

Research Article

Habitat overlap of *Paralabrax humeralis* (Cuvier & Valenciennes, 1828), *Hemilutjanus macrophthalmos* (Tschudi, 1845), and *Acanthistius pictus* (Tschudi, 1845) (Pisces; Serranidae) in the rocky subtidal south of Iquique, Chile

Félix Cisternas¹ & Walter Sielfeld¹

¹Departamento de Ciencias del Mar, Universidad Arturo Prat, Casilla 121, Iquique, Chile

ABSTRACT. A simple SCUBA diving survey was used to study the habitat use and coexistence of three species in the family Serranidae with sympatric distribution patterns along the rocky subtidal south of Iquique. Depth and microhabitat were recorded for each sampled individual. Samples were taken at 15 different beaches through SCUBA diving in the deepest areas of the first rocky fringe, herein referred to as the transition zone. The data were analyzed according to depth and frequency of use (microhabitat, habitat) for each species and considering three size classes. Dendograms were created to interpret the similarities in the use of beaches, microhabitat, and habitat. The results showed the species to be independent in their use of the microhabitat and habitat. The most abundant species was the roving *Paralabrax humeralis* whose habitat was mostly associated with *Lessonia trabeculata*. *Hemilutjanus macrophthalmos* and *Acanthistius pictus* are cavity specialists, although their microhabitat use differed according to the size of the cavity: *H. macrophthalmos* occupied larger caves (> 0.5 m) and *A. pictus* mostly smaller cavities (< 0.5 m). The lack of juvenile *A. pictus* individuals seems to indicate the use of an alternative ecosystem. The distribution patterns of these Serranids varied throughout the study area, indicating a dependence on the geomorphology of the substrate and the presence of the structural species *L. trabeculata*.

Keywords: sympatric species, transition zone, microhabitat, habitat, Serranidae, Chile.

Sobreposición de habitat de *Paralabrax humeralis* (Cuvier & Valenciennes, 1828), *Hemilutjanus macrophthalmos* (Tschudi, 1845) y *Acanthistius pictus* (Tschudi, 1845) (Pisces; Serranidae) asociado al submareal rocoso al sur de Iquique, Chile

RESUMEN. Un simple método de censo mediante SCUBA, se empleó para comprender la utilización de hábitat y coexistencia entre tres especies de la familia Serranidae que presentan un patrón de distribución simpátrico, dentro del submareal rocoso al sur de Iquique. Se obtuvieron las profundidades y microhabitats de los ejemplares muestreados. Los muestreos se realizaron en 15 playas con buceos hasta el límite inferior de la primera franja rocosa, denominada en este trabajo como zona de transición. Los datos se analizaron utilizando profundidad, frecuencia del uso de microhabitat y hábitat, por especie y tres categorías de tamaño. Se realizaron dendogramas para interpretar las similitudes en la utilización de playas, microhabitat y hábitat, los resultados muestran una independencia específica en el uso de microhabitat y hábitat. *Paralabrax humeralis* es la especie más abundante, presenta una forma merodeadora y su hábitat está principalmente asociado a *Lessonia trabeculata*. *Hemilutjanus macrophthalmos* y *Acanthistius pictus* son especialistas de cavidades, aunque presentan diferencias en el uso de hábitat mediado por el tamaño de las cavidades, *H. macrophthalmos* es especialista de cavernas grandes (> 0,5 m) en cambio *A. pictus* utiliza principalmente cavidades pequeñas (< 0,5 m). No se observaron ejemplares juveniles de *Acanthistius pictus*, lo cual supone la utilización de un ecosistema alternativo. Los patrones de distribución de estas especies de la familia Serranidae a lo largo de la zona muestreada, indican una dependencia hacia las características geomorfológicas del substrato y la presencia de la especie estructural *Lessonia trabeculata*.

Palabras clave: simpátricas, zona de transición, microhábitat, hábitat, Serranidae, Chile.

INTRODUCTION

Biodiversity patterns and ecosystem organization along the subtidal rocky coast of northern Chile depend on three factors: characteristics of oceanographic processes, the substrate and the presence of structural species (e.g. *Lessonia* spp., *Macrocystis* spp.). The later two factors seem to provide a diversity of shelter and feeding grounds for a great variety of marine organisms (Reñones *et al.*, 1997). In the case of fishes where habitat selection seems to be mediated by predation and feeding (Lockett & Suthers, 1998), there is uncertainty to what extent substrate type or the presence of structural species or a combination of both factors along with the effect of oceanographic processes are triggering the patterns of fish assemblages in northern Chile. For example, a pioneer work suggested that although algae provide food for fish, a rocky substrate is more important than the presence of *Lessonia trabeculata* in terms of creating areas with a large number of fish species (Moreno *et al.*, 1979), arguing that spatial heterogeneity determines the number of species that might occupy a habitat. This hypothesis implies habitat segregation as the best form of coexistence. Núñez & Vásquez (1987) suggest that coexistence patterns for subtidal kelp fish off central Chile are principally mediated by differential habitat usage. According to Fasola *et al.* (1997), the factors that determine the assemblage structure and resource partitioning among coexisting species are unclear and competition greatly affects niche partitioning. These authors hypothesize that fish communities in reef environments are structured by several interacting processes, physical disturbances, recruitment limitations, resource availability of space, shelter and food, interspecies competition, and predation. Segregation mediated by habitat, also known as “ecological isolation”, seems to be critical in related species, such as in the case of the “coexistence mechanism” mediated by a spatial factor, which is considered to be a niche axis (Moreno *et al.*, 1977).

Microhabitats constitute one of the most representative and easiest to measure niches and happen to be a factor regulating the coexistence of sympatric fish species (Núñez & Vásquez, 1987). The family Serranidae is represented by three species of sympatric predators (*Paralabrax humeralis*, *Hemilutjanus macrophthalmos*, *Acanthistius pictus*) along the coastal shore ecosystems off northern Chile (Chirichigno, 1974; Mann, 1954). Vargas *et al.* (1999) suggest that these three species have coexistence mechanisms other than feeding given by their different habitat uses. The family Serranidae coexists on the continental shelf off northern Chile (extending to 200 m depth)

(Stuardo, 1988) in a subtidal kelp forest of *L. trabeculata* (extending no deeper than 20 m) (Núñez & Vásquez, 1987). The coexistence of these fish species is mediated by differential habitat usage and habitat segregation within the kelp forest of the rocky subtidal off the northern Chilean coast. Consequently, it is important to analyze habitat preferences in order to understand the Serranidae distribution and coexistence.

If the species of the Serranidae family cohabitate in the rocky subtidal, then their coexistence must be mediated by their differential use of habitat. Within the rocky subtidal south of Iquique, *P. humeralis*, *A. pictus*, and *H. macrophthalmos* use the habitat differently, presumably defined by the studied microhabitat categories. Thus, it seems important to understand their distribution and coexistence mechanisms according to habitat and microhabitat use. In this study, we analyze the bathymetric and beach distributions with regard to the microhabitat and habitat use of *P. humeralis*, *A. pictus*, and *H. macrophthalmos* along the rocky subtidal south of Iquique (20°17'S-20°45'S) off northern Chile.

MATERIALS AND METHODS

Samples were taken south of Iquique (20°17'S-20°45'S) (Fig. 1) to the deepest zone of the subtidal rocky fringe where the soft bottom begins. Sampling lasted from 17 August until 23 October of 2000 with a total of 15 diurnal dives. Samples were taken using roving SCUBA diving. All caves and rocky spaces were examined and microhabitat and depth were recorded for each individual grouper fish. The fish were estimated under the water to be in one of three size categories (i.e., < 25; 25,1 - 45 > 45 cm). The divers had become acquainted with these categories (small, medium, large) prior to sampling using a spear fishing method of recognition and laboratory length measurements. Depth distribution was recorded at intervals of 5 m (5, 10, 15, 20 m). Habitat was recorded as the total type of fish microhabitat. The following microhabitat categories were used: water column, air bubbles, soft bottom, rock, boulder rock, flat rock, cavities (< 0.5 m), caves (> 0.5 m), cliffs, shell reef, *Tetrapigus niger* (dominant benthic hard bottom equinoderm), anemone, sponge, *Lessonia trabeculata*, algal turf, crustose algae, and soft algae. A microhabitat was determined when the fish presence frequency exceeded 55%. Similarity charts were created using the Schoener index (Fasola *et al.*, 1997).

$$IS = 1 - 0.5 \cdot \sum |P_{xi} - P_{yi}|$$

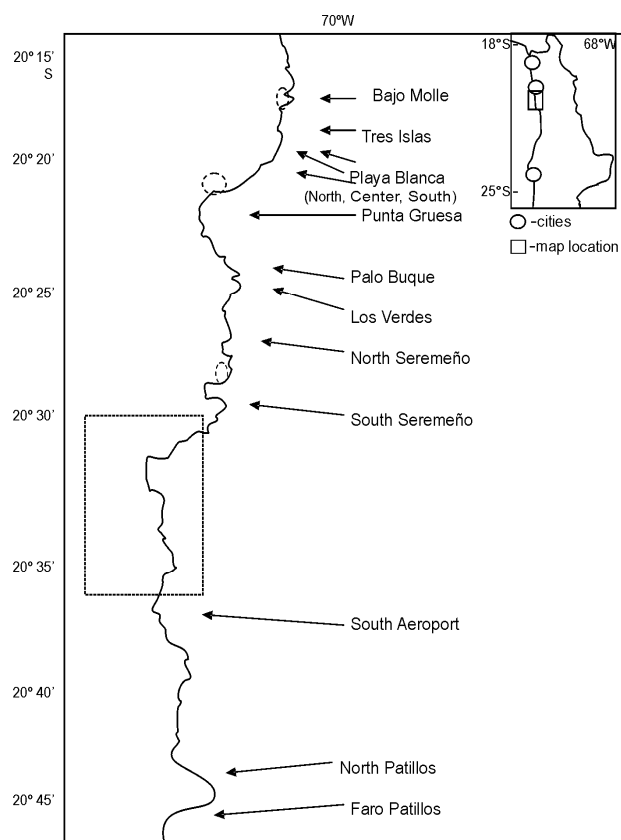


Figure 1. Research zone with 15 beaches (20°17'S-20°45'S), spotted lines indicate protected areas.

Figura 1. Zona de muestreo con 15 playas (20°17'S-20°45'S), líneas punteadas indican zonas protegidas.

where P is the proportion of i in x and y; two mode dendograms were built: (1) Mode Q: i represents the fish species; similarity analysis for beaches and microhabitats and (2) Mode R: x and y represent the fish species; intra and interspecific fish overlap of Serranidae in habitat and microhabitat use (Ludwig & Reynolds, 1988).

RESULTS

All told, 397 *P. humeralis* were found distributed through the entire first rocky fringe and at all depths from 0 to 25 m (Fig. 2). The modes of the 146 *H. macrophthalmos* specimens observed were found between 10 and 15 m depth (Fig. 3). *A. pictus* (19 specimens) tended to prefer the central part of the rocky fringe between 5 and 15 m depth (Fig. 4). Two groups of beaches overlapped showing no latitudinal association patterns (Fig. 5). Microhabitat cavities (< 0.5 m) were segregated from the rest of the microhabitat as only *Acanthistius pictus* was found in these. The microhabitats *Tetrapigus niger*, boulder type rock,

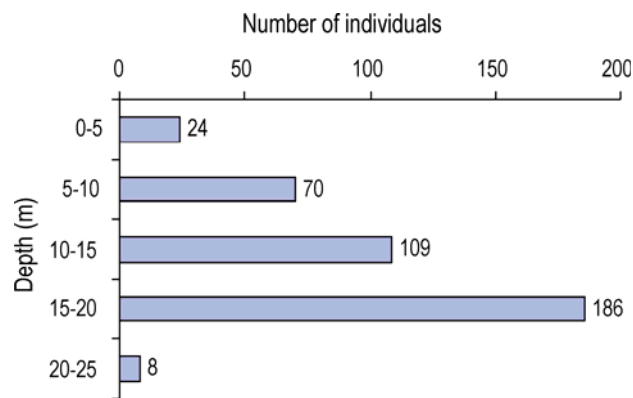


Figure 2. Bathymetrical distribution of *Paralabrax humeralis*.

Figura 2. Distribución batimétrica de *Paralabrax humeralis*.

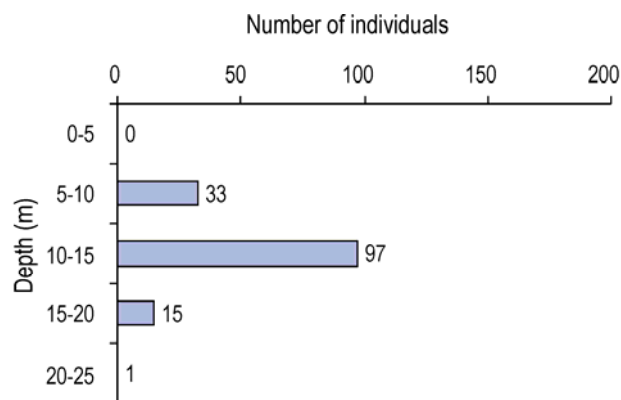


Figure 3. Bathymetrical distribution of *Hemilutjanus macrophthalmos*.

Figura 3. Distribución batimétrica de *Hemilutjanus macrophthalmos*.

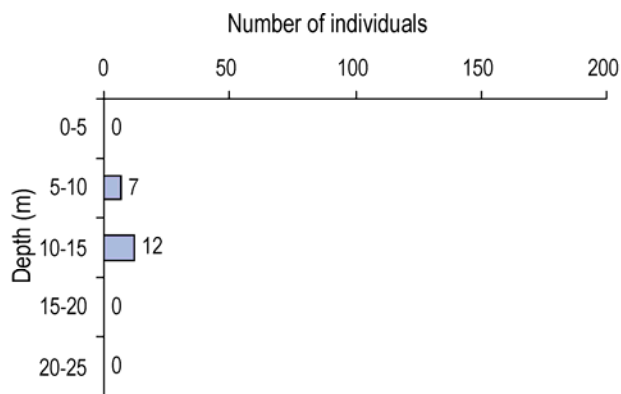


Figure 4. Bathymetrical distribution of *Acanthistius pictus*.

Figura 4. Distribución batimétrica de *Acanthistius pictus*.

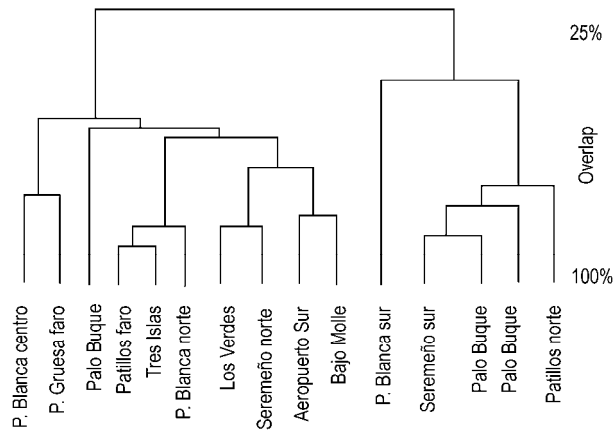


Figure 5. Beaches overlap according to the frequency of occurrence of Serranid assemblages.

Figura 5. Sobreposición de playas de acuerdo a frecuencia de conjuntos de Serranidae.

caves (> 0.5 m), and sponges had overlaps that were mostly characterized by the presence of *H. macrophthalmos*. Microhabitats of rock, anemone, soft bottom, *L. trabeculata*, shell reef, cliffs, and the water column showed high overlaps linked to a dominance of *P. humeralis* (Fig. 6). This roving species occupied rocky sandy substrates, *L. trabeculata*, and shell reef microhabitats (Fig. 7). *H. macrophthalmos* was a cave specialist, found over rock, boulder-type rock, and cave microhabitats (> 0.5 m) (Fig. 8). *A. pictus* was a cavity specialist associated with rock, boulder-type rock, and cavity microhabitats (< 0.5 m) (Fig. 9). The roving species (*P. humeralis*) was segregated from the cavity specialists (*H. macrophthalmos*, *A. pictus*) (Fig. 10a).

In general, it can be assumed by presence or absence of species in similar relevant habitats (Fig. 10b) and by the frequency use of relevant habitats (Fig. 10c) that the Serranidae coexist. The use of relevant microhabitats showed a total interspecific segregation with intraspecific consistency for size categories, where in general there was a roving species (*Paralabrax humeralis*) and cavity specialist. Cavity specialists were further more segregated into cave (> 0.5 m) specialists (*H. macrophthalmos*) and cavity (< 0.5 m) specialists (*A. pictus*) (Fig. 10d).

DISCUSSION

Not all beaches offer a habitat with a geomorphology that creates cavities (< 0.5 m) and caves (> 0.5 m). Thus, cavity specialists (*H. macrophthalmos*, *A. pictus*) are absent at some beaches. Sampling shows that

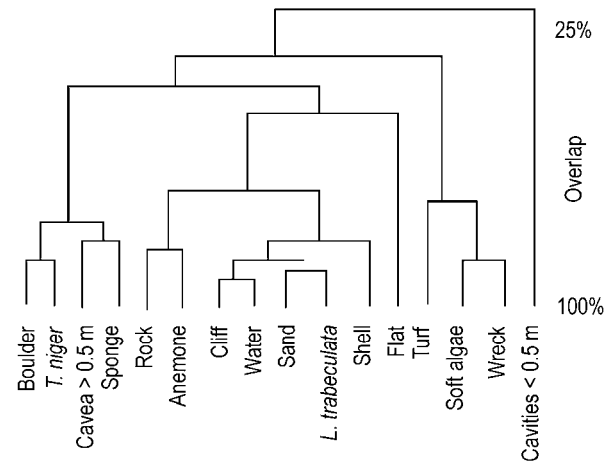


Figure 6. Microhabitat overlap according to the frequency of occurrence of Serranid assemblages.

Figura 6. Sobreposición de microhábitat de acuerdo a frecuencias de conjuntos de Serranidae.

some areas are dominated by *H. macrophthalmos* (Fig. 6). *H. macrophthalmos* and *A. pictus* are cavity specialists and are associated with boulder-type rock, which creates cave (> 0.5 m) and cavity (< 0.5 m) areas. Another area is dominated by *P. humeralis* (Fig. 6), related to the presence of *L. trabeculata* and/or shell reefs. *L. trabeculata* is important in increasing surface area throughout the first rocky fringe; this subtidal rocky bottom is known as a subtidal forest (Núñez & Vásquez, 1987).

The roving species *P. humeralis* was found mostly grouped and agglomerating in number across the transition zone. It was also highly associated with shell reefs that are found in transition zones, on the bottom of the first rocky fringe. The transition zone is characterized by rocks from the bottom breaking the surface and a continuation of the soft bottom, with mostly isolated rocks. *P. humeralis* was observed more often in this study, possibly due to its roving nature, which makes it easier to spot. Herein, *P. humeralis* was recorded in association with microhabitat cavities (< 0.5 m) and caves (> 0.5 m) as it was found resting next to rocky spaces in these microhabitat categories. *A. pictus* made up only 3% of the fish encountered; it is easier to overlook this cavity specialist (< 0.5 m) when it is inside cavities. Smaller *A. pictus* individuals were not found and, according to research by Vargas & Sielfeld (1997), *A. pictus* may use soft bottom areas as nursery grounds. This study takes into consideration only the first rocky fringe, though *P. humeralis* and *H. macrophthalmos* have been caught along the entire continental shelf off northern Chile (Samame *et al.*, 1978; Mendieta & Castillo, 1988; Velez *et al.*, 1988; Espino, 1990).

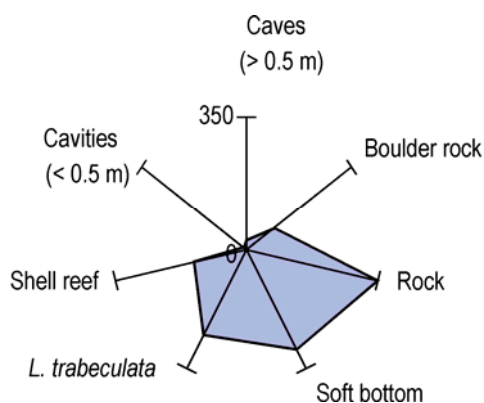


Figure 7. Number of relevant microhabitat use for *Paralabrax humeralis*.

Figura 7. Número de uso de microhábitat relevante de *Paralabrax humeralis*.

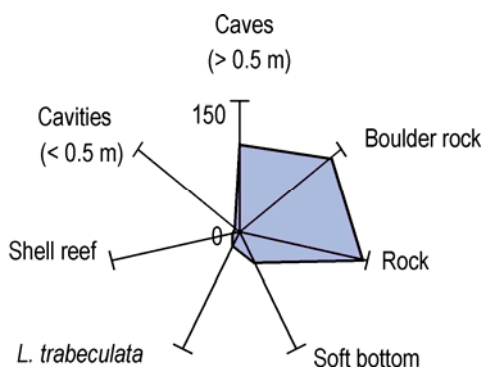


Figure 8. Number of relevant microhabitat use for *Hemilutjanus macrophthalmos*.

Figura 8. Número de uso de microhábitat relevante de *Hemilutjanus macrophthalmos*.

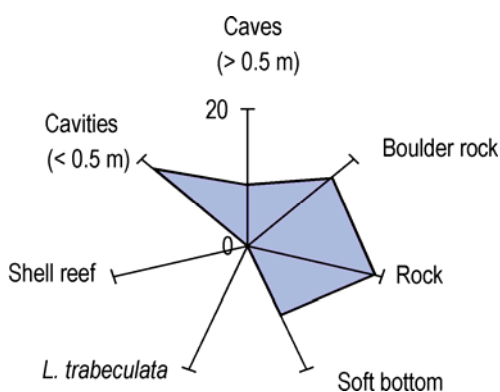


Figure 9. Number of relevant microhabitat use for *Acanthistius pictus*.

Figura 9. Número de uso de microhábitat relevante de *Acanthistius pictus*.

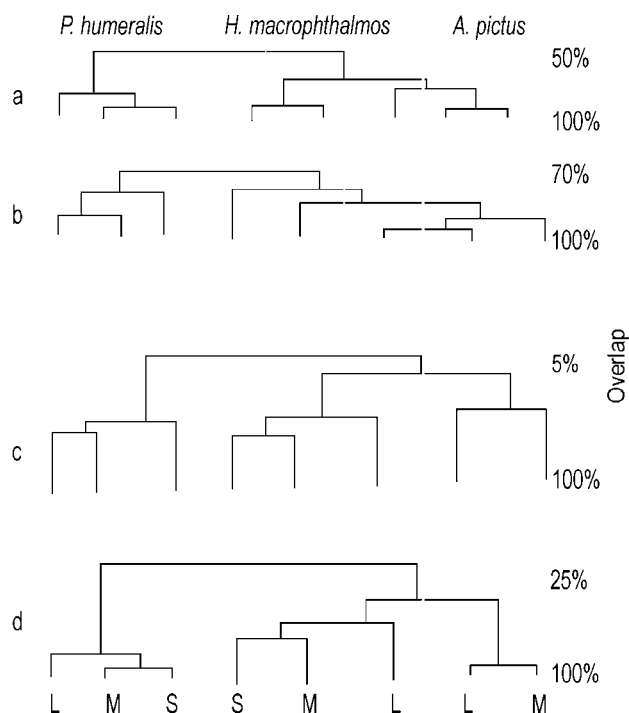


Figure 10. Fish overlap according to: a) frequency microhabitat use, b) presence or absence in relevant habitat use, c) frequency relevant habitat use, and d) frequency relevant microhabitat use (L: large, M: medium, S: small).

Figura 10. Sobreposición de peces de acuerdo a a) frecuencia en uso de microhábitat, b) presencia y/o ausencia en uso de hábitat relevante, c) frecuencia en hábitat relevante, y d) frecuencia en microhábitat relevante (L: grande; M: mediano; S: pequeño).

Serranidae appear to be associated with different types of habitats dominated by soft bottom microhabitats. *P. humeralis* preferred soft bottom habitats mostly associated with the transition zone, isolated rocks, and a surrounding shell reef. Cavity specialists (*A. pictus*, *H. macrophthalmos*) also preferred soft bottom habitats, mostly sand on the floor of caves (> 0.5 m) and cavities (< 0.5 m). Though flat rocks and wrecks were important to Serranidae, they were present at only one study site and the data was not relevant as a whole. These microhabitats were irrelevant for this research but seem to be a very important habitat for both roving and cavity specialists of the Serranidae.

Serranidae in the rocky subtidal south of Iquique include a roving species (*P. humeralis*) associated with rocks, sand, *L. trabeculata*, and shell reefs as well as cavity specialists (*H. macrophthalmos*, *A. pictus*); *H. macrophthalmos* occupies large caves (> 0.5 m) and *A. pictus* small cavities (< 0.5 m) (Figs. 7 to 9).

ACKNOWLEDGEMENTS

This paper was generated as part of mEU project CENSOR (Climate Variability and El Niño Southern Oscillation: implications for natural resources and management, contract 511071, contribution N° 0299).

REFERENCES

- Chirichigno, N. 1974. Clave para identificar los peces marinos del Perú. *Inst. Mar Perú-Callao*, 44: 347-402.
- Espino, M. 1990. "El Niño": su impacto sobre los peces demersales del Perú. *Bol. Inst. Mar Perú*, 14(2): 3-27.
- Fasola, M., L. Canova, F. Foschi, O. Novelli & M. Bresan. 1997. Resource use by a Mediterranean rocky slope fish assemblage. *Mar. Ecol.*, 18(1): 51-66.
- Lockett, M. & I. Suthers. 1998. Ontogenetic diet shift and feeding activity in the temperate reef fish *Cheilodactylus fuscus*. *Pro. Linn. Soc. N.S.W.*, 120: 105-116.
- Ludwig, J.A. & J.F. Reynolds. 1988. *Statistical ecology*. John Wiley & Sons, New York, 337 pp.
- Mann, G. 1954. *La vida de los peces en aguas chilenas*. Instituto de Investigaciones Veterinarias. Universidad de Chile, Santiago, 342 pp.
- Mendieta, A. & J. Castillo. 1988. Distribución y biomasa de los peces demersales en la plataforma norte del Perú en los veranos australes de 1985 y 1987. In: H. Salzwedel & A. Landa (eds.). *Recurso y dinámica del ecosistema de afloramiento peruano*. *Bol. Inst. Mar Perú, Callao, Vol. extraord.*, pp. 213-216.
- Moreno, A., H. Zamorano & E. Duarte. 1977. Distribución y segregación espacial de las poblaciones de peces en bahía South (Isla Doumer, Antártica) *Ser. Cient. Inst. Antárt. Chil.*, 5(1): 45-58.
- Moreno, C.A., E. Duarte & H. Zamorano. 1979. Variación latitudinal del número de especies de peces en el sublitoral rocoso: una explicación ecológica. *Arch. Biol. Med. Exper.*, 12: 169-178.
- Núñez, L.M. & J.A. Vásquez. 1987. Observaciones tróficas y de distribución espacial de peces asociados a un bosque submareal de *Lessonia trabeculata*. *Estud. Oceanol.*, 6: 79-85.
- Reñones, O., J. Moranta, J. Coll & B. Morales-Nin. 1997. Rocky bottom fish communities of Cabrera Archipelago National Park (Mallorca, Western Mediterranean). *Sci. Mar.*, 61(4): 495-506.
- Samame, M., J. Castillo, L. Flores & R. Vilchez. 1978. Estructura, distribución y abundancia de peces demersales. *Inf. Inst. Mar Perú-Callao*, 47: 1-28.
- Stuardo, J. 1988. Características ambientales y aspectos biológicos y distribución de los principales recursos marinos de la plataforma austral Sudamericana. *Inf. UNESCO Cienc. Mar*, 47: 44-62.
- Vargas, M.P., R.A. Soto & G.L. Guzmán. 1999. Cambios interanuales en la alimentación de peces submareales del norte de Chile entre los 20°11'S y 20°20'S. *Rev. Biol. Mar. Oceanogr.*, 34(2): 2000.
- Vargas, M. & W. Sielfeld. 1997. Playa Chipana (21°19'S, 70°04'W): a nursery and smolting area for marine coastal fish in northern Chile. *Arch. Fish. Mar. Res.*, 45(2): 167-182.
- Vélez, J., M. Espino & J. Zeballos. 1988. Variaciones de la ictiofauna demersal frente a Perú entre 1981 y 1987. In: H. Salzwedel & A. Landa (eds.). *Recurso y dinámica del ecosistema de afloramiento peruano*. *Bol. Inst. Mar Perú, Callao, Vol. extraord.*, pp. 203-212.

Received: 8 Jun 2007; Accepted: 9 April 2008