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EXPLOITATION OF THE VOLUTE SNAIL *ZIDONA DUFRESNEI* IN ARGENTINE WATERS, SOUTHWESTERN ATLANTIC OCEAN

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ABSTRACT *Zidona dufresnei* (fine snail) is a common gastropod species in the Southwestern Atlantic Ocean, which has been exported to Asian countries for human consumption since 1988. Landings of *Z. dufresnei* increased from 1974 to a maximum record of 1,300 mt (whole shelled animal) in 1997, followed by a steady decline through 2002. No resource management effort have been applied to this species since the beginning of its catch history, about 30 y ago. Information provided in this work, together with previous studies on the reproductive biology and population dynamics of *Z. dufresnei*, will contribute to establish effective precautionary policies to manage this resource. We suggest that *Z. dufresnei* is in a phase of over-exploitation since 1988 until present, we propose a rational management as size selectivity, with a minimum capture size of 16 cm, closure of the fishery during the reproductive season, from September to December and to rotate the fishing areas. This study provides historical and updated information as an attempt to implement corrective measures towards a better management of the fishery on the Argentine Continental Shelf.

KEY WORDS: volutes, marine snail, *Zidona dufresnei*, coastal fishery, Argentine Sea

INTRODUCTION

Marine gastropods represent approximately 2% of the molluscs fished in the world, and several gastropod species, such as *Haliotis* spp., *Strombus* spp., *Busycon* spp. and *Concholepas concholepas* have high economic value in international markets and play substantial social roles in small-scale artisanal fisheries (Leiva & Castilla 2002).

Resource sustainability has been difficult to achieve when incomes are growing. The number of overfished populations, and the indirect effects of fisheries on marine ecosystems, indicates that management has failed to achieve a principal goal, sustainability (Botsford et al. 1997). This situation has been promoted through a fishing behavior involving successive exploitation cycles, as well as the replacement of depleted stocks or fishing areas by new ones. As a result, various marine gastropods were incorporated as a new fishery resource. However, many of these show serious problems of overexploitation because of their high economic value and excessive capture (Tegner 1989, Castilla 1996, Ponce-Díaz et al. 1998, Hobday et al. 2001), resulting in some cases in the collapse of the fishery. The economic and social consequences caused by the depletion of marine gastropod stocks promoted the development of new management policies focusing on biologic and economic sustainability (Prince et al. 1998, Castilla 1997, 1999, 2000).

In recent years *Zidona dufresnei* (Donovan, 1823) became a valuable resource in Argentina. This species inhabits the western coast of the Southern Atlantic Ocean, between 25 and 60 m depth on sandy bottoms from Río de Janeiro, Brazil (22°S) to Patagonian waters of San Matías Gulf, Argentina (42°S) (Kaiser 1977). Snails are exported as fresh meal or canned products to different markets, mainly to Asian countries, with only a small proportion being used in the domestic market. In particular, *Z. dufresnei* has been exploited by the Argentinean and Uruguayan fleets for the last 30 y and is one of the few volutids of great commercial value

occurring in the fishing area common to both countries. Only the large muscular foot, representing 60% of the whole body mass without shell, is used for consumption.

Previous studies on *Z. dufresnei* have focused on its taxonomy (Clench & Turner 1964) and anatomy (Novelli & Novelli 1982, Ayçaguer 2002). During the reproductive cycle of *Z. dufresnei*, emission of gametes occur in two pulses during the austral spring and summer (October to March), with two peaks of major activity in October and January to February (Giménez & Penchaszadeh 2002). Although a small proportion of snails attain sexual maturity at a minimum shell length of 12.8 cm, 50% of the population becomes sexually mature at a size of 15.7 cm and 15 cm for females and males, respectively (Giménez & Penchaszadeh 2003). In this species, maximum lifespan is 18 y and individuals are sexually mature at an age of 8–9 y. (Giménez et al. 2004).

This article summarizes information on the fishery of *Z. dufresnei* in Argentina and provides historical data and updated catch reports related to biologic parameters and propose a rational management of the resource.

MATERIAL AND METHODS

The study was carried out between January 1999 and December 2000 off the Mar del Plata coast in Buenos Aires Province, Argentina (Fig. 1) at depths from 40–60 m on sandy and mixed shell-sand bottoms. The data used in this study were obtained from commercial fishing at the Mar del Plata harbor. The bottom trawling fleet was composed of 25 vessels ranging from 20–26.5 m long equipped with and 450–650 HP engines, and a trawl net of 42 mm mesh size.

Historical catch and landing data were obtained from FAO STAT Fishery Data (FAO 2004). Every month, one box randomly chosen from landings at Mar del Plata harbor containing about 50 individuals of *Z. dufresnei* was sampled. The shell length of each snail was measured to the nearest mm with a vernier caliper. The proportion of *Z. dufresnei* males and females was compared using the χ^2 test (Sokal 1998). The sizes of individuals

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caught between 1999 and 2000 were compared using the Kruskal-Wallis test.

To evaluate the importance of the snail fishing areas: A, Querandí (37°10'S); B, Mar del Plata (38°20'S); and C, Quequén (39°10'S) (Fig. 1), we analyzed the daily weight of the total catch of *Z. dufresnei* (SAG y P, 2002) per boat to obtain the catch per unit of effort (CPUE, mt/boat/day). The CPUE of *Z. dufresnei* among areas and between years was compared using 2-way ANOVA. All landings took place at the Mar del Plata harbor. Monthly catches among and within the three fishing sites during 2000 were compared using repeated-measures analysis of variance (ANOVA). Prior to analysis, variables were tested for normality and homoscedasticity. When necessary, Tukey test was used for *a posteriori* comparisons.

The faunal composition of the by-catch was studied from material obtained on board of a "Capitán Cánepa" vessel (INIDEP) on a research cruise performed on October 1999 using a trawl net of 2 cm mesh.

RESULTS

Historical Data

Although in Argentina snail fishery started in 1974 (FAO, 2004), it was established as a commercially relevant fishing resource in 1988 (Lasta et al. 1998). Landings of *Z. dufresnei* increased from 1974 onwards to reach a maximum record of 1300 mt in 1997, followed by a steady decrease through 2002, when landing values dropped to half as compared with 1997 (Fig. 2).

The size structure of *Z. dufresnei* individuals sampled in 1999 ($n = 508$) and 2000 ($n = 543$) from landings at the Mar del Plata

harbor and captured in the Mar del Plata fishing area (area B), is shown in Figure 3. The analysis of the sizes of *Z. dufresnei* revealed the presence of individuals below the size of first maturity during all months between 1999 and 2000 (Fig. 4). The percentages of juveniles were 38.6% and 37% for 1999 and 2000, respectively. There were monthly fluctuations in the frequency of juveniles, and peaks equal to or higher than 65% were observed in March and May of the two studied years.

There were no annual variations in the proportion between the foot weight and size of snails. The proportion of sexes calculated from 1,051 snails landed in the Mar del Plata area was 1:1 (513 males, 538 females; χ^2 test, $P > 0.05$).

Species Composition of Catches

Ninety per cent of volutids captured in the Mar del Plata fishing area were *Z. dufresnei*, and the remainder was *Adelomelon beckii*. The most conspicuous by-catch species of the *Z. dufresnei* fishery is shown in Table 1. By-catch represented 5% of the total capture.

Landings Seasonality

During the study period (1999 to 2000) (Fig. 5), significant differences were found between months (1-way ANOVA, $F_{\alpha=0.05, 3, 20} = 3.3027$, $P < 0.05$), where landings decreased during the winter months of 1999 and 2000. (Tukey test $P < 0.05$).

The daily fishing activities allowed comparison of the CPUE of *Z. dufresnei* obtained from sampling areas A (Querandí), B (Mar del Plata) and C (Quequén) between 1999 and 2000. No significance differences were found in the CPUE attributable to year-

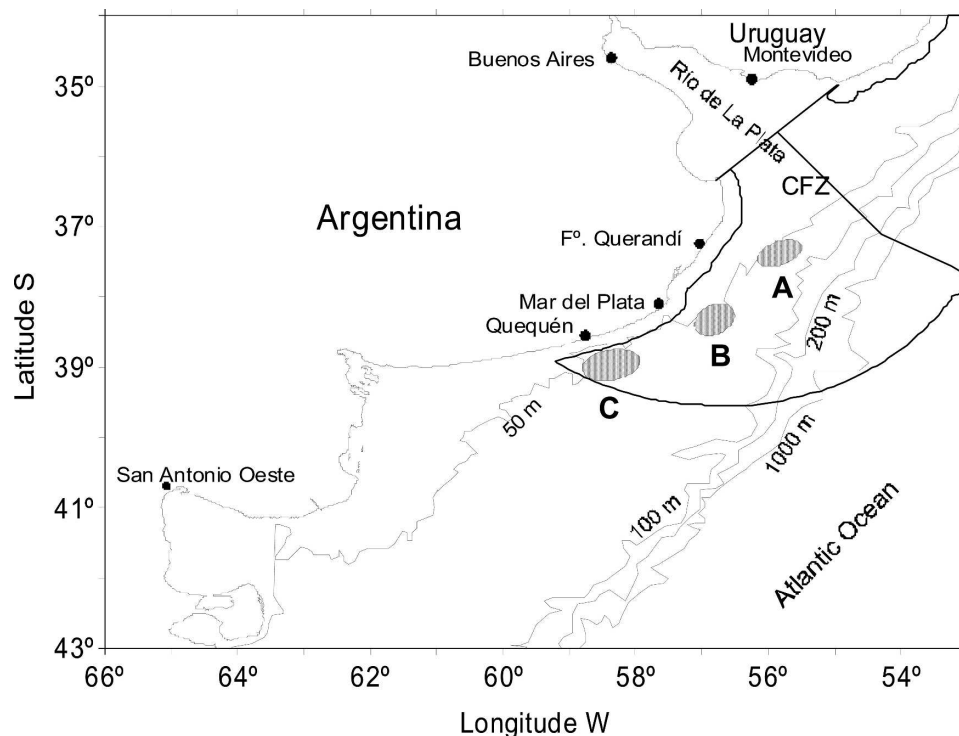


Figure 1. Map of the fishing zones and the Common Fishing Zone with Uruguay. A, Querandí (37°10'S); B, Mar del Plata (38°20'S); and C, Quequén (39°10'S).

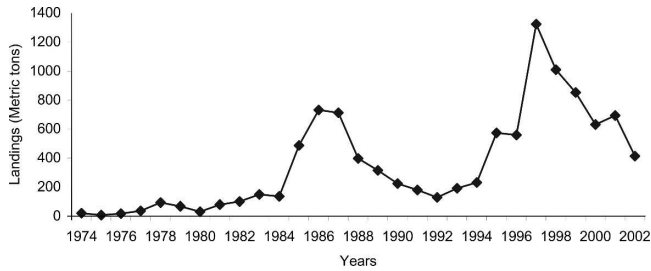


Figure 2. Historical records of *Zidona dufresnei* landings from Argentina (FAO 2004).

fishing area interaction (2-way ANOVA, $F_{\alpha=0.05, 2, 508} = 0.1938$; $P > 0.05$) (Fig. 6). There were significant differences in the CPUE among areas (2-way ANOVA, $F_{\alpha=0.05, 2, 508} = 13.9184$ $P < 0.001$). Area C showed the highest CPUE values (Tukey test $P < 0.05$). No significant differences were found between years (2-way ANOVA, $F_{\alpha=0.05, 1, 508} = 1.5962$; $P > 0.05$).

Monthly catches from the three fishing areas during 2000 are shown in Figure 7. There were no significant differences among areas (Repeated measures ANOVA, $F_{\alpha=0.05, 8, 116} = 1.38798$; $P > 0.05$), but significant differences were found in landings attributable to month-fishing area interaction (repeated measure, ANOVA, $F_{\alpha=0.05, 4, 58} = 55.39524$; $P < 0.001$). A Seasonal pattern was observed in all fishing areas.

DISCUSSION

Landings of *Z. dufresnei* in the Mar del Plata area showed a marked seasonality (Fig. 5). During the winter time, the drop in landings reflects lower catches because the harsh climatic conditions, which reduce the access of the coastal fleet to the fisheries areas (personal communication from fishermen, Mar del Plata). In addition, the low landings in winter are caused by the closure of the *Z. dufresnei* fishery after the recorded peaks of PSP toxins taking place in autumn (Carreto et al. 1996).

At present, *Z. dufresnei* is the most important snail fishery in Argentina because it is located in areas of easy access where it is found in high densities and has a better palatability in comparison with other co-occurring volutid species.

Data suggest that the fishery of *Z. dufresnei* showed the same temporal exploitation phases proposed by Castilla and Fernández

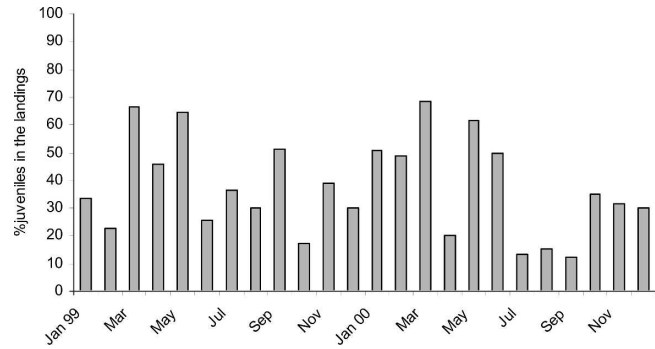


Figure 4. Percentage of *Zidona dufresnei* juveniles (<15 mm in shell length) in the landings from Mar del Plata area.

(1998) for the gastropod *Concholepas concholepas* in Chile. Such exploitation phases are as follows: (1) "Initial exploitation phase," characterized by relatively low and constant landings, there are no major foreign market openings and an absence of management frameworks. In *C. concholepas* this phase extended between 1960 and 1975 and in *Z. dufresnei* between 1974 and 1984. (2) "Expansive extraction phase," characterized by an increasing demand from foreign markets (e.g., Asia and the United States), which increased export of shellfish. In *C. concholepas* this phase extended between 1976 and 1980 and in *Z. dufresnei* between 1984 and 1988. (3) "Over-exploitation phase," characterized by strong foreign market forces, exponential increase in unit prices and easy access to stocks, with the concurrent increase in catch volumes. In *C. concholepas* this phase extended between 1979 and 1989, and in *Z. dufresnei* between 1988 until present. (4) "Closure phase," characterized by overfished or severely depleted populations determining multimonth or annual fishery closures (Defeo et al. 1993, Castilla 1997). Fishery closures were thus used to evaluate the capacity for recovery of depleted populations under absence of fishing (Castilla & Defeo 2001). This phase occurred for *C. concholepas*, from 1989 to 1992. (5) "Stabilization of extraction and institutionalization phase." The information collected on the previous phase improves the quality of management guidelines. Op-

TABLE 1.

By-catch composition from the *Zidona dufresnei* fisheries in Mar del Plata area.

| Principal Groups | Species |
|------------------|---|
| Echinoderms | <i>Astropecten brasiliensis brasiliensis</i> Müller & Troschel 1842 |
| | <i>Arbacia dufresnii</i> (Blainville 1825) |
| Annelids | <i>Aphrodita longicornis</i> Kinberg 1855 |
| Bivalves | <i>Aequipecten tehuelchus</i> (d'Orbigny 1846) |
| | <i>Mytilus edulis platensis</i> d'Orbigny 1846 |
| | <i>Ostrea puelchana</i> d'Orbigny 1841 |
| Gastropods | <i>Adelomelon beckii</i> (Broderip 1836) |
| | <i>Crepidula argentina</i> Simone, Pastorino & Penchaszadeh 2000 |
| Crustaceans | <i>Libinia spinosa</i> Milne Edwards 1834 |
| Fishes | <i>Paralichthys patagonicus</i> Jordan 1889 |
| | <i>Percophis brasiliensis</i> Quoy & Gaimard 1824 |
| | <i>Squatina argentina</i> (Marini 1930) |
| | <i>Discopyge tschudii</i> Heckel 1846 |

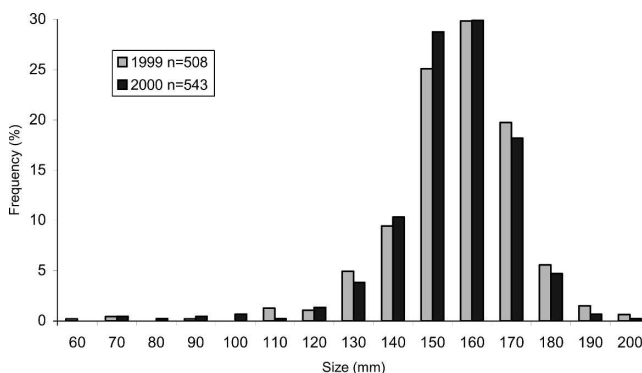


Figure 3. Size structure of *Zidona dufresnei* individuals in 1999 and 2000 from landings at the Mar del Plata harbor.

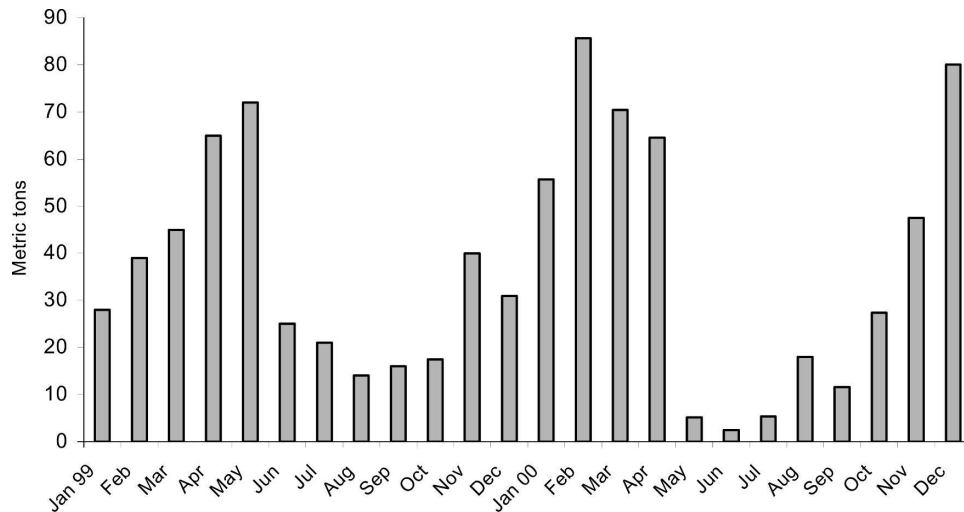


Figure 5. *Zidona dufresnei* landed at the harbor of Mar del Plata during 1999 and 2000.

erational management instruments based on area-specific management plans (minimum legal sizes, fishery gear restrictions, total catch levels per fisher and catch per fishing ground) are implemented in Chile (Castilla et al. 1998). *C. concholepas* has been in this phase since 1992. (6) "Mature and consolidation phase," characterized by sustainable exploitation over time through effective resource management. The muricid *C. concholepas* fishery is close to attaining this phase (Castilla 1999, 2000).

This information suggests that *Z. dufresnei* would be following the same pattern of phases as *C. concholepas*. Presently *Z. dufresnei* seem to be in the over-exploitation phase. The fact that this phase was longer for *Z. dufresnei* than for *C. concholepas* would affect the rate of resource depletion.

Until present, no studies have been conducted to determine appropriate mesh sizes of nets and to evaluate or improve fishing selectivity for gastropods in the Southwestern Atlantic. Therefore, the question about maximum individual production in function of capture: "could selection be optimized?" still remains unanswered. As with most marine benthic resources in Latin American coun-

tries, *Z. dufresnei* still continues in the "over-exploitation phase."

Over-exploitation can also be detected through the analysis of sizes from captured specimens. The frequency of individuals with large body sizes decreased, whereas those with intermediate sizes increased. When the size at first sexual maturity (Giménez & Penchaszadeh 2003) was compared with the size distribution of collected snails, more than one third of the latter was below the size of sexual maturity. Fluctuations observed in Figure 4 indicated that during summer months when fishing pressure was heavier, the proportion of individuals below the size of sexual maturity was greater than in the rest of the year.

The analysis of landing data indicates that Mar del Plata (area B) is the most important fishing area with the heaviest exploitation. Information on the accompanying species is useful to assess further changes in the local community, thereby reducing potential impacts on the ecosystem. Indirect trophic (food web) interactions induced by fishery removals represent a second class of important indirect effects of fishing. (Botsford et al. 1997)

Even when mussels (*Mytilus edulis platensis*), oysters (*Ostrea puelchana*) and scallops (*Aequipecten tehuelchus*) are species of commercial importance, only the first develop in high densities near the study area. Although by-catch represents 5% of the total capture, further studies regarding the by-catch community composition must be performed to assess changes in the ecosystem and impacts associated by the bottom trawling used in these fisheries.

Guidelines that could be adopted for the management of this small-scale fishery are the rotation of exploited areas, together with size-selective fishing (from the size at first sexual maturity onwards) and fishing coordinated with the reproductive cycle.

Z. dufresnei is vulnerable to over-exploitation because of slow growth (Giménez et al. 2004), late attainment of sexual maturity (Giménez & Penchaszadeh 2003), low dispersal capacity caused by the direct development of a small number of embryos within egg-capsules attached to hard substrates (Penchaszadeh & de Mahieu 1976).

We propose a minimum capture size of 16 cm for *Z. dufresnei*, taken into account that the size at first maturity is 15 cm for males and 15.7 in females (Giménez & Penchaszadeh 2003). We

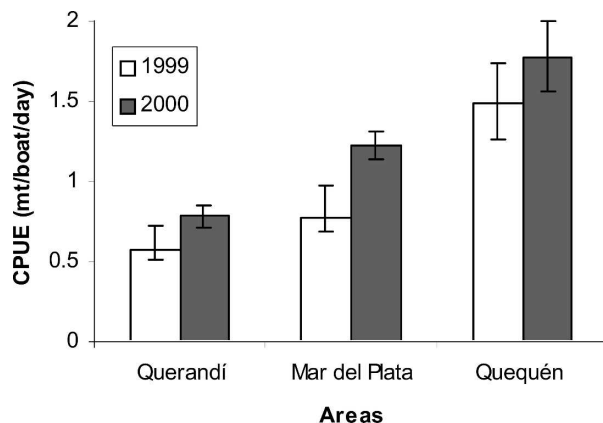


Figure 6. *Zidona dufresnei* from sampling areas A (Querandí), B (Mar del Plata) and C (Quequén) in 1999 and 2000. Mean (\pm standard error) annual CPUE values (mt/boat/day).

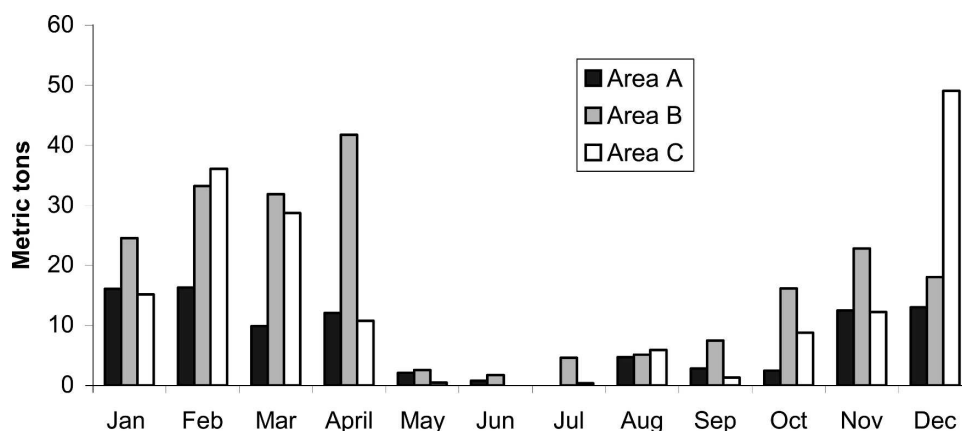


Figure 7. Monthly landings of *Zidona dufresnei* from sampling areas A (Querandí), B (Mar del Plata) and C (Quequén) during 2000.

recommend a fishery ban for *Z. dufresnei* during part of the reproductive season, from September to December (Giménez & Penchaszadeh 2002). All facts mentioned earlier in this article address the necessity and urgency of establishing policies to regulate the minimum capture size and to protect fishing areas of *Z. dufresnei*.

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LITERATURE CITED

- Ayçaguer, C. 2002. Anatomía de las volutas del Atlántico Sudoccidental, I: Anatomía general y del sistema reproductor de *Zidona dufresnei* (Donovan, 1823) (Neogastropoda: Volutidae). *Com. Soc. Malac. Urug.* Vol VIII N 76–77:159–180.
- Botsford, L. W., J. C. Castilla & C. H. Peterson. 1997. The management of fisheries and marine ecosystems. *Science* 277:509–515.
- Carreto, J. I., C. El Busto, H. Sancho, M. Carignan, Y. Takeshi & Y. Oshima. 1996. Comparative studies on paralytic shellfish toxin profiles on marine snails, mussels and an *Alexandrium tamarense* isolate from the Mar del Plata coast (Argentina). *Rev. Invest. Des. Pesq.* 10:101–107.
- Castilla, J. C. 1996. La futura red chilena de parques y reservas marinas y los conceptos de conservación, preservación y manejo en la legislación nacional. *Rev. Chil. Hist. Nat.* 69:253–270.
- Castilla, J. C. 1997. Chilean resources of benthic invertebrates: fishery, collapses, stock rebuilding and the role of coastal management areas and National Parks. In: D. A. Hancock, D. C. Smith, A. Grant & J. P. Beumer, editors. Developing and sustaining world fisheries resources: the state of science and management. Second World Fisheries Congress proceedings. CSIRO, Collingwood, Australia. pp. 130–135.
- Castilla, J. C. 1999. Coastal marine communities: trends and perspectives from human-exclusion experiments. *Trends Ecol. Evol.* 14:280–283.
- Castilla, J. C. 2000. Roles of experimental marine ecology in coastal management and conservation. *J. Exp. Mar. Biol. Ecol.* 250:3–21.
- Castilla, J. C. & O. Defeo. 2001. Latin American benthic shellfisheries: emphasis on co-management and experimental practices. *Rev. Fish Biol. Fish.* 11:1–30.
- Castilla, J. C. & M. Fernández. 1998. Small-scale benthic fisheries in Chile: on co-management and sustainable use of benthic invertebrates. *Ecol. Applic.* 8:124–132.
- Castilla, J. C., P. Manríquez, J. Alvarado, A. Rosson, C. Pino, C. Espoz, R. Soto, D. Oliva & O. Defeo. 1998. The artisanal caletas as unit of production and basis for community-based management of benthic invertebrates in Chile. *Can. Spec. Publ. Fish. Aquat. Sci.* 125:407–413.
- Clench, W. J. & R. D. Turner. 1964. The subfamilies Volutinae, Zidoninae, Odontocymbiolinae and calliotectinae in the Western Atlantic. *Johnsonia* vol. 4 No. 43.
- Defeo, O., A. de Alava, V. Valdivieso & J. C. Castilla. 1993. Historical landings and management options for the genus *Mesodesma* in coasts of South America (Chile). *Biol. Pesq.* 22:41–54.
- F.A.O. 2004. FAOSTAT Fishery Data. FAO Statistical Databases (<http://www.fishbase.org.ph/report/FAO/FAOSearchMenu.cfm>)
- Giménez, J., T. Brey, A. Mackensen & P. E. Penchaszadeh. 2004. Age, growth and mortality of the prosobranch snail *Zidona dufresnei* (Donovan, 1823) in the Mar del Plata area, SW Atlantic Ocean. *Mar. Biol.* 145:707–712.
- Giménez, J. & P. E. Penchaszadeh. 2002. The reproductive cycle of *Zidona dufresnei* (Donovan, 1823) (Caenogastropoda, Volutidae) from the southwestern Atlantic Ocean. *Mar. Biol.* 140:755–761.
- Giménez, J. & P. E. Penchaszadeh. 2003. Size at first maturity in *Zidona dufresnei* (Caenogastropoda, Volutidae) of the Southwestern Atlantic Ocean (Mar del Plata, Argentina). *J. Mar. Biol. Ass. UK.* 83:293–296.
- Hobday, A. J., M. J. Tegner & P. L. Haaker. 2001. Overexploitation of a broadcast spawning marine invertebrate: decline of the white abalone. *Rev. Fish Biol. Fish.* 10:493–514.
- Kaiser, P. 1977. Beiträge zur Kenntnis der Voluten (Mollusca) in argentinisch-brasilianischen Gewässern (mit der Beschreibung zweier neuer Arten). *Mitt. Hamburg. Zool. Mus. Inst. Brad.* 74:11–26.
- Lasta, M. L., N. F. Ciocco & C. S. Brevec. & A. M. Roux. 1998. Moluscos bivalvos y gasterópodos. El Mar Argentino y sus recursos pesqueros. In: E. Boschi, editor. Los moluscos de interés pesquero. Cultivos y estrategias reproductivas de bivalvos y equinoideos. INIDEP. Mar del Plata 2. pp. 115–142.
- Leiva, G. E. & J. C. Castilla. 2002. A review of the world marine gastropod fishery: evolution of catches, management and the Chilean experience. *Rev. Fish Biol. Fish.* 11:283–300.
- Novelli, R. & A. Novelli. 1982. Algumas consideracoes sobre a subfamilia Zidoninae e notas sobre a anatomia de *Adelomelon brasiliana* (Lamarck, 1811), Mollusca, gastropoda, Volutidae. *Atlântica* 5:23–34.

- Penchaszadeh, P. E. & G. C. de Mahieu. 1976. Reproducción de gasterópodos prosobranquios del Atlántico Suroccidental. *Volutidae. Physis A* 35(91):145–153.
- Ponce-Díaz, G., A. Vega-Velásquez, M. Ramade-Villanueva, G. León-Carvalho & R. Franco-Santiago. 1998. Socioeconomic characteristics of the abalone fishery along the west coast of the Baja California peninsula, Mexico. *J. Shellfish Res* 17:853–857.
- Prince, J., C. Walters, R. Ruiz-Avila & P. Sluczanowski. 1998. Territorial user's rights and the Australian abalone (*Haliotis* sp.) fishery. In: G. S. Jamieson & A. Campbell, editors. *Proceedings of the North Pacific Symposium on Invertebrate Stock Assessment and Management*. Can. Spec. Publ. Fish. Aquat. Sci. 125. pp. 367–375.
- SAGP y A. 2002. Dirección Nacional de Pesca y Acuicultura. www.sagpya.mecon.gov.ar/0-0/index_pesda.htm.
- Sokal, R. R. 1998. *Biometry. The principles and practice of statistics in biological research*. New York: W.H. Freeman and Company. 887 pp.
- Tegner, M. J. 1989. The California abalone fishery: production, ecological interactions, and prospects for the future. In: J. F. Caddy, editor. *Marine invertebrate fisheries: their assessment and management*. New York: John Wiley and Sons. pp. 401–420.