Comunicaciones de la Sociedad Malacológica del Uruguay ISSN 0037- 8607

9 (89): 61 – 67. 2006

ARTÍCULO ORIGINAL

LARGE GASTROPODS BY–CATCH IN THE HAKE FISHERY AT THE ARGENTINEAN – URUGUAYAN COMMON FISHING ZONE

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ABSTRACT

Studies dealing with conservation of non-targeted benthic fauna on Southwestern Atlantic waters are scarce. In particular, by-catch of mollusks by trawlers in hake fishery has received little attention. In order to estimate the frequency and specific composition of gastropod by catch in benthic trawling at the Argentinean-Uruguayan Common Fishing Zone, a total 24 stations were surveyed during a 37 days cruise in a commercial fishing vessel targeting hake (*Merluccius hubbsi*). Large gastropod by-catch was noticed in 100% of the fishing operations and its species identified *in situ*. Four species of large benthic gastropods were collected: *Fusitriton magellanicus, Adelomelon ancilla, Odontocymbiola magellanica* and *Trophon acanthodes.* In addition, shell length was measured from a random sample in order to construct the size-frequency distributions. These showed that most size classes from 5.6 cm were represented. Observations on the degree of shell damage showed that ca. 30% of the individuals of *A. ancilla* and *O. magellanica* presented some kind of injury caused by the fishing operations. In order to avoid or minimize damage to large benthic gastropods populations and to ensure their conservation, the need for monitoring the effect of hake fisheries upon non-targeted species is stressed.

KEY WORDS: by-catch, gastropods, hake, trawling, *Odontocymbiola, Adelomelon, Fusitriton, Trophon.*

RESUMEN

Captura incidental de gasterópodos bentónicos en la pesquería de merluza en la Zona Común de Pesca Argentino-Uruguayo. Los estudios relacionados con conservación de fauna bentónica no explotada comercialmente son escasos para el Atlántico Sudoccidental. En particular, la captura incidental de moluscos en la pesca de arrastre de merluza (*Merluccius hubbsi*) ha recibido poca atención. Para estimar la frecuencia y composición específica de la captura incidental de gasterópodos en esta pesquería se monitorearon un total de 24 estaciones durante un crucero de 37 días en un buque factoría. La captura incidental de gasterópodos se registró en el 100% de los lances, siendo sus especies identificadas *in situ*. Cuatro especies de grandes gasterópodos bentónicos fueron colectadas: *Fusitriton magellanicus, Adelomelon ancilla, Odontocymbiola magellanica* y *Trophon acanthodes.* Además, se registraron las tallas de las especies de una muestra aleatoria para construir las distribuciones de frecuencias de tamaño. Las mismas mostraron que la mayor parte de las clases de tamaño a partir de 5.6 cm estuvieron representadas. Observaciones acerca del grado de daño del caparazón indicaron que cerca del 30% de los individuos de *A. ancilla* y *O. magellanica* presentaron algún tipo de deterioro ocasionado por la operación de pesca. En este contexto, se propone monitorear el efecto de las pesquerías de merluza sobre la comunidad bentónica en general y sobre los gasterópodos en particular para implementar medidas de manejo y conservación.

PALABRAS CLAVE: captura incidental, gasterópodos, Merluza, arrastre, *Odontocymbiola, Adelomelon, Fusitriton, Trophon.*

INTRODUCTION

Commercial bottom trawling is known to cause critical damages on benthic communities (Dayton *et al.*, 1995; Jennings & Kaiser, 1998; Lindeboom & de Groot, 1998; Hall, 1999; Collie *et al.*, 2000; Kaiser & de Groot, 2000). Direct killing of individuals, exposure of animals to predation and habitat deterioration are some ways in which benthic macrofauna is affected by this activity. Mortality due to trawling disturbance is generally size-dependent and positively correlated with body size, with small-sized benthic animals such as polychaetes or ophiuroideans suffering lower mortality when compared with large benthic animals (Lindeboom

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& de Groot, 1998; Bergman & van Santbrink, 2000). Other indirect effects that result from changes in species density in a network of predatory or competitive interactions may also have strong and unpredictable effects in the benthic community, as documented elsewhere (see Paine, 1974; Dungan, 1986; Schmit, 1987; Kneib, 1988; Posey & Hines, 1991; Bronmark *et al.*, 1992).

The hake (*Merluccius hubbsi*) fishery in the Argentinean-Uruguayan Common Fishing Zone (AUCFZ) can be expected to cause a strong impact on benthic communities and seabeds, owing mainly to the high activity, typical of the area, and the discard of undesired species (Mugetti *et al.*, 2004). Though there are not studies quantifying by-catch of invertebrate fauna, there is evidence of biomass degradation and a decrease in distribution areas of highly vulnerable benthic species, such as rays currently included in addenda to CITES and World Conservation Union: Convention of Migratory Species (Cané *et al.*, 1999).

At present, quantitative studies on benthic fauna at the area are mainly restricted to targeted species such as the scallop *Psychrochlamys patagonica* (King & Broderip, 1832) (*e.g.* Defeo & Gutiérrez, 2003; Gutiérrez & Defeo, 2003) and the deep-sea red crab *Chaceon notialis* Manning & Holthius, 1989 (Delgado & Defeo, 2004). However, studies dealing with conservation of non-targeted malacofauna on Southwestern Atlantic waters are scarce. In particular, benthic large gastropods are of ecological importance due to its predatory role and its current or potential economic importance (Riestra *et al.*, 2000; Riestra & Fabiano, 2000; Fabiano *et al.*, 2003; Masello, 2000). Further, observations on gastropod shell damage caused by trawling are of interest and may be useful as a monitoring tool for fishing effort: the bivalve *Arctica* has been used as an indicator organism for the intensity of bottom trawling in the southern North Sea, with shells from heavily fished areas characterized by a high degree of damage (Witbaard & Klein, 1994). However, no study exists on the impact of the hake fishery on non-targeted species of the marine malacofauna (Scarabino, 2004). In this vein, this paper describes preliminary observations on qualitative (species composition, degree of shell damage) and quantitative (size frequency distributions) aspects of the effect of hake trawlers on large benthic gastropods, in order to provide baseline data for future assessments.

STUDY AREA

The study area comprises the southern portion of Uruguayan and the northern portion of Argentinean continental shelf, between 36 and 40º S in the AUCFZ. The southern portion of the area is influenced by the shelf-break front, a permanent feature that characterizes the border of the shelf. This front is originated by the confluence of subantarctic shelf waters and the cooler and more saline waters of the Malvinas current (Martos & Piccolo, 1988; Lutz & Carreto, 1991). Cyclical variations in the geographical location of the front are associated with the dynamics of the Malvinas Current (Olson *et al.*, 1988; Fedulov *et al.*, 1990). At 38–39°S the front varies seasonally, moving offshore during summer and onshore during spring and autumn, as pointed out by Carreto *et al*. (1995). Its inner boundary lies between the 90 and 100 m isobath. The shelf-break front may be followed northwards up to the Brazil-Malvinas Confluence. The Brazil-Malvinas confluence extends offshore to the oceanic domain, and inshore over the shelf, defining a thermohaline sub-surface front between subtropical shelf waters and subantarctic shelf waters (Piola *et al.*, 2000). This subtropical shelf front is located near the 50 m isobath at 32ºS and extends southwards towards the shelf-break near 36ºS (Acha *et al.*, 2004). These oceanographic features make Uruguayan shelf and the northern portion of the Argentinean continental shelf a high productivity area, supporting large fisheries targeting several species.

MATERIAL AND METHODS

I analyzed data from "Programa Nacional de Observadores a Bordo" of Dirección Nacional de Recursos Acuáticos (DINARA), Ministerio de Ganadería, Agricultura y Pesca, Uruguay. Observations were made in November 2004 during a 37 days cruise in a 70 m length commercial fishing vessel targeting hake (*M. hubbsi*). The fishing gear consisted in a bottom trawl, with 120 mm mesh size between opposite knots, a vertical aperture of 3.8 m and 98 m between the doors. The average tow time was 4 hours, with the gear set four or five times per day. A total of 24 stations were chosen to encompass the broadest range of environmental conditions. The exact location of the stations was determined by Global Positioning System (GPS). Mean operational depth was calculated for all the stations. After each tow, the by-catch was observed once it had been sent to the processing area. Short observation periods (30´) were randomly set during processing time, since it was not feasible to examine the entire catch without disrupting the operations. All large gastropods observed during these periods were thus noticed and identified *in situ*. Size (as shell length) was then measured from this random sample to determine the size-frequency distributions (SFD´s). Only alive specimens were considered. In addition, qualitative observations on species-specific nature and degree of shell damage were performed.

RESULTS

Without exception, at least one (but commonly three) species of large gastropods were present as by-catch in all stations. Four species of large shelled benthic gastropods, belonging to three families, were collected: the rannelid *Fusitriton magellanicus* (Röding 1798), the volutids *Adelomelon ancilla* (Lightfoot 1786) and *Odontocymbiola magellanica* (Gmelin 1791), and the muricid *Trophon acanthodes* Watson 1882 (Fig. 1). After each tow, all gastropods were discarded.

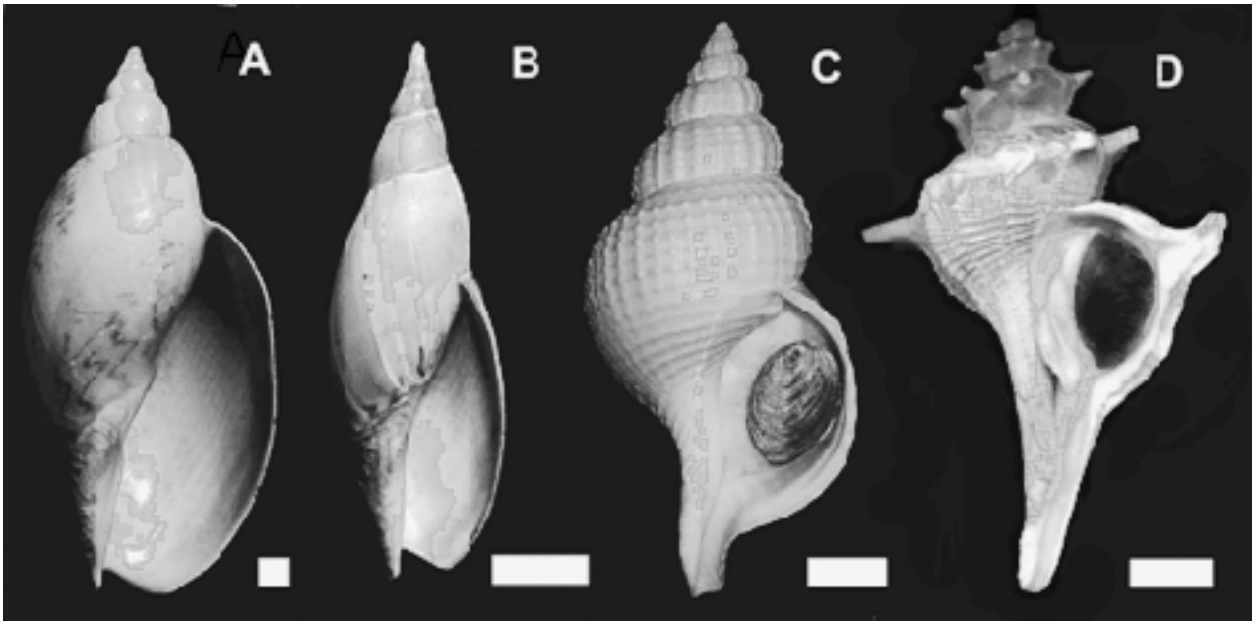

Figure 1. Shelled gastropods occurring as by-catch in southwestern Atlantic hake fishery: *O. magellanica* (A), *A. ancilla* (B), *F. magellanicus* (C) and *T. acanthodes* (D). Scale bar: 1 cm.

Before returned to the sea, some 356 shells were measured. Roughly, 50% of the examined shells belong to *A. ancilla* (178 specimens). *Fusitriton magellanicus* (121 individuals, 34%) and *O. magellanica* (53 specimens, 15%) followed in terms of relative abundance. Finally, *T. acanthodes* was represented by 5 specimens (1%). *Adelomelon ancilla* was the most ubiquitous large gastropod occurring as by-catch during the cruise, its presence being noticed in 23 stations. Shell length of the measured individuals ranged from 5.6 to 20 cm, with a mean size of 11.8 cm. Size-frequency distribution for this species showed a peak at the 11 cm size class. This species was caught in waters ranging from 89 to 343 m. *Fusitriton magellanicus* occurred at 22 stations in depths ranging from 73 to 315 m and had a mean shell length of 8.9 cm. The modal class for the SFD was 9 cm. *Odontocymbiola magellanica* reached 22.5 cm of maximum shell length and mean and modal sizes of 15.5 and 16 cm. respectively. This species was recorded in depths ranging from 71 to 146 m. A poorly-known species, *Trophon acanthodes*, occurred at five stations, its mean shell length being 9.4 cm. Locations of the records for each species are shown in Figure 2. Figure 3 shows the SFD´s for *A. ancilla*, *F. magellanicus* and *O. magellanica*. SFD for *T. acanthodes* is not shown owing to the low number of individuals collected.

The observations on nature and degree of shell damage suggested that this depended on species shell features. Volutid species were the most damaged (*ca*. 30% of the specimens), displaying variable degrees of injury, from broken lips to completely destroyed shells with soft parts being completely exposed. Typically the larger specimens were more frequently damaged that smaller ones. *Fusitriton magellanicus* and *T. acanthodes* were less affected. However, both showed eventually some kind of minor damage. In particular, the latter often presented broken siphonal channel and spines.

DISCUSSION

Large gastropod by- catch in the hake fishery at the AUCFZ seems to be a common fact, as may be inferred by the proportion of tows in which these animals were collected (100%). Although data on large gastropods by-catch are scanty, this figure is higher than other reported, like those from New Zealand deep water trawl fishery (82%; Probert *et al.*, 1997) for all benthic

invertebrates. Carranza *et al.* (in press) reported nearly 70% of large gastropods by-catch during white croaker surveys made at the inner Uruguayan shelf. In the immersed gillnet fishery of southern Brazil, benthic invertebrates were less frequently entangled, and large gastropods (*Adelomelon riosi* Clench & Turner 1964, *Odontocymbiola simulatrix* Leal & Bouchet 1989) presented values of 0.15 and 0.03 individuals/100 nets respectively (Alvarez-Perez & Wahrlich, 2005). The higher values observed in this study could be attributed to higher average tow time and the features of the fishing array employed (*e.g.* horizontal aperture).

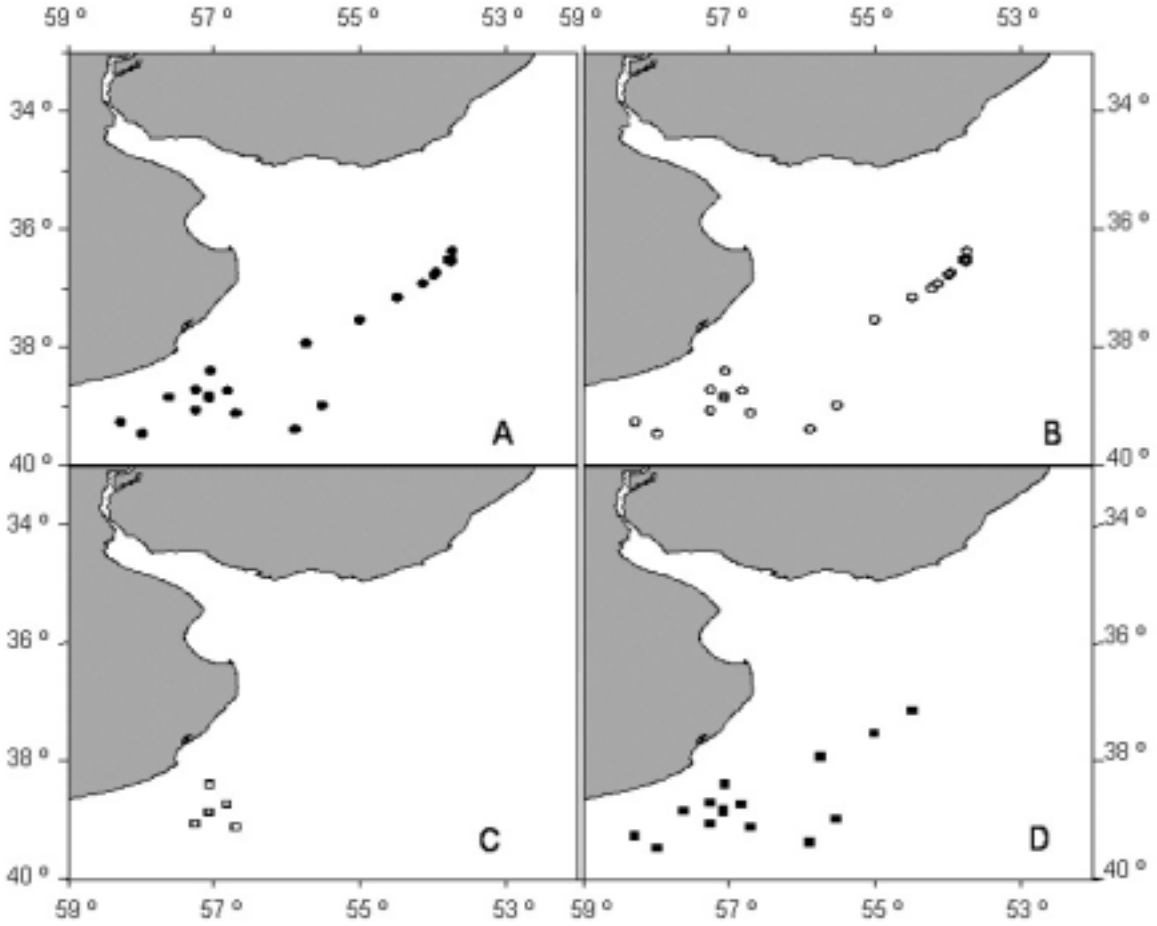

Figure 2. Map of the study area showing the location of fishing operations surveyed and the records of individual species: (A) *A. ancilla*, (B) *F. magellanicus*, (C) *T. acanthodes* and (D) *O. magellanica.*

As shown by the SFD´s , most size classes were affected by trawling, since small shells (*i.e.* > 5.6 cm shell length) are caught by the fishing gear. However, it has been shown that for the volutid *Zidona dufresnei* (Donovan 1823), that sampling efficiency of a 42 x 42 mm mesh size fishing gear is far from 100% below 160 mm shell length (Giménez *et al.*, 2004). In this context, the observed SFD´s are suspected to be heavily biased towards larger animals. This is of importance since size selection caused by the fishing gear may cause changes in population's size structure.

Volutid species were more vulnerable to shell damage, due mainly to their large size. *Fusitriton magellanicus* was less vulnerable due to its smaller size and to the protection conferred by encrusting sea anemones (Actiniaria) and sponges. The resistance to shell crushing is also enhanced by the typical reflected outer lip of the ranellid shell. *Trophon acanthodes* posses also a thicker shell, and is often colonized by sea anemones. The degree of direct shell damage (which is in turn dependent on species shell features and size), and the time spent on deck before returned to the sea are likely to affect the survivorship of the trawled specimens. Alvarez-Perez & Wahrlich (2005) suggested that indirect mortality tended to be higher in organisms between 200 and 1000 g on average, being quantitatively less important in very large or very small species.

Discarded or damaged benthos inputs may have also effects on the trophic web structure. Although

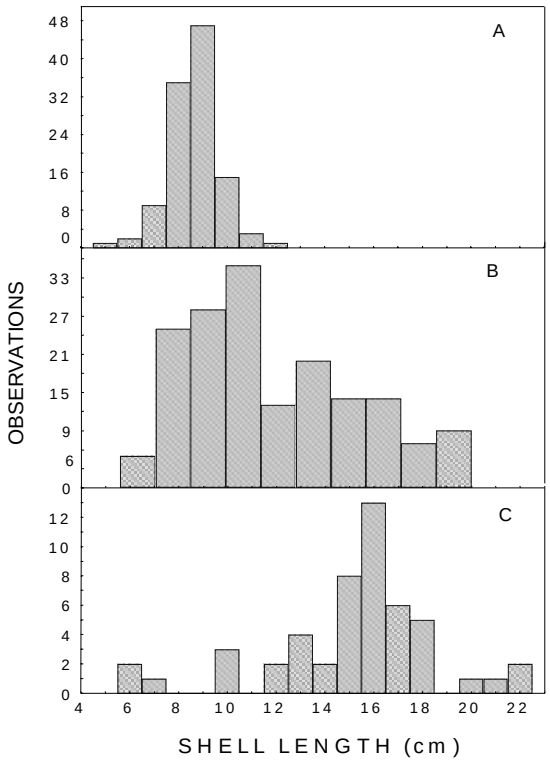

Figure 3. Size-frequency distributions for *F. magellanicus* (A), *A. ancilla* (B) and *O. magellanica* (C).

the direct importance of this additional food resource is considered to be relatively small, the importance may be relatively larger for scavenging fish than for invertebrates (Groenewold & Fonds, 2000). It is estimated that after a single beam trawling about 6% to 13% of the annual secondary production of macrobenthos per unit area, would suddenly become available to scavengers and to the detritus food chain, leading to shortcuts in trophic relationships and therefore enhancing secondary production (Groenewold & Fonds, 2000). It is also suggested that the by- catch may in turn affect particularly the nature of the trophic relationships between benthic gastropods and demersal fishes. Further, all the gastropods reported here are predatory species, for which top-down effects on the trophic web may be expected. In this context, changes in their populations would have significant effects in the marine ecosystem (Jennings & Kaiser, 1998).

The results highlight the need for monitoring the effect of hake fisheries upon the macrozoobenthos, in order to avoid or minimize damage to benthic populations. Future studies should be focused on quantitative aspects of the by-catch, thus estimating the amount and specific composition of discarded biomass and rates of lethal and sub-lethal injuries caused by trawling activity on large benthic gastropods and other benthic invertebrates.

ACKNOWLEDGEMENTS

The author wish to acknowledge Marina and Estela for encouragement and support. F. Scarabino, S. Martínez, L. Ortega, M. Arim and W. Norbis provided helpful and constructive comments and bibliography. Special thanks to Omar Defeo, Pablo Penchaszadeh and an anonymous referee for their valuable comments that helped to improve this manuscript. The crew of the fishing vessel monitored is also thanked. Financial support from PEDECIBA and CSIC is acknowledged.

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Recibido: 8 de noviembre de 2005
Aceptado: 26 de octubre de 2006.