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"RAPIDO" TRAWL FISHING IN THE NORTHERN ADRIATIC: DIRECT IMPACT ON EPIFAUNA

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RIASSUNTO

Pesca con il rapido nell'Adriatico Settentrionale: impatto diretto sull'epifauna

Lo scopo del presente lavoro è stato quello di valutare gli effetti della pesca condotta con il rapido, sia a breve che a lungo termine, a carico delle comunità bentoniche nell'Adriatico settentrionale, e l'impatto che l'attrezzo esercita direttamente sull'epifauna che vive nei fondali sabbiosi e fangosi. Le aree prese in esame sono state alcune zone fangose sottocosta e sabbiose poste al largo, nelle quali, rispettivamente, si pratica soprattutto la pesca dei pesci piatti e dei Pettinidi.

In base alle analisi effettuate, sembra che l'impatto del rapido sul by-catch sia diverso a seconda della specie esaminata, perché correlato alle dimensioni, alla morfologia, alla fragilità degli organismi e all'ambiente dove essi vengono pescati.

L'impatto è stato di lieve entità per i Gasteropodi provvisti di conchiglia, i Bivalvi e i Poriferi; per altre specie, come Echinodermi e Crostacei, è stata notata una certa differenza nell'entità dell'impatto sugli organismi danneggiati.

ABSTRACT

The aim of this work was to assess the short- and long-term effects of "rapido" trawl fishing on benthic communities in the Northern Adriatic and the direct impact of the gear on epifauna living on sandy and muddy bottoms. The study areas were muddy in-shore and sandy off-shore areas, the target species for fishing being mainly flatfish and pectinids respectively.

Analyses showed that the impact of the rapido gear on by-catch is species-dependent, being connected with the size, morphology and fragility of organisms, and with the environment in which the species are fished.

Hard-shelled gastropods, bivalves and porifers only suffered slightly. Other species, like echinoderms and crustaceans, revealed certain differences in the extent and percentages of severely damaged specimens.

As regards fishing-grounds and target species, a catch mainly consisting of hardshelled bivalves (such as pectinids) is presumed to produce a much more severe impact

on specimens in the codend when compared with catches made from a soft, in-shore muddy bottom, characterised by the presence of macroalgae (e.g. *Ulva* sp.) and flatfish.

Key-words: rapido gear, by-catch, impact, Adriatic

INTRODUCTION

In the recent past, due to growing interest in the sustainable development of human activities capable of slowing the depletion of natural resources (FAO, 1996), increasing efforts have been made to assess the impact of fishing gears on the seabed (Hall, 1999).

So far, research lines have mainly been represented by the physical effects of towed gear on the bottom, short- and long-term effects on epi- and in-faunal communities, direct mortality of benthos due to trawling, and the direct impact of the gear on by-catch.

Investigators have been focussing on several types of gears: trawls (Wassenberg and Hill, 1989; Brylinsky and Gibson, 1993; BEON, 1994; Kaiser and Spencer, 1996; Tuck *et al.*, 1998), scallop dredges (Caddy, 1973; Eleftheriou and Robertson, 1992; Currie and Parry, 1996; Giovanardi *et al.*, 1998; Hall-Spencer and Moore, in press) and hydraulic dredges (Hall *et al.*, 1990; Pranovi and Giovanardi, (1994). Results have shown variable effects depending on the type of sea bottom sand, mud, rock), habitat (deep-sea, intertidal, temperate or tropical waters, etc.) and fishing gears.

Within the framework of a research project funded by the General Direction of the Ministry for Agricultural and Forestry Resources, aimed at assessing the short- and long-term effects of "rapido" trawl fishing on benthic communities in the Northern Adriatic, attention has also been paid to the direct impact of the gear on epifauna living on sandy and muddy bottoms, providing one of the few data sets for the area (Hall-Spencer *et al.*, 1999).

MATERIALS AND METHODS

By-catch composition and biometric data (length measurements, wet weight) were collected during several surveys in 1998 on board two commercial trawlers, respectively working in muddy in-shore and sandy off-shore areas, their target species being mainly flatfish and pectinids (Fig. 1). The vessels were equipped with toothed dredges, locally named "rapido" and used exclusively in the Adriatic (Fig. 2). As may be seen, in the upper part of the triangular frame, a wooden plate acts as a depressor, allowing high towing speeds (6-7 knots) to be reached. Unlike Scottish dredges, rapido teeth are fixed (see Hall-Spencer, *this volume),* since the Northern Adriatic may be viewed as an extensive trawlable platform made up of sand and mud, almost devoid of obstacles. The direct effects of fishing gear on by-catch species just before the beginning of sorting operations were quantified on a scale of three: no impact (0), medium impact (1) and high impact (2). Bycatch samples were also collected during sorting (only on vessels fishing for pectinids) and immediately before their final discard into the sea (from both vessels). For some taxa (crustaceans, starfish, brittlestars), impact was also measured on a finer scale (Tab. I).

Tab. 1: Impact levels applied to crabs, starfish and brittlestars
Tab. 1: Scale di impatto applicate ai granchi, stelle marine e ofiure

Class	Impact level	Description
Crustacea (Wassemberg and Hill, 1989)	0	No impact
	I	Loss of I pereiopod
	2	Loss of 2 or more pereiopods
	3	Loss of 1 nipper
	4	Loss of I nipper and I or more pereiopods
	5	Loss of both nippers
	6	Crushed carapace
Asteroidea Ophiuroidea	0	No impact
	I	Loss of I arm
	2	Loss of 2 arms
	3	Loss of 3 arms
	4	Loss of 4 arms
	5	Loss of 5 arms
	6	Crushed body/disc

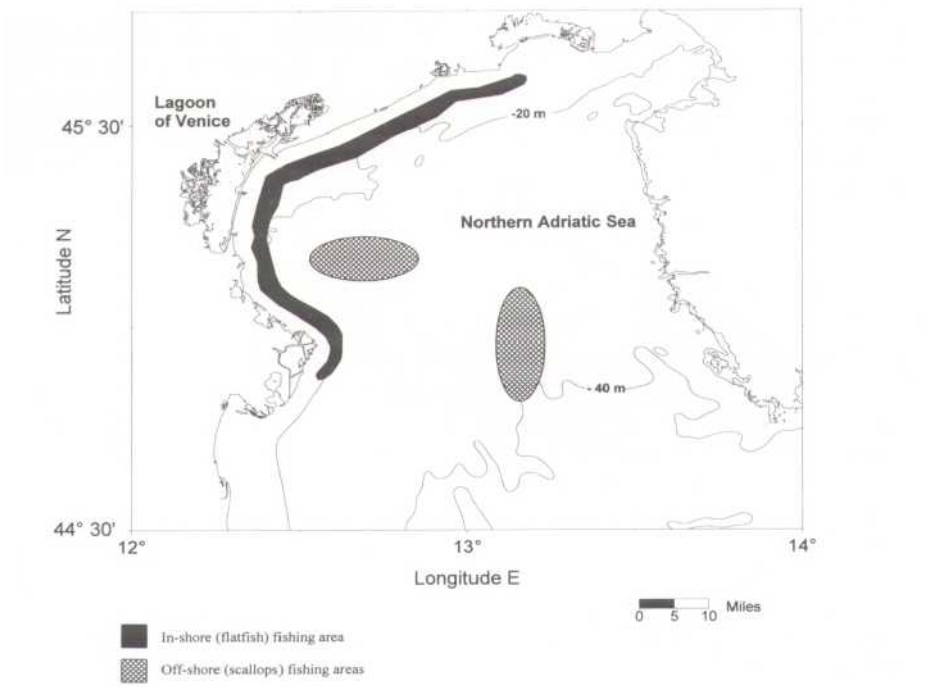


Fig 1 Fishing areas exploited with "rapido" gear.
Fig. 1: Aree di pesca interessate dall'azione del rapido

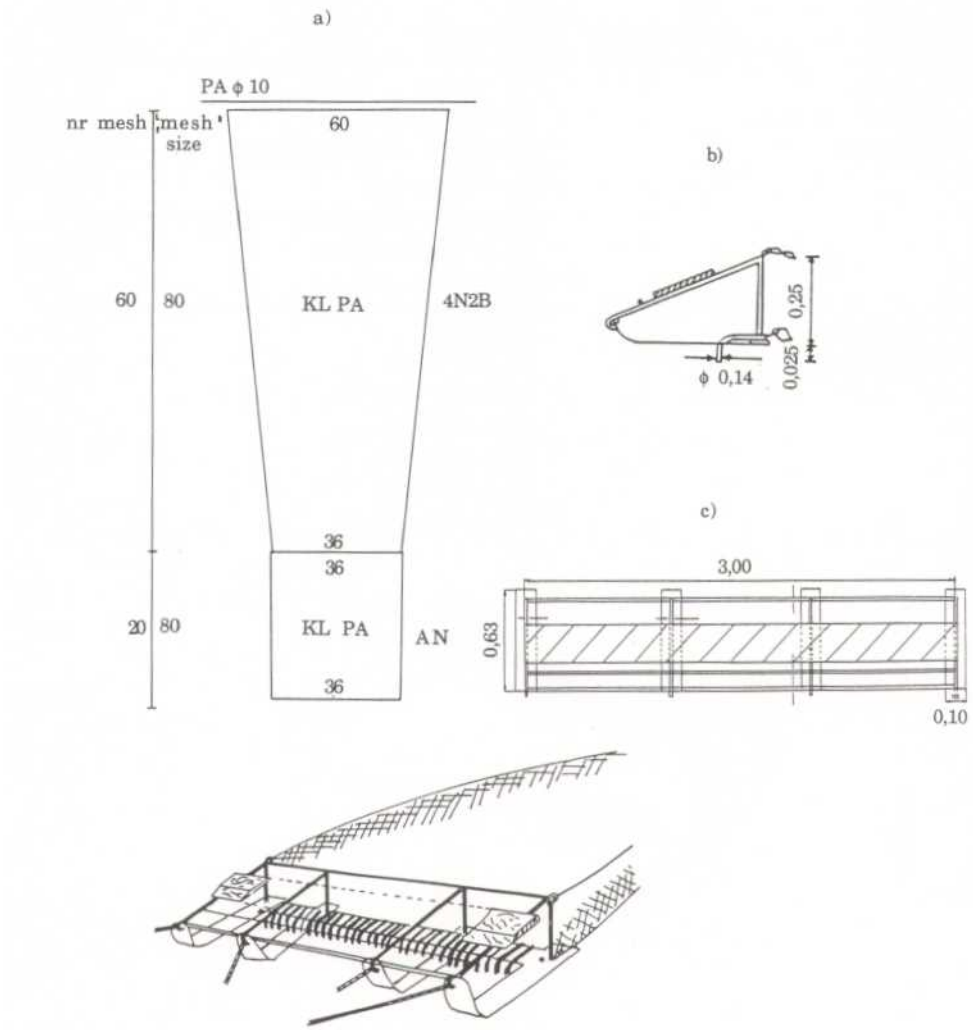


Fig. 2: Structure of "rapido" gear.
Fig. 2: Struttura del rapido

Gear selectivity was also tested by means of a cover net (28 mm mesh size) fixed at the codend (40 mm mesh size) of rapido commercial gear. The test consisted of short hauls (4-6 min), at the end of which both cover and codend were emptied. Specimens collected were then classified according to the above impact scales.

RESULTS

The data collected allow us to describe and quantify the effects of direct gear impact on epifaunal taxa living in both sampling grounds (Fig. 3, Tab. 2).

At the end of sorting, an increase in the percentage of organisms undergoing impact was found in the samples; by-catch species collected off-shore always had higher impact values, expressed as their percentages in each class of impact. The impact on several taxa is shown in Figs 4-12.

Impact differences with respect to sampling levels and target fishing vessels were then statistically assessed by means of the Mann-Whitney U-test. The results (on three representative species fished both in-shore and off-shore) are shown in Tabs. 3-4.

Tab. 2: Impact values recorded off-shore (shaded) and in-shore at the opening of the codend for major by-catch taxa.

Tab. 2: Valori di impatto registrali al largo (in grigio) e sottocosta all'apertura del sacco per i principali taxa del by-catch

Phylum	***Impact O*** (%)	***Impact*** (%)	***Impact 2*** (%)
Mollusca	60.8	4.2	35.0
	91.5	7.3	1.2
Arthropoda	14.7	35.3	50.0
	54.2	22.6	23.2
Echinodermata	1.3	53.8	44.9
	5.7	61.4	32.9

At the end of sorting activity an increase in the percentage of organisms undergoing impact is found in the samples; by-catch species collected off-shore always show higher impact values, expressed as their percentage in each class of impact. Impact on several taxa is shown in figs. 4-12.

Differences in the impact with respect to sampling levels and target fishing vessel were then statistically assessed by means of Mann-Whitney U-test; results of the test (on three representative species fished both in-shore and off-shore) are shown in Tabs. 3-4.

Tab. 3: Comparison of the impact by sorting level (Mann-Whitney U-test) for species collected both off-shore (shaded) and in-shore.
Tab. 3: Confronto dell'impatto fra stadi di cernita (Mann-Whitney U-test) per le specie raccolte sia al largo (in grigio) che sottocosta.

Sorting level	***O. ophiura***	***A. irregularis***	***Liocarcinus sp.***
Before vs. intermediate	0.00000	0.00152	0.43832
Intermediate vs. after	0.00002	0.81304	0.00062
Before vs. after	0.00001	0.00170	0.00001
Before vs. after	0.03077	0.00286	0.00059

Tab. 4: Comparison of the impact of off-shore vs. in-shore sorting level (Mann-Whitney U-test) for species collected on both fishing grounds.
Tab. 4: Confronto dell'impatto tra stadi di cernita delle catture al largo e sottocosta (Mann-Whitney U-test) per le specie raccolte su entrambe le aree di pesca.

	O. ophiura	***A. irregularis***	***Liocarcinus* sp.**
Before sorting	0.64121	0.00286	0.00000
After sorting	0.85679	0.88377	0.00000

The impact values recorded for *Ophiura ophiura, Astopecten irregularis* and *Liocarcinus* sp. *(L. depurator* off-shore and *L. vernalis* in-shore) as the net arrived on deck (before sorting) and after sorting were significantly different, and this was true for both fishing vessels.

In cases where intermediate samples were taken, a different relationship of impact vs. sampling level was found between the species considered: damage to *A. irregularis* was mostly concentrated in the first phase of sorting (no significant differences between intermediate and final samples), whereas in *Liocarcinus* sp. such damage occurred later (no differences between before and intermediate samples). Impact damage to O. *ophiura* occurred in all stages of sorting.

When the direct impact of the same fishing gear on epifauna was compared, it was found to differ significantly (except for O. *ophiura),* although only *Liocarcinus sp.* revealed differences in in-shore vs. off-shore impact values at the end of sorting.

Furthermore, body size and impact level were inversely correlated (N=113, Spearman R=-0.334; p=0.0003) in *A. irregularis* fished in off-shore areas but not in in-shore ones. Instead, *Liocarcinus* sp. and O. *ophiura* showed no relationships between body size and impact, irrespective of fishing ground or sampling level.

The cover net experiment showed how gear selectivity may greatly differ from

Fig. 3: Averaged values of direct impact of rapido gear on total by-catch
Fig. 3: Valori medi dell'impatto diretto del rapido sul by-catch totale

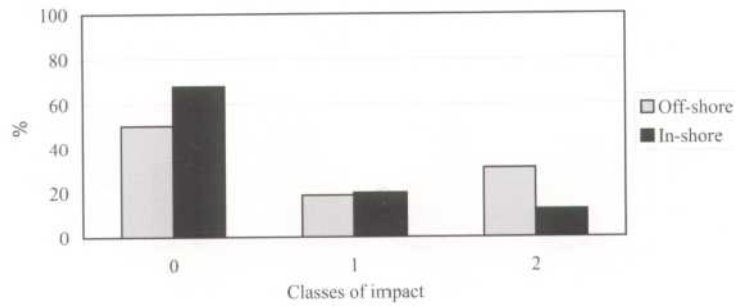


Fig. 4: MOLLUSCS. Impact of off-shore (O) and in-shore (I) rapido gear before and after sorting activity
Fig. 4: MOLLUSCHI. Impatto del rapido al largo (O) e sottocosta (I) prima e dopo le operazioni di cernita

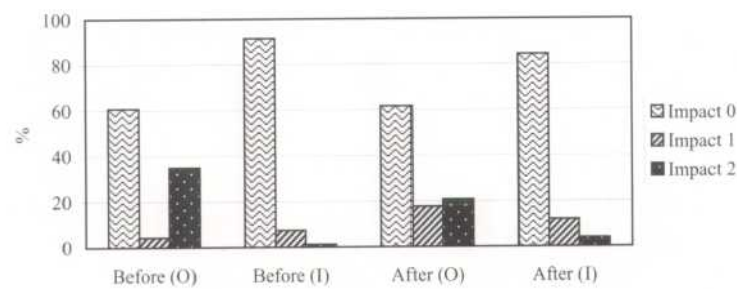


Fig. 5: ARTHROPODS. Impact of off-shore (O) and in-shore (I) rapido gear before and after sorting activity
Fig. 5: ARTROPODI. Impatto del rapido al largo (O) e sottocosta (I) prima e dopo le operazioni di cernita

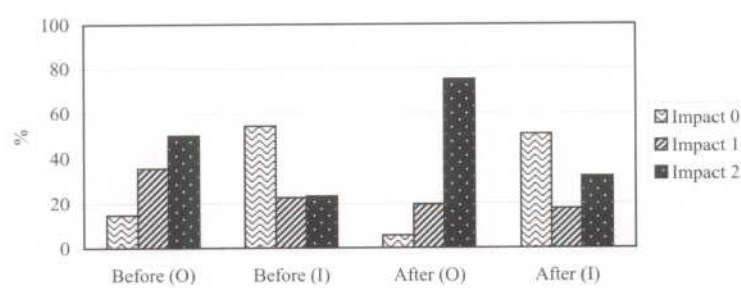


Fig. 6: ECHINODERMS. Impact of off-shore (O) and in-shore (I) rapido gear before and after sorting activity
Fig. 6: ECHINODERMI. Impatto del rapido al largo (0) e sottocosta (I) prima e dopo le operazioni di cernita

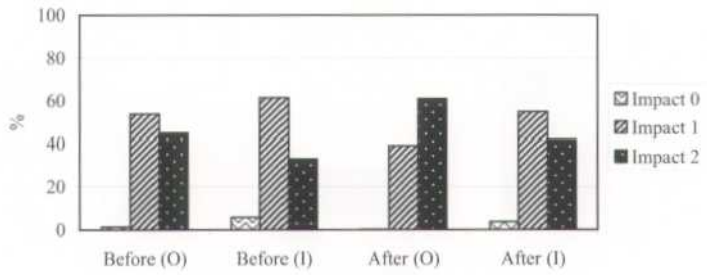


Fig. 7: ARTHROPODS. Impact of off-shore (O) and in-shore (I) rapido gear before and after sorting activity
Fig. 7: ARTROPODI. Impatto del rapido al largo (O) e sottocosta (I) prima e dopo le operazioni di cernita

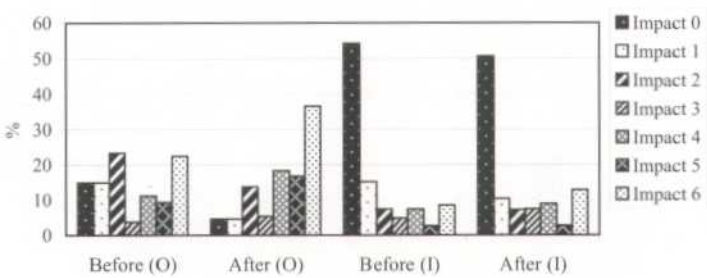


Fig. 8: ECHINODERMS. Impact of off-shore (O) and in-shore (I) rapido gear before and after sorting activity
Fig. 8: ECHINODERMI. Impatto del rapido al largo (O) e sottocosta (I) prima e dopo le operazioni di cernita

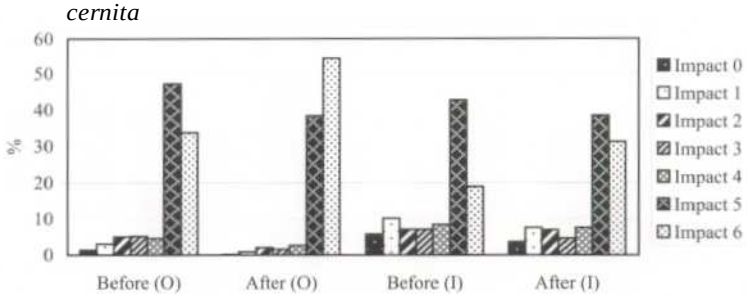


Fig. 9: ASTEROIDS. Impact of off-shore (O) and in-shore (I) rapido gear before and after sorting activity
Fig. 9: ASTEROIDEI. Impatto del rapido al largo (O) e sottocosta (I) prima e dopo le operazioni di cernita

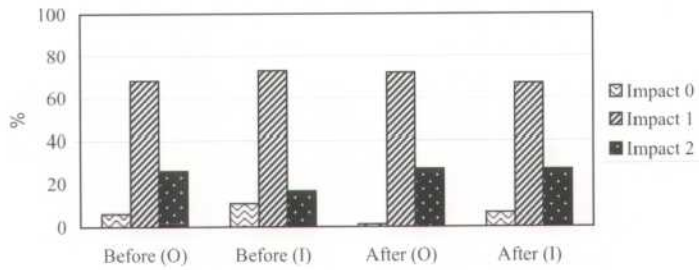


Fig. 10: OPHIUROIDS. Impact of off-shore (O) and in-shore (I) rapido gear before and after sorting activity
Fig. 10: OFIUROIDEI. Impatto del rapido al largo (O) e sottocosta (I) prima e dopo le operazioni di cernita

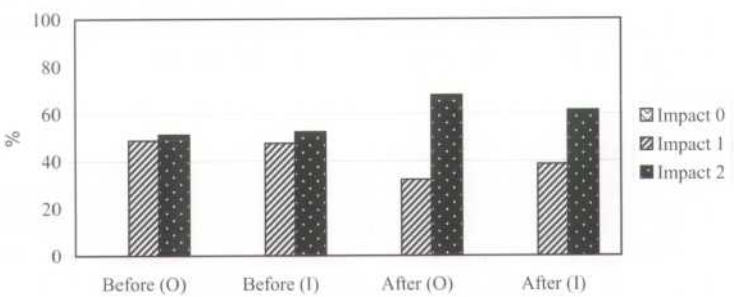


Fig. 11: GASTROPODS. Impact of off-shore (O) and in-shore (I) rapido gear before and after sorting activity
Fig. 11: GASTEROPODI. Impatto del rapido al largo (O) e sottocosta (I) prima e dopo le operazioni di cernita

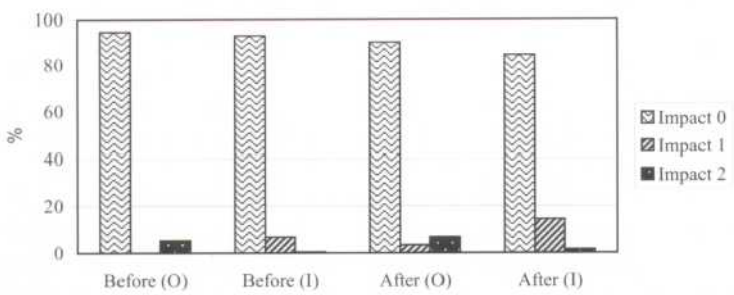
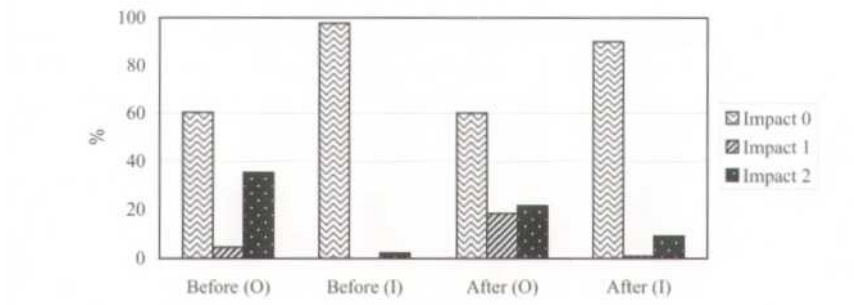


Fig. 12: BIVALVES. Impact of off-shore (O) and in-shore (I) rapido gear before and after sorting activity
Fig. 12: PELECIPODI. Impatto del rapido al lago (O) e sottocosta (I) prima e dopo le operazioni di cernita



species to species: for example, the great majority of *A. irregularis* was found in the codend, whereas all specimens of *Natica stercusmuscarum* were found in the cover. Specimens passing through the meshes of the codend net were also classified on the impact scale. The number of specimens of O. *ophiura* with damage to the disc found in the cover was double that of specimens trapped in the codend.

DISCUSSION AND CONCLUSIONS

The impact of the rapido gear on by-catch seems to be species-dependent, being connected with the size, morphology and fragility of the organisms. Molluscs were less damaged than either Crustaceans or Echinoderms in the off-shore pectin id-fishing vessel than in the in-shore one seeking flatfish. Echinoderms suffer from direct gear impact and sorting more severely than crustaceans, on both 0-2 and 0-6 impact scales. Crushed echinoderms with 5 arms affected were classified as class 6, thus explaining the before-vs-after reduction of class 5 (Fig. 7).

In accordance with data reported by Hall-Spencer *et al.* (1999), hard-shelled gastropods, bivalves and porifers such as *Suberites* sp. only underwent slight impact damage (80-100% scored 0 and none scored 2) due to the gear. In other species, a ±10% (crustaceans, *A. irregularis)* or even greater differences (brittlestars, *Psammechinus microtuberculatus, Atrina fragilis, Sepia officinalis)* in the percentages of severely damaged specimens were observed in our study. On the whole, the impact percentages reported by Hall-Spencer *et al.* (1999) were similar to those observed in our in-shore fishing vessel.

Generally, low-impact classes occurred in higher percentages before the beginning of sorting, and specimens collected off-shore were more severely damaged than inshore ones. For some organisms (e.g., O. *ophiura),* impact simply increased steadily from net opening to the end of sorting; *A. irregularis* was mostly damaged during

sorting, and *Liocarcinus* sp. at the end of it. This may be due to the fragility of O. *ophiura* and to the greater mobility of *Liocarcinus* sp. compared with *A. irregularis.*

Statistical analysis confirmed that impact values recorded before sorting were significantly different between the two fishing vessels, and this was interpreted in the light of the different fishing grounds and target species considered. A catch mainly consisting of hard-shelled bivalves (such as pectinids) is presumed to cause much more severe impact to specimens in the codend when compared with catches from an in-shore soft muddy bottom, characterised by the presence of macroalgae (like *Ulva* sp.) and flatfish. This may also explain why, in *A. irregularis,* impact is or is not significantly linked to body size, depending on the type of fishing ground.

Preliminary results on how severe impact is on organisms escaping through meshes during fishing hauls show that this passage causes considerable damage to organisms but that impact is influenced by morphological differences: *O. ophiura* specimens escaping through the meshes were more severely damaged than those trapped in the codend, whereas all N. *stercusmuscarum* in the cover were classified as impact 0.

In conclusion, rapido gear does have an impact on epifauna, but by-catch components are not all affected in the same way. This depends not only on their body shape and the presence of hard structures, but also on the environment in which they are fished.

ACKNOWLEDGEMENTS

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