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Semblanzas Ictiológicas Iberoamericanas
Andrés Conrado Milessi Millán

Hugo L. López
y
Justina Ponte Gómez

Indizada en la base de datos ASFA C.S.A.
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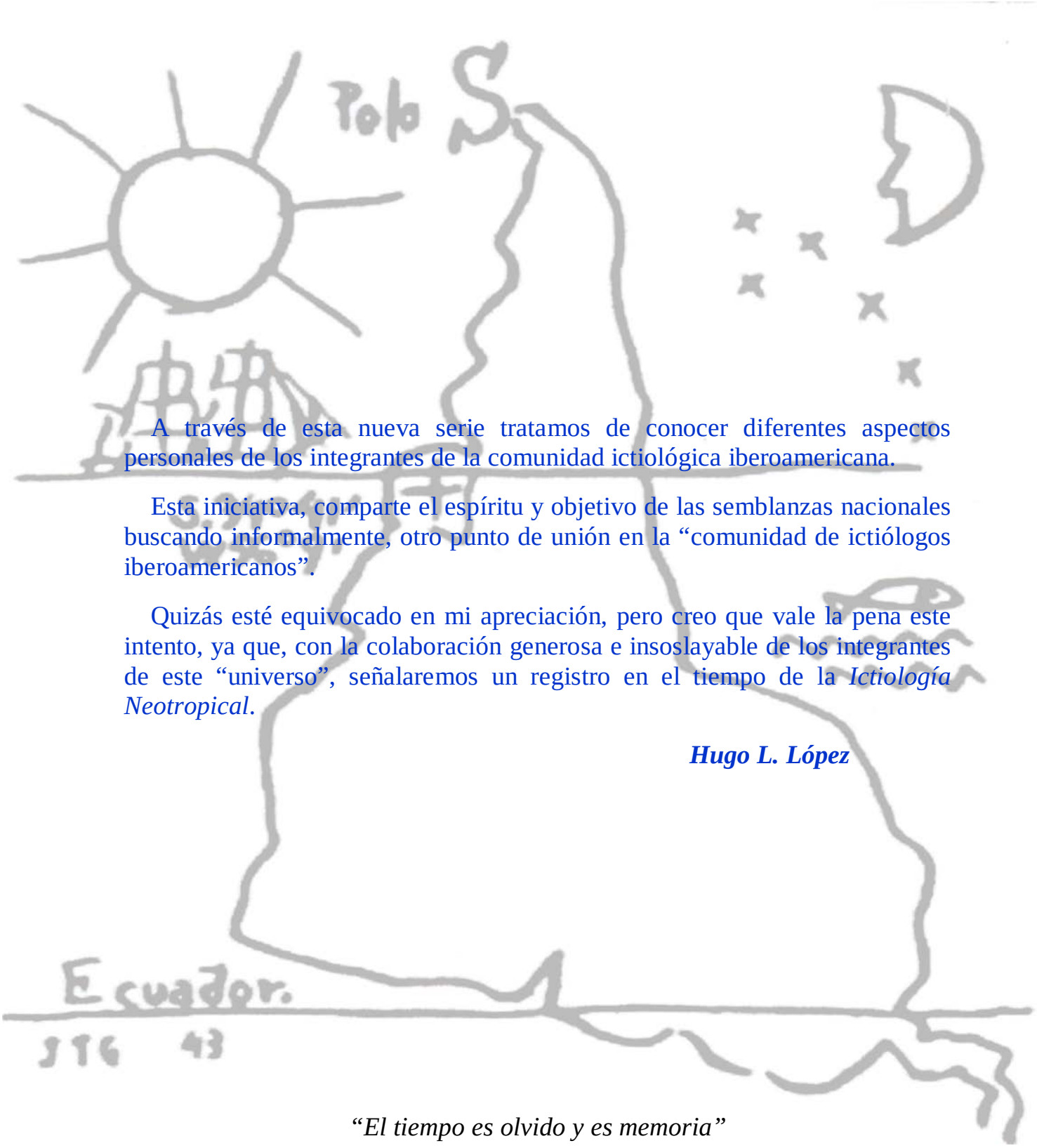
El pasado dice cosas que interesan al futuro
Eduardo Galeano



A través de esta nueva serie tratamos de conocer diferentes aspectos personales de los integrantes de la comunidad ictiológica iberoamericana.

Esta iniciativa, comparte el espíritu y objetivo de las semblanzas nacionales buscando informalmente, otro punto de unión en la "comunidad de ictiólogos iberoamericanos".

Quizás esté equivocado en mi apreciación, pero creo que vale la pena este intento, ya que, con la colaboración generosa e insoslayable de los integrantes de este "universo", señalaremos un registro en el tiempo de la *Ictiología Neotropical*.

Hugo L. López

"El tiempo es olvido y es memoria"

Jorge L. Borges

Semblanzas Ictiológicas Iberoamericanas

Andrés Conrado Milessi Millán

Mario Lasta y Andrés Milessi a bordo del B/I Capitán Canepa (INIDEP), Argentina, 2000

Hugo L. López y Justina Ponte Gómez

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Mayo de 2015

Imagen de Tapa

Pesca de altura a bordo del B/I Aldebaran (DINARA, Uruguay) ejemplar de pez sable (*Trichiurus lepturus*), 2009

Imagen de fondo de la Introducción

Porque en realidad nuestro norte es el sur, dibujo de Joaquín Torres García

Andrés Milessi con sus hijas y esposa, 2014
De izquierda a derecha, adelante: Carmela e Isabella Milessi y Laura Perez; atrás, Andres

Nombre y apellido completos: Andrés Conrado Milessi Millán

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-**Una película**: *La tormenta perfecta* (2000)
-**Un tema musical**: *Cuando Juega Uruguay* de Jaime Roos; R*edemption song* de Bob Marley
-**Un artista**: Don Alfredo Zitarrosa, Joaquin Torres Garcia
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Sitio Argentino de Producción Animal

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IDENTIFICACION DE TRES ESPECIES DEL GENERO *SQUATINA* (CHONDRICHTHYES, SQUATINIDAE) EN LA ZONA COMUN DE PESCA ARGENTINO-URUGUAYA (ZCPAU)

IDENTIFICATION OF THREE SPECIES OF GENUS SQUATINA *(CHONDRICHTHYES, SQUATINIDAE) IN THE ARGENTINE-URUGUAYAN COMMON FISHING ZONE (AUCFZ)*

Andrés Milessi[1,2], Rodolfo Vögler[1,2] & Gastón Bazzino[3]

RESUMEN

Hasta el presente no existía una correcta identificación de las especies de *Squatina* (Dumeril, 1806) en aguas Uruguayas de la Zona Común de Pesca Argentino-Uruguaya (ZCPAU). En dos cruceros de investigación realizados a bordo del B/I "Aldebarán" en octubre de 1995 y abril de 1996, a través de 143 lances efectuados entre 8 y 125 m de profundidad, se registró la presencia de *S. guggenheim* y de *S. argentina*, y se identificó por primera vez a *S. occulta* dentro de la ZCPAU. La separación de las especies se realizó según los criterios establecidos por Vooren & Da Silva (1991) a través de la utilización de los siguientes caracteres morfológicos externos: presencia o ausencia de una fila medio-dorsal de espinas; forma y tamaño de la aleta pectoral, y patrón de coloración dorsal.

PALABRAS CLAVES: Chondrichthyes, *Squatina*, Zona Común de Pesca Argentino-Uruguaya.

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ABSTRACT

Historically, the identification of the species of *Squatina* (Dumeril, 1806) in Uruguayan waters of the Argentine-Uruguayan Common Fishing Zone (AUCFZ) was not clear. During two research surveys carried out onboard of R/V "Aldebaran", on October 1995 and April 1996, 143 tows were performed between 8 and 125 m depth, in order to record the presence of *S. guggenheim* and *S. argentina*, and for the first time, indentifying *S. occulta* in AUCFZ. The taxonomic identification of the species was done under criterions established by Vooren & Da Silva (1991). The external morphological characters employed were: presence or absence of a median dorsal row of spines, shape and size of the pectoral fin and the the dorsal colour pattern.

KEYWORDS: Chondrichthyes, *Squatina*, Argentine Uruguayan Common Fishing Zone.

INTRODUCCION

En aguas del Atlántico Sudoccidental, desde la plataforma hasta el talud continental, habitan cuatro especies de *Squatina* (Dumeril, 1806) (Compagno, 1999; Fazzano *et al.*, 1999). La especie más septentrional es *S. dumeril* (Le Sueur, 1818) distribuyéndose desde Nueva Inglaterra (EEUU) hasta el litoral norte de Brasil (Fazzano *et al.*, 1999).

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FISHERIES RESEARCH

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Long-term impact of incidental catches by tuna longlines: the black escolar (*Lepidocybium flavobrunneum*) of the southwestern Atlantic Ocean

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Abstract

We analyze intra and inter-annual harvesting patterns of the black escolar *Lepidocybium flavobrunneum* (Gempylidae), an important component of the incidental catch of the Uruguayan tuna fleet (UTF) at the southwestern Atlantic Ocean (SAO), based on daily information of catch, fishing effort and individual weight of all the specimens caught during 16 years (1981–1996). The analysis also compares the activities of two fishing fleets that operated in two different periods of fishery development: category A, which comprises Japanese vessels that operated between 1981 and 1991, and category B, consisting of American and Spanish vessels that operated between 1992 and 1996. The relative representation of the total incidental catch significantly increased during the 16-year period of activity of the UTF, reaching 43% of the total catch in 1995. A recurrent seasonal pattern in fishing effort, catch and catch per unit of effort (CPUE) was observed, peaking in austral winter and spring. The daily number of hooks and total catch were significantly higher for category A, which exerted 2.7 times higher number of hooks and obtained catches 3.33 times higher than category B. Differing with the above trends, mean daily CPUE of a category B vessel was 16% higher than category A, which can be attributed to the increase of fishing power. The mean individual weight decreased almost 40% in 15 years, i.e., from 23.2 kg in 1982 to 14.1 kg in 1996, suggesting overexploitation risks of this incidental species. The effect of increasing fishing power and the effectiveness of management measures for large pelagics at the SAO are discussed.
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Keywords: Black escolar; *Lepidocybium flavobrunneum*; Incidental catch; Tuna fisheries; Southwestern Atlantic; Management; Harvesting patterns

1. Introduction

Three main groups of species can be distinguished from fishing activities: target, incidental and discarded. The last two components are basically non-target species incidentally captured by the fishing gear, even though some individuals of the target species are discarded or released alive because of their size, condition, etc. Moreover, some incidental species have market value, generally lower than that of the target species, and thus they are commercialized (Hall, 1996). The majority of these species are rarely caught, but others constitute an important percentage of the total catch, which is recurrent over space and time (Alverson et al., 1994; Hall, 1996, 1998).

Incidental catch constitutes an important source of uncertainty in both assessment and management of

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PRIMER REGISTRO DE *MANTA BIROSTRIS* (DONNDORFF 1798) (BATOIDEA: MOBULIDAE) EN EL RIO DE LA PLATA, URUGUAY

A NEW RECORD OF MANTA BIROSTRIS *(DONNDORFF 1798) (BATOIDEA: MOBULIDAE) IN THE RIO DE LA PLATA, URUGUAY*

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RESUMEN

Se registró la presencia de un macho de la mantarraya *Manta birostris* (Donndorff 1798) en la desembocadura del arroyo Pando (34º 48' S-55º 43' O), Río de la Plata, Uruguay. El ancho del disco fue de 4.20 m con un peso estimado de 900 kg. Este hallazgo es el primer registro de *M. birostris* para las costas uruguayas y representa una ampliación, hacia el sur, del área de distribución de esta especie en el Océano Atlántico sudoccidental. Se discute, además, la ocurrencia de esta especie oceánica en aguas estuarinas.

Palabras claves: *Manta birostris*, distribución, Atlántico sudoccidental, Chondricthyes.

ABSTRACT

A male specimen of the giant manta ray, *Manta birostris* (Donndorff 1798), was founded at the Pando stream mouth, Uruguay (34º 48' S-55º 43' W). The disk width was 4.20 m and the total body weight was estimated in 900 kg. This finding, the first ever to be register on the coastal waters of Uruguay, extends the known distribution of the manta ray into the south-western Atlantic. The presence of this oceanic specie in estuarine waters is discussed.

Keywords: *Manta birostris,* distribution, south-western Atlantic, Chondricthyes.

INTRODUCCION

Los géneros *Manta* y *Mobula* pertenecen a la familia Mobulidae, orden Batoidea, y se caracte-rizan por poseer un par de lóbulos cefálicos prominentes a ambos lados de la cabeza. Estas mantarrayas pueden ser encontradas cerca de la costa o en aguas oceánicas subtropicales o tropicales. Estos animales son poco ágiles en maniobrar sobre el fondo marino, pero son rápidos nadadores en la columna de agua (Compagno 1990) y se les encuentra generalmente cerca de la superficie (Figueiredo 1977). La diferencia entre los dos géneros mencionados es la ubicación de la boca, que tiene posición terminal en *Manta* (Stehmann 1977, Chirichingo & Vélez 1998), y posición ventral en *Mobula*. Otra característica de *Manta* es que sus hendiduras branquiales son relativamente mayores que en *Mobula* (Bigelow & Schroeder 1953), a su vez *Manta* posee los lóbulos cefálicos muy desarrollados, con bordes redondeados, los cuales son distintivos de este género (Chirichingo & Vélez 1998).

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Osseous skeletal material and fish scales in marine sediments under the oxygen minimum zone off northern and central Chile

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Abstract

The significance of whale falls for the study of the biogeography, evolution and biodiversity of deep-sea biota has been recently recognized by international programs since large carcasses are known to give rise to biogenic chemosynthetic ecosystems. However, the plain accumulation of smaller bone material in the shallower settings of the continental shelf and upper slope under the hypoxic conditions of the Oxygen Minimum Zone (OMZ), has received much less attention. Here we describe new findings of skeletal material and fish scales in marine sediments under the OMZ off northern and central Chile which, combined with previous reports for the study area, lead us to suggest the existence of a band in the benthos of accumulation of bones and scales extending at least twenty degrees in latitude (18–38° S). Future studies should focus on the characterization of biotic communities living upon these resources in order to elucidate their peculiarities and importance in the Eastern South Pacific.
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Keywords: bone remains; fish scales; paleoecology; tanatocoenosis; oxygen minimum zone; Chile

1. Introduction

Marine sediments bearing large amounts of skeletal remains of fishes and mammals are quite scarce in the world ocean (Brongersma-Sanders, 1948, 1957). In general, these deposits are associated with oxygen-deficient settings (e.g. oxygen minimum zones or OMZs, enclosed basins with poor bottom circulation, fjords etc.) (Soutar, 1967; Soutar and Isaacs, 1969; Shackleton, 1987). High mortalities and low degradation rates of organic matter in OMZs (Degens et al., 1964) apparently favor the preservation of skeletal remains of marine macro-organisms such as fish and mammals (De Vries and Pearcy, 1982). On the other hand, considerable pulses of labile organic matter to the seafloor, like those produced by large carcasses (e.g. whales) and its subsequent utilization by anaerobes, could provide an appropriate substrate for the establishment of ecosystems relying on reduced compounds for energy (Smith and Kukert, 1989; Smith et al., 2002; Goffredi et al., 2004).

Among important OMZ areas in the world where appropriate conditions for the accumulation of fish debris may occur are the Santa Barbara Basin (e.g. Soutar, 1967; Schimmelmann et al., 1994), the Gulf of California (Holmgren-Urba and Baumgartner, 1993), the Cariaco Basin, Venezuela (Hughen et al., 1996), some fjords with stagnant bottom water conditions

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The mean trophic level of Uruguayan landings during the period 1990–2001

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Abstract

The worldwide increasing trend in fishing catches together with the impact of fishing on ecosystems and inefficient fishery management have led to overfishing and frequent collapse of traditional fish stocks. In this context, the assessment of fishery-induced impacts and the implementation of ecosystem-based fisheries management programs are urgently required. In this study, the mean trophic level (TLm) and the fishing-in-balance (FIB)-index of Uruguayan landings during 1990 and 2001 were estimated using the trophic level of 60 fishery resources.

A decline in total landings (*Y*) is observed, which is explained by the lower fishing yield in major fishery resources (especially demersal). Moreover, a marked decreasing trend in TLm at a rate of approximately 0.28 trophic levels per decade, and a decreasing trend in FIB-index since 1997 were observed. The present situation of fishery resources in Uruguay (fully exploited or overexploited) and the drop in Y, FIB and TLm can be considered as indirect indicators of the fishing impacts on the trophic structure of Uruguayan marine communities. We suggest that a more holistic ecosystem-based fisheries management could help to alleviate the critical situation of fish stocks in Uruguayan waters.
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Keywords: Ecosystem management; Trophic structure; Fisheries; Overfishing; Uruguay

1. Introduction

The increasing trend in world catches (FAO, 2002), the fisheries impact on ecosystems (Goñi, 1998; Hall, 1999; Hollingworth, 2000; Pauly, 2003), the failure in traditional stock assessment and management and the economic subsidies of fisheries (Pauly et al., 2002) lead to overfishing of marine resources, and, in some cases,

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Assessing the sources of the fishing down marine food web process in the Argentinean-Uruguayan Common Fishing Zone

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SUMMARY: The temporal trend in the mean trophic level (*mTL*), fisheries-in-balance index (FIB), trophic categories landing (TrC) and landing profile (LP) of the exploited marine community (82 species) in the Argentinean-Uruguayan Common Fishing Zone (AUCFZ) were examined from 1989 to 2003. The total landings (Y_t) (rs=-0.561; P<0.05) and the Yt of carnivores and top predators has declined, while the Y_t of herbivores, detritivores and omnivores has increased. Consequently, the *mTL* significantly decreased (rs =-0.88; P<0.01) at a rate of 0.41 from 1991 (*mTL* =3.81) to 2003 (*mTL* =3.4), and the FIB index has declined in the last 6 years. The LP temporal pattern showed four periods with significant differences in their species composition and Primary Production Required, which shows a strong decline in the traditional fishery resources (i.e. *Merluccius hubbsi*, *Micropogonias furnieri*), and increases in crustacean (*Chaceon notilis*), molluscs (*Zygochlamys patagonica*) and some fishes (*Macrodon ancylodon*, *Macruronus magallanicus*, Rajidae). The *mTL* trend reflects the changes in the AUCFZ landing structure. This was characterized by large, slow-growing and late-maturing species during the early 1990s, while during recent years, early 2000s, it was mainly characterized by medium-sized fishes, crustaceans and molluscs. The examination of the *mTL*, FBI, TrC trajectories and LP temporal pattern suggests that new fishery resources are developing or that the fishing effort has been redistributed from overexploited resources to lightly exploited resources. In addition, the examination of discriminator and common species, and the fact that traditional resources are being over-fished support the hypothesis that the *mTL* trend has been influenced more by the impacts of new fishing technologies than the changes in market-driven exploitation and environmental fluctuation. These results provide evidence of the fishing down process along AUCFZ.

Keywords: trophic structure, landing profiles, overfishing, ecosystem management, Argentina, Uruguay.

RESUMEN: EVALUANDO EL ORIGEN DEL PROCESO 'FISHING DOWN MARINE FOOD WEB' EN LA ZONA COMÚN DE PESCA ARGENTINO-URUGUAYA. – La tendencia temporal en el nivel trófico medio (*mTL*), índice de balance de las pesquerías (FIB), desembarques de categorías tróficas (TrC) y perfiles de desembarque (LP) de la comunidad marina explotada (82 especies) en la Zona Común de Pesca Argentino-Uruguaya (ZCPAU) fue examinada entre 1989 y 2003. Los desembarques totales (Y_t) (rs=-0.561; P<0.05) y los desembarques de carnívoros y predadores tope disminuyó, mientras que los desembarques de herbívoros, detritívoros y omnívoros se incrementaron. Consecuentemente, el *mTL* decreció significativamente (rs =-0.88; P<0.01) a una tasa de 0.41 desde 1991 (*mTL* =3.81) a 2003 (*mTL* =3.4), por su parte el índice FIB disminuyó en los últimos 6 años. El patrón temporal de LP presentó cuatro periodos significativamente diferentes en su composición específica y la Producción Primaria Requerida (PPR), con una fuerte caída en los recursos pesqueros tradicionales (i.e. *Merluccius hubbsi*, *Micropogonias furnieri*), y el incremento en crustáceos (*Chaceon notilis*), moluscos (*Zygochlamys patagonica*) y algunos peces (*Macrodon ancylodon*, *Macruronus magallanicus*, Rajidae). La tendencia en el *mTL* refleja cambios en la estructura de los desembarques de la ZCPAU, que fue discriminada por especies grandes, de lento crecimiento y tardía maduración en los inicios de los 90', mientras que durante los años recientes, inicios de los 2000, ellos fueron principalmente discriminados por peces de tallas medianas, crustáceos y moluscos. Las trayectorias de *mTL*, FIB, TrC y el patrón de LP sugieren el desarrollo de nuevos recursos pesqueros o la redistribución del esfuerzo de recursos sobreexplotados a recursos explotados o poco explotados. Asimismo, el análisis de las especies discriminantes y comunes, junto con la sobrepesca de

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Changes in trophic level of *Squatina guggenheim* with increasing body length: relationships with type, size and trophic level of its prey

Rodolfo Vögler · Andrés C. Milessi · Luis O. Duarte

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Abstract The occurrence of changes in the trophic level (TL) of sharks with growth has not been quantified until now. Here length-related changes on *Squatina guggenheim* Marini trophic level were determined, and shifts in type, size and trophic level of its prey were analysed. Sampling took place during five bottom trawl surveys conducted in the Argentine–Uruguayan Common Fishing Zone during spring (December/1995, October/1997) and fall (March/1997, March–April/1998, May–June/1998), using an Engel bottom-trawl net to capture the sharks. Three length groups were defined based on diet composition and using a cluster analysis (group I, 23–60 cm; group II, 61–80 cm; group III, 81–91 cm L_T). An ANOSIM procedure detected significant differences ($P<0.05$) in the diet spectrum between the three length groups. The smallest sharks (group I) ingested fish prey ranging from 5 to 21 cm L_T, medium sharks (group II) fed on fish prey between 11 and 35 cm L_T, and largest sharks (group III) preyed on fish between 13 and 40 cm L_T. Diet structure of length groups were discriminated by almost the same prey taxa that characterized them. The increase of *S. guggenheim* body length promoted a decrease in the relative importance of small pelagic fishes. Contrarily, prey as medium benthopelagic fishes, medium pelagic squid and medium benthopelagic fishes showed an inverse tendency, indicating a broad diet spectrum of adults. Predator-length and prey-length relationship indicated a trend where 44.8% of *S. guggenheim* diet was integrated by prey <20% of their own body length and 32.8% of their diet was composed by prey >30% of their own length. The increase of mean prey weight was associated with the increase of predator weight and length. Smallest sharks (group I) were identified as secondary consumers (TL<4) whereas medium sharks (group II) and largest sharks (group III) were placed as tertiary consumers (TL>4). The study revealed an increase in *S. guggenheim* TL with shark growth as a consequence of changes on type, size and TL of prey ingested.

Keywords Angular angel shark · Feeding ecology · Predator–prey interactions · Uruguay · Marine food webs

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Introduction

Sharks are typical top predators in marine ecosystems (Stevens et al. 2000), playing a major role in the

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Trophic mass-balance model of a subtropical coastal lagoon, including a comparison with a stable isotope analysis of the food-web

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ABSTRACT

Stable isotopes and mass-balance trophic models (e.g., ECOPATH) are well-known and widely used approximations to describe food-web structure, but their consistency is not properly established. Here we analyze the food-web structure of a subtropical-temperate coastal lagoon using two approaches: stable isotopic techniques and mass-balance modelling, exploring also the correspondence between the outputs of both methods. We compared trophic positions (TPs) derived by these two approaches for 14 consumers in Laguna de Rocha (LR). TPs based on stable isotopes were taken from a recent study. ECOPATH trophic levels were estimated by a model presented here constructed based on field data for the period 2003–2006 and literature data. The model incorporated over 50 species in 27 trophic groups, including primary producers, invertebrate and vertebrate consumers. The origin and quality of data (pedigree routine) indicated that 68% of the information was locally bound, although several unknowns were detected. Birds and mammals represented the highest trophic levels (4.2 and 3.98, respectively). Network analysis estimated a size of the system (fluxes and biomasses) of 451 t wet weight km^{-2} $year^{-1}$, while transfer efficiency, primary production/respiration and production/biomass ratios, and several ecological indexes characterized LR as an underdeveloped system. TPs derived from isotopic analysis were highly correlated with trophic levels estimated by ECOPATH according to a linear regression model through the origin ($r^2 = 0.82$, $n = 14$, $p \ll 0.01$). The slope of the linear model (0.88 ± 0.019, estimate $\pm$ SD) indicated that TPs derived from isotopic analyses were slightly higher (~13.5% on average) than those derived from the mass-balance model. Current results support the overall consistency of the use of both stable isotopes and mass-balance modelling approaches as descriptors of this aquatic food-web.

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1. Introduction

Understanding the driving forces of ecosystem functioning and the resilience capacity of natural systems to human-induced or environmental changes constitutes a fundamental goal of modern aquatic ecology. Ecosystem modelling is a complementary tool to experimental and observational approaches to investigate ecosystem functioning, and is particularly suited to explore responses to perturbations and to analyze emergent properties that are not readily measurable. For instance, mass-balance models like ECOPATH can be used to explore potential impacts of environmental modifications on certain groups and how such effects might propagate through the whole ecosystem via trophic web interactions (Christensen and Pauly, 1992).

Stable isotope analyses constitute a radically different and widely used approach to describe trophic interactions in natural systems (Fry et al., 1987; Chanton and Lewis, 2002) and to define time-integrated feeding relationships within an ecosystem (Peterson and Fry, 1987; France, 1995). Fractionation of stable N isotopes between the consumer and its food source results in the preferential assimilation of the lighter form, and constitutes a useful tool to determine relative trophic position (TP) of consumers along coexisting food-chains within an ecosystem (Peterson and Fry, 1987; Van der Zanden and Rasmussen, 2001; Post, 2002). The trophic position is a dimensionless index that identifies what kind of food an organism uses, or in other words, how much above the primary producer's level (or level 1) the organism in question

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DIRECT AND INDIRECT ESTIMATES OF NATURAL MORTALITY FOR THE PATAGONIAN SCALLOP *ZYGOCHLAMYS PATAGONICA*

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ABSTRACT The adequacy of empirical estimates of natural mortality (*M*) for the Patagonian scallop *Zygochlamys patagonica* (King & Broderip, 1832) is assessed against a direct estimate based on catch-at-age data obtained from fishery research surveys and auxiliary information on fishing effort exerted by the commercial fleet. Based mostly on growth parameter information resulting from the von Bertalanffy equation, we obtained empirical estimates of *M* based on formulas commonly used in fisheries assessment and quantified variation in their estimates though parametric bootstrapping. The modal values of direct estimates of *M* was 0.38/y, with a 95% confidence interval in the range 0.09–0.77/y. Estimates obtained with empirical models were close to direct estimates. In particular, a model developed for invertebrate species (Arce's model) was very close both in point values and variability. Our results suggest that for this species, the empirical estimates, which are easily obtainable and broadly used in many fisheries, can be reliably used when no other estimates are available. However, we contend that in other cases their use should be limited to species when the performances of empirical methods were compared with direct evaluations of *M*.

KEY WORDS: natural mortality, empirical methods, *Zygochlamys patagonica*, Argentina

INTRODUCTION

Natural mortality (*M*) is certainly one of the most widely needed parameters in models of fish population dynamics. Unfortunately, it is also one of the most difficult to estimate (e.g., Pauly 1980). The need of having reliable estimates of *M* to manage fish stocks led to the development of empirical methods related to regression-based approaches. These generally provide estimates of *M* from its univariate or multivariate relationship with life history and environmental variables (e.g., Pauly 1980). Thus, in most cases, *M* is inferred or estimated based on a variety of methods that have varying robustness to departures from the assumptions of the statistical methods used.

The Patagonian scallop *Zygochlamys patagonica* (King & Broderip, 1832) is distributed along the Magellanic Biogeographic Province, in the southwestern Atlantic Ocean between 35°50′S and Cape Horn (55°56′S) (Ciocco et al. 2006). A new fishery developed in the mid 1990s, with major fishing areas located along the Shelf Break Frontal System in the southwestern Atlantic, in the Argentine continental slope (Bogazzi et al. 2005). It rose to become an important economic activity with exportations in 2006 of 10,000 t adductor muscle with a value of US $60 million (Ciocco et al. 2006). The main concentrations, known as beds, are found around 90 m and 120 m deep (Waloszek 1991, Defeo & Brazeiro 1994, Lasta & Bremec 1998, Valero 2002, Gutiérrez & Defeo 2003), and some commercially attractive beds on the continental shelf of the Malvinas Islands at about 53°S (Bizikov & Middleton 2002).

As in any other fishery, estimates of *M* became important for their management. Techniques used for estimating *M* in scallops include change in abundance of a cohort over time, loss of tagged individuals, proportion of clackers, catch curve analysis, and empirical relationships (Orensanz et al. 2006). However, most of these methods have also been described as "qualified guesses" (Sparre & Venema 1992).

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The first estimates of *M* of *Z. patagonica* were obtained using size-converted catch curve methods that resulted in an estimate 1.039/y (Lasta et al. 2001). Valero (2002) estimated *M* using an integrated age-structured size-based model (Fournier et al. 1990) to describe monthly dynamics of abundance and shell growth of the Patagonian scallop in an area (216 km^2) closed to fishing in Reclutas Bed. The model consisted of survival equations, which account for *M* (the only source of mortality in this area assuming that fishing closure was effective), cohort-specific individual growth, and variability of size at age, and a selectivity ogive of the sampling gear. This model was fitted to monthly time series of size frequency distributions (SFDs) and local density estimates. Maximum likelihood estimates of *M* ranged from 0.31–0.46/y, depending on model run characteristics (mainly, differences in assumptions about gear selectivity). For different conditions (e.g., $M = 0.31$/y, run 14, Table 3.6 in Valero (2002)), maximum likelihood estimates ranged from 0.2–0.4/y.

Herein, using reliable estimates of the von Bertalanffy growth equation available for all commercially important beds of Patagonian scallops, we assessed the value of commonly used empirical relationships to approximate *M*. Our first purpose was to use the statistical catch-at-age method to estimate *M* using auxiliary information on fishing effort exerted by the commercial fleet, and then to compare that estimate with those obtained with empirical models commonly used in fishery assessments.

MATERIALS AND METHODS

Study Area

The study area, located between 38°S and 40°S along the shelf break, involved the northern Patagonian scallop ground (Management Northern Unit), including several fishing beds (MdQ, Reclutas, and San Blas beds; Fig. 1). This ground is under the influence of the shelf-break front (Bogazzi et al. 2005), which marks the transition of diluted sub-Antarctic shelf waters and cold, salty, relatively nutrient rich waters of the Malvinas

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First record of *Pomacanthus paru* in the Río de la Plata, Argentina

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The first record of an adult male of French angelfish Pomacanthus paru *(total length = 295 mm; total weight = 855.3 g) in the coastal waters of Rio de la Plata mouth, Argentina is here reported. This finding extends the known limit to about 1200 km from the previous reported southernmost distribution of this tropical fish.*

Keywords: taxonomy, geographical distribution, satellite images

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On 24 April 2013 a French angelfish *Pomacanthus paru* (Bloch, 1787) was found in the coastal waters of the Buenos Aires province, Argentina. The specimen was caught by the Yguá/Betty trawlers fishing vessels operating in the Río de la Plata River, Argentina (36°13′S 56°33′W) at 10 m of depth in a sandy sediment area (Figure 1). The fish was found during the routine sampling fish programme in landing ports; a total length of 295 mm and a total weight of 855.3 g were recorded. Macroscopic analysis of the gonad indicates the specimen was an adult male in maturity stage 2 (resting).

Few species of pomacanthid fish are found in the Atlantic Ocean, of which seven species have been reported off oceanic islands and only four species in open oceanic waters (Floeter & Gasparini, 2000; Floeter *et al.*, 2008). Reported distribution of *Pomacanthus paru* in the western Atlantic is restricted to tropical waters from Florida (USA) to the south of Brazil, including the Gulf of Mexico, the Bahamas and the Caribbean Sea (Burgess, 2002). The current southern limit for this species is known to be 28°S in Santa Catarina (Brazil) (Uyeno *et al.*, 1983; Carvalho-Filho, 1999; Hostim-Silva *et al.*, 2006). However, the individual found in this study extends the previously reported distribution by around 1200 km southwards. *Pomacanthus paru* is usually reported in shallow coral or rocky reef environments, growing up to 50 cm in length and as yet no migrations have been reported (Froese & Pauly, 2013). External morphological characteristics make this species easily identifiable by doing a rapid comparison with published pictures or photographs (Uyeno *et al.*, 1983; Froese & Pauly, 2013). In addition, detailed dichotomous classification keys are also available (Burgess, 2002). In this paper, we used both these methods to identify this fish at the species level. Analysis of the stomach content revealed this specimen was full, with the stomach weighing 7.3 g. Several different food items were found, including hydrozoans, sponges, algae, bryozoans, crustaceans and fish remains. Unfortunately, due to the high degree of digestion it was not possible to identify these prey items to a lower taxonomic level. A full stomach containing a variety of prey items suggests the fish was feeding when it was found and thus, has adapted to the local environment.

We analysed also the sea surface temperatures (SST, Aqua MODIS 4 km spatial resolution from: http//oceancolor.gsfc.nasa.gov), in the days previous to when the fish was caught. The SST showed waters higher than 20°C, suggesting warm water flows coming from the Brazilian coast. This oceanographic process is known as warm coastal drift (Balech, 1986; Balech & Erlich, 2008) and it is common in Argentine waters at the end of the austral summer and during the autumn when winds coming from the north and north-east become stronger (Martos & Piccolo, 1988; Guerrero *et al.*, 1997; Palma *et al.*, 2008). The flowing of warm waters with southward direction permits the arrival of subtropical and tropical fish to the Río de la Plata (Solari *et al.*, 2010) and even further south off Mar del Plata, 38°S (Menni & García, 1982; Cousseau & Figueroa, 1989; Izzo *et al.*, 2010; Milessi *et al.*, 2012). This first report of *P. paru* in Argentine coastal waters is another piece of information supporting the hypothesis that the warm coastal drift allows changes in tropical and subtropical fish distribution. The specimen was deposited in the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP fish collection No. 840).

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RAPID COMMUNICATION

The determination of maturity stages in male elasmobranchs (Chondrichthyes) using a segmented regression of clasper length on total length

A.M. Segura, A.C. Milessi, R. Vögler, F. Galván-Magaña, and V. Muggeo

Abstract: A novel statistical method for estimating the stages of maturity in male sharks and skates based on a segmented regression (SRM) is proposed. We hypothesize that this method is able to find the transition points in the three-phase relationship between total length (TL) and clasper length (CL). We applied an SRM to TL–CL data of nine species, from large pelagic sharks (e.g., *Carcharhinus falciformis*) to small coastal skates (e.g., *Rioraja agassizi*), captured in the southwestern Atlantic and northeastern Pacific. As expected, SRM detected two breakpoints, defining three maturity stages (immature, maturing, and mature), in six out of nine species. For three species, it was not possible to find two breakpoints because of incomplete sampling of TL. This novel method is noninvasive, it is applicable to previously collected data, is easy to use, and provides a reliable tool for increasing our understanding of elasmobranch reproductive strategies.

Résumé : Une nouvelle méthode statistique pour estimer les stades de maturité des requins et raies mâles reposant sur une régression segmentée (SRM) est proposée. Nous postulons que cette méthode permet de trouver les points de transition dans la relation à trois phases entre la longueur totale (TL) et la longueur du ptérygopode (CL). Nous avons appliqué une SRM aux données de TL–CL de neuf espèces allant de grands requins pélagiques (p. ex. *Carcharhinus falciformis*) à de petites raies côtières (p. ex. *Rioraja agassizi*) capturés dans le sud-ouest de l'Atlantique et le nord-est du Pacifique. Comme prévu, la SRM a fait ressortir deux points de rupture qui définissent trois stades de maturité (immature, en cours de maturation et mature) dans six des neuf espèces. Pour trois espèces, il n'a pas été possible de trouver deux points de rupture en raison de l'échantillonnage incomplet de la TL. Cette nouvelle méthode n'est pas invasive, peut s'appliquer à des données déjà recueillies, est d'utilisation facile et constitue un outil fiable permettant d'accroître la compréhension des stratégies de reproduction des élasmobranches. [Traduit par la Rédaction]

Introduction

Elasmobranch population models are generally structured by stage or size; thus, the correct definition of transition points (e.g., from juvenile to mature individuals) is essential for improving our estimates of stage-specific population parameters. Maturity stages can be estimated using several methods, from microscopic gonadal inspection to macroscopic observation of reproductive characteristics, such as clasper calcification or clasper length (for a review see Walker 2005). In male elasmobranchs, noninvasive macroscopic reproductive variables commonly used for classifying maturity stages include the clasper calcification degree and a measure of the clasper length (CL). The former relies on the ability of the observer to classify rigidity, whereas the latter is well-defined and can be measured accurately. By using clasper calcification alone, the determination of maturity stages is to some extent subjective (Walker 2005), and it is difficult to compare its estimates among studies or even in the same study if maturity is evaluated by different field observers in different periods (Walker 2005). These drawbacks could produce biased estimates of population parameters.

In this study, we propose and evaluate the use of a novel statistical method, based on a segmented regression model (SRM; Muggeo 2003), to estimate the breakpoints and slopes in the total length (TL)–CL relationship of male elasmobranchs. We hypothesize that the TL–CL relationship presents three linear phases, with each step representing successive maturity stages that can be effectively modelled by SRM: (*i*) immature, (*ii*) maturing, and (*iii*) mature organisms. We evaluated the performance of the SRM in the estimation of maturity stages in the males of nine elasmobranch species, including sharks (pelagic and demersal), guitarfish, and skates. We discuss the applicability of the method by comparing our results with previous maturity estimates.

Methods

Basics of the statistical method

In a regression model in which the effect of the covariate on the response variable changes abruptly at unknown covariate values, the relationship between the response and the explanatory variable is said to be segmented, broken-line, or piecewise linear (Muggeo 2003). The values of the explanatory variable at which

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Modelling production per unit of food consumed in fish populations

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HIGHLIGHTS

- We developed a general framework to estimate production-to-consumption ratio (p/Q).
- This framework is based on the generalised von Bertalanffy growth function.
- This modelling framework relates p/Q directly to population length or age-structure.
- Models proposed were assessed using simulated populations.
- Models proposed were applied to three harvested fish populations.

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ABSTRACT

The ratio of production-to-consumption (ρ) reflects how efficiently a population can transform ingested food into biomass. Usually this ratio is estimated by separately integrating cohort per-recruit production and consumption per unit of biomass. Estimates of ρ from cohort analysis differ from those that consider the whole population, because fish populations are usually composed of cohorts that differ in their relative abundance. Cohort models for ρ also assume a stable age-structure and a constant population size (stationary condition). This may preclude their application to harvested populations, in which variations in fishing mortality and recruitment will affect age-structure. In this paper, we propose a different framework for estimating (ρ) in which production and consumption are modelled simultaneously to produce a population estimator of ρ. Food consumption is inferred from the physiological concepts underpinning the generalised von Bertalanffy growth function (VBGF). This general framework allows the effects of different age-structures to be explored, with a stationary population as a special case. Three models with different complexities, depending mostly on what assumptions are made about age-structure, are explored. The full data model requires knowledge about food assimilation efficiency, parameters of the VBGF and the relative proportion of individuals at age a at time y ($P_y(a)$). A simpler model, which requires less data, is based on the stationary assumption. Model results are compared with estimates from cohort models for ρ using simulated fish populations of different lifespans. The models proposed here were also applied to three fish populations that are targets of commercial fisheries in the south-east Pacific. Uncertainty in the estimation of ρ was evaluated using a resampling approach. Simulation showed that cohort and population models produce different estimates for ρ and those differences depend on lifespan, fishing mortality and recruitment variations. Results from the three case studies show that the population model gives similar estimates to those reported by empirical models in other fish species. This modelling framework allows ρ to be related directly to population length- or age-structure and thus has the potential to improve the biological realism of both population and ecosystem models.

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