a limited fishing mortality dilution can be expected depending only on the degree of interchange between trawlable and not trawlable areas (RICKER, 1975). The physiological aspect, on the contrary, might have a sharp influence. Its theoretical background was based on the classic " 'trawl catch by exhaustion paradigm', in which small and medium size round-fish cannot sustain the speed of the boat for a long time, while larger animals, having higher sustainable speed and/or higher energy reserves, can keep going longer, for hours in some cases, herding in the trawl path, and thus escape capture altogether (GODØ *et al.,* 1990, ENGÅS, 1994). The proofs to sustain this paradigm in the Mediterranean Hake are mainly the practical absence of large hakes in commercial trawl catches as opposed to their (unexpected) presence in gill net and longline catches, which would confirm the pile-up of adult females on fishing grounds, but hidden to trawl hauls (especially those realised during the experimental surveys). For example, according to ABELLA et al. (1997), the Mediterranean Hake would start avoiding trawl capture around 20cm, approaching almost full avoidance above 50cm TL. It seems worth recalling some arguments about this.

Trawl efficiency theory. The 'trawl catch by exhaustion paradigm' was recently revisited; especially in depleted stock, short tows are at least as efficient as long tows in catching fish of any size, probably as a consequence of the surprise effect and the weaker herding ability of fish at low density (GODØ *et al.,* 1990).

Comparison with the past. Even considering the difficulty in standardising the information, the comparison of old and modern bottom trawl catches clearly indicates a higher presence of large size hake in the past than in the present situation. 'Big' hake (named 'baccalà' or 'panzoni', by Sicilian or Tuscan fishermen) were reported as quite common in the trawl catches when long line and gill net fisheries were absent or strongly limited. For example, MATTA (1955) quoted the capture in the Tuscan archipelago of a high percentage (up 68%) of large hake (40-75 cm) and quite a few 'parecchi' or 'big' hake (TL>80 cm), with a maximum size of trawl-caught fish of 95 cm TL. Similar results were gained in the waters surrounding Sicily; according to SCACCINI et al. (1970), big hake were found in the catches of both bottom trawls (Northern coasts; page 14) and bottom long lines (off Capo Passero; page 15).

Comparison with the present. The most impressive exemplum of differences in length frequency distributions can be found in those produced within the SAMED program (ORSI RELINI *et al.,* 2002; Fig. 9, page 32), which were obtained by hauling the same experimental gear and methodology; large hake were more represented in those areas (such as the Aegean Sea) which are likely to have suffered a lower fishing pressure than the other traditional Mediterranean fishing grounds. Another relevant piece of evidence was the comparison of LFD gathered by using commercial gear in close areas at different exploitation levels within the Straits of Sicily (Fig. 2); in fact, the al-

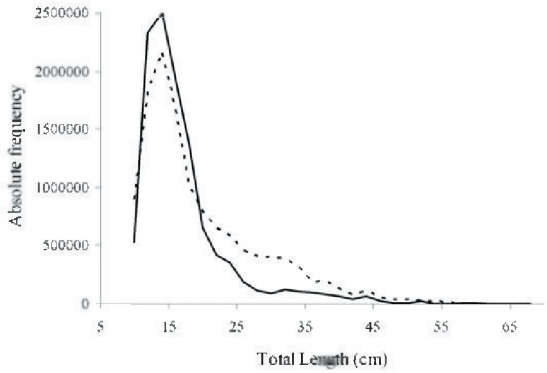

Fig. 2: Experimental absolute length frequency distribution of females *Merluccius merluccius,* obtained in two adjacent zones (A solid, more exploited and B, dotted lines, less exploited area) of the Straits of Sicily (unpublished data). Samples were gathered in the same period (8 th September - 22 nd November 1997), with the same vessel (Sant'Anna, 197 GT, 1012 HP engine) and commercial gear (vertical opening = 1 m; stretched mesh size = 31 mm; haul duration = 1h; haul speed = 1.45-1.52 m s^{-1}).

most overlapping shape in recruits is remarkable, whereas a slight increase in juvenile spawning (25 – 55 cm) components is detectable only in the LFD gathered in the less exploited area, resulting in a high significant difference according to the Kolmogorov-Smirnov test (two tailed test; p=0,01; d = 0.049 vs. critical d = 0.029).

Comparison of gear efficiency. To our knowledge, neither direct experimental data on Mediterranean hake avoidance ability nor parametric comparison of the fishing efficiency of the different gears are available. As a matter of fact, the few studies available concerning other gadoids (HUSE *et al.,* 2000) would suggest that 1) long lines tend to catch fish in poor condition in search of food, and the most active swimmers are more vulnerable, 2) the gillnets tend to catch fish in spawning or higher condition, which are moving mainly for reproductive reasons, and 3) the bottom trawl is more generalist and gives a more representative idea of the condition of the population. The analysis of catch data from other gears would be very attractive, but the collection and interpretation of these data present several difficulties (ENGÅS & LØKKEBORG, 1994). Obviously, it is true that large size Mediterranean hake are caught by gillnets and long lines, but if we compare these figures as a percentage after the exclusion of trawled juveniles, a strong similarity between trawls and set nets landings results (cfr. Fig. 1b). Further, although trawlers catch a huge number of juveniles, medium and large size specimens (from 30 to 50 cm and more) are still captured in heavily exploited stock (mature fisheries; ALDEBERT *et al.,* 1993, page 214) and this component can be quite visible on the right side of the LFD of lightly exploited stocks, as evidenced both in historical (PICHOT, 1973; Libyan waters) and recenty (PETRAKIS & STERGIOU, 1997; Hellenic waters) publications.

Overall it seems wiser to build up, within regulatory bodies such as GFCM, an assessment format for hake based on size-dependent growth/natural mortality pattern and reproductive value, but maintaining (as a risk-averse option) the classic 0->1

asymptotic fishing mortality by size/age pattern, at least until direct experimental data will allow a quantitative validation of the avoidance phenomenon.

Adopting such a new assessment format would support the proposal for short-term management advice, likely to be more acceptable to fishermen; for example, as also suggested *in nuce* by CADDY & SEJIO (2002), the *plethora* of regulations could be replaced by the adoption of a 40 mm square mesh in trawl cod ends and by setting limitations on set net fisheries. The former would result in a strong reduction of fishing mortality in recruits, given improved selectivity (SALA *et al.,* 2008), whereas the latter will interest a minimal fraction of the current fishing effort on hake. Finally, the expected slight increase in the efficiency of larger mesh bottom trawl (MOUS *et al.,* 2002) might represent an indirect test of the incidence of avoidance.

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