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Preface

Advances in fisheries research in Ibero-America

1. Introduction

The fisheries of Ibero-America[1] are characterized by encompassing a broad spectrum in terms of their magnitude, capture modalities and economic projection. Many of them are developed at small scale so having reliable statistic information is extremely difficult (FAO, 2014). Particularly in Latin America, this characteristic is due in part to the great diversity of coastal ecosystems; for example those associated with the major continental basins in South America, that generate great estuarine systems as the Amazon and Orinoco rivers and Rio de la Plata. On the other hand, it is also observed the existence of highly productive areas along the South American coast in the Pacific Ocean, generated by the supply of nutrients from the Cold Humboldt Current. That is why fisheries of different scales, artisanal, coastal medium range and industrial, either targeting fish or invertebrates coexist in many regions. This diversity is reflected in the landing levels, catching methods and quality of the fishery data. In many cases this information as well as the impact generated by commercial exploitation is not recorded, so the economic and social impact of the fishery cannot be measured. The gap observed between the information available and necessary for proper understanding of population dynamics and fisheries, makes it difficult to determine the management schemes that can best fit the context of the exploitation of resources. Considering those aspects, different approaches to co-management involving local communities has been proposed for many Latin American countries (Begossi, 2010).

The trend in Ibero-America catches has largely fluctuated since 1950 (Fig. 1) with two major peaks in 1970 and 1994 of 17 and 25 millions of tonnes landed respectively, that accounted for more than 27% of the total world capture during those years. This figure shows the global importance of the fishery at this region. However, the cause of this large fluctuation is the Peruvian anchoveta (*Engraulis ringens*), and especially the collapse of this fishery in 1970–1972. When this species was excluded from the statistics, Ibero-American catches increased steadily from 1.5 to 16.3 million tonnes between 1950 and 1995 (Fig. 1). During this period, the importance of this fishery increased from 7 to 18% of the total world capture. At the same time, the contribution of the Spanish and Portuguese catches has decreased; these countries accounted for 60% of the Ibero-American landings in 1950 to less than 8% in recent years, i.e. the increase in catches since 1950 is mostly due to Latin American countries. However, since 1995 there was a continuous decline in marine landings, considering or not Peruvian anchoveta (Fig. 1), as well as in the contribution to total world catch which was about 10% in 2012 (excluding *E. ringens*). In comparison, the increase in the inland catches has been multiplied by 5 since 1950, the vast majority taken in South America lakes and rivers (FAO, 2014). These trends have boosted the concern about fishery status in Ibero-America that is known for only few stocks. Since 1950, seven countries were responsible for 90%—on average—of the commercial landings in this region (Fig. 2). Peru and Chile dominated the catches in the period described, with 4.8 and about 3 million tonnes landed during 2012, respectively. In the case of Peru, the anchoveta comprises most of the catches, especially before 1976. For all countries considered, there was an initial period of increasing catches that peaked at different moments, but the last 20 years generally shown a decreasing pattern except for Brazil, Mexico and Ecuador (Fig. 2).

In 2012 the pelagic marine species landed by industrial fisheries (anchoveta, herrings, sardines, mackerels and tunas) were the major contributors of the region, especially in the Pacific countries: Mexico, Central America, Ecuador, Peru and Chile (Table 1). During this year the last two countries also had important catches of squids. In contrast, landings in Argentina and Uruguay were dominated by demersal species (Table 1), being hakes the most abundant resources.[2,3] The other countries, especially Brazil and Spain, were characterized by more diversified catches. The main characteristic of the Spanish and Portuguese fleets is that they operate worldwide compared with Latin America that basically fish on their own waters.

Small-scale fisheries are present in all countries, being the majority in many and, hence, they are of a major social impact since they contribute to a great proportion of the national commercial landings (Begossi, 2010). In terms of captures, artisanal fleet is especially relevant in Brazil, where it co-exists with industrial fisheries that concentrate their harvesting on high market value species such as lobster, shrimp and tuna, but artisanal fisheries are responsible for approximately 54% of the total marine landings, mainly anchovies, sardine, mullets, croakers and shrimps (FAO,

[1] It refers collectively to all Spanish- and Portuguese-speaking countries in America (i.e. Latin America), together with Spain and Portugal themselves.

[2] Consejo Federal Pesquero, Argentina. Estadísticas pesqueras. www.cfp.gob.ar/index.php?inc=estadisticas

[3] Uruguay en Cifras 2012. http://www10.iadb.org/intal/intalcdi/PE/2012/10587.pdf

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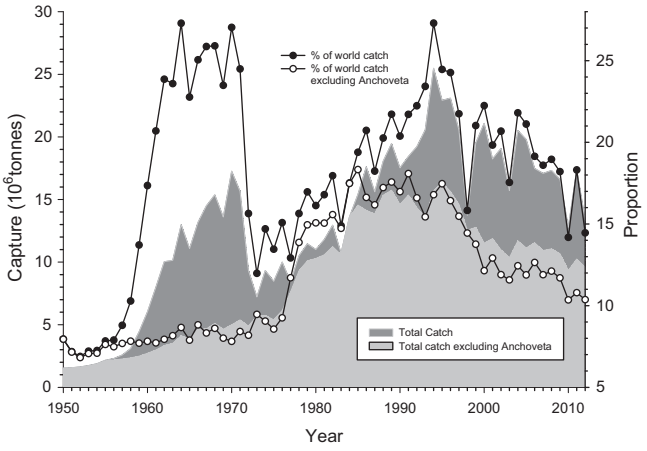

Fig. 1. Trends in total catches in Ibero-American fisheries since 1950. FAO (2014).

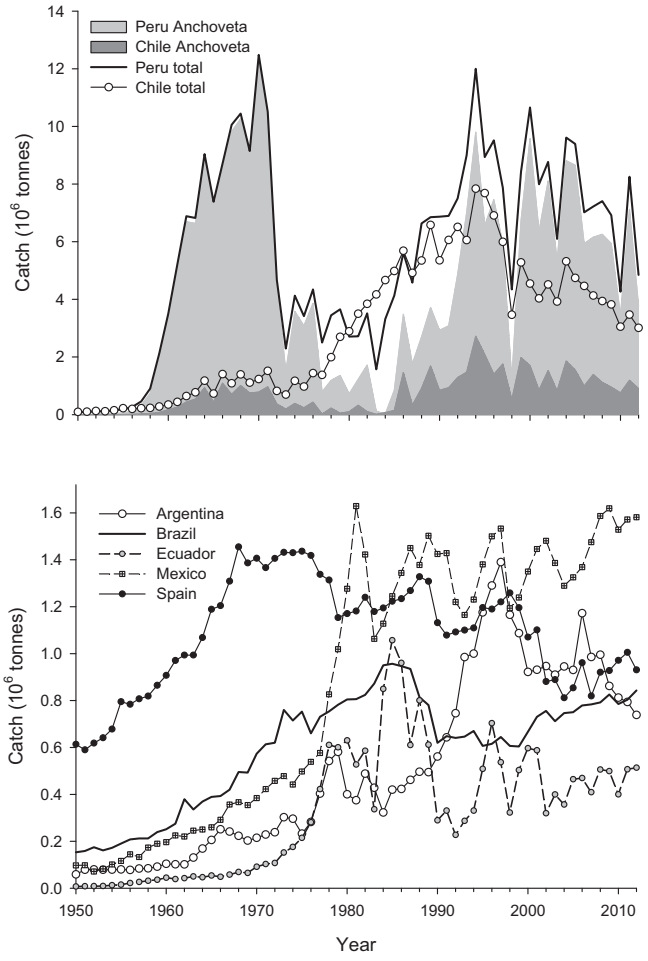

Fig. 2. Trends in catches for the Ibero-American countries with highest landings. FAO (2014).

2011). Moreover, it is important to consider that inland catches in Brazil reached about 260,000 tonnes in 2012, a 30% of the total landings, and they were also relevant in Mexico (Table 1). It is also remarkable the high production on Chilean seaweed, above 430,000 tonnes in 2012, mostly kelp.

Most of the stocks of top 10 commercial fish species are fully exploited and, therefore, have no potential for increased production, which could only be possible with effective rebuilding plans in place (FAO, 2007, 2014). In general these populations have an annual analytical assessment. However, for the vast majority of the stocks its status and even its basic biology and ecology remain unknown, especially those targeted by small-scale fleet for which part of their catches are not even likely reflected—or are unreliable—in the official landings statistics. Under these conditions, scientists are unable to undertake a full assessment of the species, and although management tools are frequently used, they have been reported as unsuccessful (Salas et al., 2007).

Currently, most fisheries are managed under the assumption that reproductive stock biomass (SSB) can generate a certain number of recruits the following year, regardless of the parental characteristics such as age or length composition of the stock and maternal condition. Therefore, the traditional recruitment models assume that the reproductive potential of a population is proportional to its adult abundance (Trippel, 1999), and that recruit survival mainly depends on SSB. During the last years this assumption has been strongly questioned, considering that the structure and composition of reproductive stocks play a fundamental role in both the quantity and quality of the eggs produced, which impacts the survival during the early life stages (Marshall et al., 1998; Marteinsdottir and Begg, 2002; Saborido-Rey and Trippel, 2013). Therefore, it is currently of great importance to develop models that consider the use of new biological reference points, which allow the incorporation of annual variability in demography and reproductive characteristics, giving more accurate information on the reproductive potential of populations (Morgan, 2008; Marshall, 2009; Murua et al., 2010).

Another central topic in the study of variations in recruitment is the role played by environmental factors in this process. Although much has been speculated about these issues, generally they have not been considered within the traditional assessment models. It is known that early life history of fishes is affected by the influence of environmental conditions. Even though it is under discussion at which developmental stage recruitment is determined, egg and larval mortality is still considered very important to establish recruitment potential.

In summary, the sum of factors including, among others, abundance, nutritional condition and age–size composition of the population, the oceanographic conditions in the breeding area, the availability of food during the larval and pre-recruit phases and the abundance of predators during the early life stages, is what will finally determine the magnitude of the future recruitment.

Despite the different economic and social conditions existing in the Ibero-American countries, currently there are numerous research groups working in fisheries reproductive ecology, in Latin America, Spain and Portugal. Those groups focus their effort to deepen the concept of sustainability, recognizing the conservation of reproductive potential and recruitment as the cornerstone of sustainable exploitation in the long term, for both industrial and artisanal fleets of marine and/or freshwater environments. It is for this reason that in November 2009 the I Ibero-American Symposium on Reproductive Ecology, Recruitment and Fisheries (I SIBECORP) took place in Vigo, Spain, to provide a forum for communication among scientist of these countries with the main objective of identifying and defining research lines of common interest in the study of the reproductive ecology applied to fisheries research (Saborido-Rey et al., 2011a,b). This symposium was followed up by the II SIBECORP (Mar del Plata, Argentina, 19–22 November 2012), organized by the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP, Argentina), in collaboration with the Consejo Federal Pesquero (Argentina), Instituto de Investigaciones Marinas (IIM-CSIC, Spain), AZTI-Tecnalia (Spain), Universidad Arturo Prat

Table 1
Nominal catches in Ibero-American countries during 2012 by group of species.

Country	Marine fish			Mollusc		Crustaceans	Freshwater	Plants	Unclassified	Total
	Pelagic	Demersal	Other	Cephalopods	Non Ceph.					
Peru	4,104,927	76,071	51,779	520,572	37,611	14,667	33,601	3585	2296	4,845,109
Chile	2,085,361	223,787	1848	146,319	44,419	40,594	0	436,035	30,553	3,008,916
Mexico	983,641	115,156	112,921	54,398	80,197	88,977	114,096	5725	26,023	1,581,134
Spain	467,701	365,292	11,241	57,797	10,622	11,888	4748	525	729	930,543
Brazil	219,638	245,081	36,199	3957	10,951	67,298	259,863		0	842,987
Argentina	40,176	466,555	159	95,384	36,933	84,530	14,323	0		738,060
Ecuador	474,426	31,360	336	91	0	7051	161		0	513,425
Venezuela	115,110	31,785	4613	349	14,345	5532	41,338		0	213,072
Portugal	115,020	64,368	454	11,603	4299	1972	90	801	11	198,618
Panama	131,488	4765	7587	0	314	1360	1414		21	146,949
Colombia	48,563	1459	2706	10	106	1156	24,000			78,000
Uruguay	883	68,298	2965	1431	178	792	1615	0	0	76,162
El Salvador	35,214	0	14,074	6	2	354	2350			52,000
Nicaragua	14,275	4662	432	26	7662	5743	625		425	33,850
Cuba	3735	7248	3324	0	822	5565	1597		0	22,291
Costa Rica	9095	4195	4095	115	45	1955	1000		0	20,500
Guatemala	15,620	465	263	10	10	833	2360			19,561
Paraguay							17,000			17,000
Dominican Rep.	3216	4370	353	36	2212	2560	906		0	13,653
Honduras	0	0	2069	0	1584	2713	100		1965	8431
Bolivia	150						6670			6820
Puerto Rico	103	280	9	6	795	75	0		0	1268
Total	8,868,342	1,715,197	257,427	892,110	253,107	345,615	527,857	446,671	62,023	13,368,349

FAO (2014).

(Chile), Universidade Federal do Paraná (UFPR, Brazil) and Instituto del Mar del Perú (IMARPE, Peru).

All research articles in this special issue of Fisheries Research were arisen from contributions presented at this symposium, where four thematic sessions were developed:

1. *Reproductive strategies of aquatic organisms*. Study of the physiological and morphological processes involved in gonadal maturation and reproductive cycle.
2. *Reproductive potential and causes of its variation*. Estimation of reproductive variables in the population, and analysis of factors that determine the ability of spawners to produce viable offspring.
3. *Recruitment process*. Egg and larval survival, growth and mortality of the early life stages in relation to the parental characteristics and environment conditions.
4. *Implications for fisheries management and assessment*. Effects of the fishing activity on reproductive potential of the population. Application of reproductive indices in assessment models and fisheries management measures.

A total of 148 contributions (46 oral presentations and 102 posters) were presented, most of them corresponding to Latin American countries (Argentina, Brazil, Chile, Colombia, Ecuador, Peru and Venezuela) and Spain. It is noteworthy that although the symposium scope included any aquatic organism subjected to fisheries, most of the contributions (over 90%) focused on finfish species. An exception to this was Peru, with 28% of the works related to marine invertebrates, as the giant squid (*Dosidicus gigas*). When considering the distribution of presentations taking into account the ecosystems studied, virtually 100% of the presentations for each country were focused in marine fisheries, except Colombia and Brazil with 80% and 30% of exposures related to freshwater species, respectively. This fact highlights the importance of continental fisheries for both countries.

The 13 papers published in this special issue summarize the most important questions and points discussed during the II SIBECORP, and in this preface we integrate some of the key findings analyzed in each work following the order of the thematic session proposed.

2. Reproductive strategies of aquatic organisms

Fish are characterized by a great variety of reproductive styles (Bruton, 1990; Murua and Saborido-Rey, 2003). This has led to group the species in different reproductive guilds and other ecological classifications, such as those described by Balon (1975). Despite the great diversity of styles reported, most marine fish belong to the guild of pelagic spawners, characterized by the absence of parental care, separate sexes, small eggs and external fertilization (Murua and Saborido-Rey, 2003). However, this typical reproductive modality can vary greatly in terms of seasonality, spawning pattern, distribution of energy resources and behavior, which define the reproductive tactics adopted by the different species (Stearns, 1992). In view of this, there is a clear need to investigate thoroughly the different reproductive strategies of aquatic species, the variation in fertility, fecundity and viability of offspring, in order to understand the mechanisms governing the annual variability in egg production, which in turn would explain changes in recruitment.

The resilience of the different fish species to commercial exploitation depends largely on the characteristics of their life histories (Hutchings and Reynolds, 2004). The life history of the species belonging to the Chondrichthyes class (sharks, rays and chimaeras) has some characteristics that make this group extremely vulnerable to inadequate and high fishing pressure (Baum et al., 2003). These features include, for example, large size at maturity, low fecundity, long gestation period and spatial segregation by sex and size (Cortés, 2000; Stevens et al., 2000). Chondrichthyans are exploited throughout the world for fisheries of different scales, and, although the fishing pressure on this group can be considered lower than that applied to teleost fish, their vulnerability has led to a rapid decline in abundance for many populations around the world (Baum et al., 2003; Dulvy et al., 2014). For this reason, recently some management plans have been developed at international level, as the FAO Plan of International Action for the Conservation and Management of Sharks. For these plans to be effective, it is essential to have

information on the biological and ecological characteristics of individual species. Colonello et al. (2014) characterize the spatial distribution of richness and reproductive modes of chondrichthyans from the Argentine Sea in relation to environmental variability. Their spatial distribution was also related to the areas closed to bottom trawling and the subsequent fishing effort relocation. High chondrichthyan richness was associated with a high thermal variability in deeper waters, while areas with great number of reproductive modes were mainly observed in coastal waters at higher sea surface temperatures. The relocation of fishing effort due to trawl fishing closures was associated to areas rich in chondrichthyans species and reproductive modes. The authors suggested that areas closed to trawling may be a valuable management tool for chondrichthyans provided that the geographical and seasonal distributions of the species are considered, as well as the problems associated with the relocation of fishing effort.

Currently, little is known about reproductive parameters of elasmobranch populations of commercial importance. Montealegre-Quijano et al. (2014) analyze the sexual development and size at maturity of the blue shark *Prionace glauca* off southern Brazil and in adjacent international waters. These authors estimated the average size at first maturity, and observed that the accelerated growth of the claspers started before the beginning of the testis maturation and semen production, whereas the accelerated development of the ovary and the oviducal glands started simultaneously. *P. glauca* from the Southwest Atlantic, as most shark species, reaches maturity at about three-fourths of its maximum size and half of its maximum age.

3. Reproductive potential and causes of its variation

From the early 1990s, it was introduced the concept of "parental effects" in exploited fish populations and its importance to assess the true reproductive potential of fish stocks. For example, several authors who analyzed the reproductive ecology of cod (*Gadus morhua*) suggested that the survival of the early life stages was influenced by the characteristics of the spawners (Kjesbu et al., 1996; Solemdal, 1997). These authors reported that reproductive experience plays an important role in defining reproductive potential, as first spawners in general produce eggs of poor quality in comparison to repeat spawners. Moreover, it has been observed that parental stock's structure, demography and condition of reproductive individuals affect the duration of spawning season and larval survival (Trippel, 1998; Nissling et al., 1998; Macchi et al., 2004), which in general have a profound effect on recruitment. It has also been suggested that egg viability may depend on maternal condition, playing a determining role in the quality of the oocytes produced (Lambert et al., 2003; Green, 2008; Macchi et al., 2013). In general, larger larvae with higher survival rates are hatched from eggs of better quality, which could in turn give higher recruitments (Rijnsdorp and Vingerhoed, 1994; Trippel, 1998). The trade-offs between growth and energetic investment in reproduction define the fitness and life history strategies of fishes (Saborido-Rey and Kjesbu, 2005). Trade-offs profoundly affect fecundity and egg production (Silva et al., 2013; Skjæraasen et al., 2013) and energetic investment can be used as proxies of reproductive output (Wuenschel et al., 2013). In Atlantic cod, for example, it has been suggested that the hepatosomatic index (HSI) is a good indicator of reproductive potential because of the role that lipids play in storing energy (Marshall et al., 1999).

In Argentine hake (*Merluccius hubbsi*) Leonarduzzi et al. (2014) analyze the proximate composition and energy density in different tissues (muscle, liver and gonad) in relation to maternal morphometrics and condition indices. These authors observed that muscle represents the main deposit of proteins and the liver is the main deposit of lipids for this species. Furthermore, it was reported that females with higher content of lipid in liver had also greater lipid reserves in muscle, indicating that larger individuals would benefit from more energy to be used in reproduction. However, there was not a relationship between the lipids in muscle/liver and lipids in gonads, which does not allow a precise estimation of the relationship between maternal condition and gonadal development. Moreover, hake females reached the same proportion of lipid and protein reserves in their gonads, which suggests that liver acts as a buffer between the soma and the ovaries, in order to ensure ovarian maturation even at low rates of energy intake. The HSI was the only index that reflected changes in lipid content and energy density, being a good indicator of the physiological condition of the Argentine hake females.

The information about lipid content, particularly fatty acids, has proven to be very useful also as biomarkers. This was demonstrated by the results of Medina et al. (2014), who examine the fatty acid composition in different tissues of female southern hake (*Merluccius australis*) from Chile to explore whether they could be used as bio-indicators of the origin of females collected in different spawning areas (inshore vs. offshore). Results revealed that the fatty acid in the tissues analyzed differed between zones, suggesting that their main food and overall trophic levels varied between areas. Fatty acids can therefore be utilized as bioindicators of the origin of females, supporting the hypothesis of alternative reproductive zones for southern hake in the northern Chilean waters.

Zudaire et al. (2014) also analyze the lipid composition in tissues of a migratory pelagic species as the yellowfin tuna (*Thunnus albacares*) from the Western Indian Ocean, with the goal of understanding its reproductive energy allocation strategy and to assess the relation between female condition and reproduction. Yellowfin tuna exhibited a strategy of low energy allocation before reproduction. The different lipid classes in gonads described an accumulative pattern through the maturity process from immature to hydration phase. Neutral lipids, mainly triacylglycerols and sterol- and wax-esters, and phospholipids deposits became depleted as the ovary developed, suggesting a transfer of lipids directly from liver to the oocytes during vitellogenesis. In contrast, muscle total lipid content was low and constant throughout ovarian development. Hence, the lack of substantial endogenous energy investment for ovarian development makes yellowfin tuna an income-capital breeder species for which the cost of reproduction depends mainly on concurrent energy income from feeding and only little on stored lipids. The authors did not find a significant relationship between lipid class composition in gonads/liver and fecundity, however, the results will contribute to understand the underlying processes involved in the energy dynamics during reproduction of this high fecund species.

4. Recruitment process

Egg production determined by a certain spawning biomass cannot be enough to assure a good recruitment in the future, if other spawning population characteristics are not analyzed. As previously mentioned, it is important to consider the role of several parental factors in the survival of the offspring, but the interaction between the early life stages and the environment is particularly essential. Thus, it is crucial to perform studies on distribution, abundance and larval behavior in relation to environmental variation, and its effects on larval growth and mortality. For example, it is important to analyze how temperature or another oceanographic variable affects production cycles and food availability for larvae and therefore their nutritional status. Some oceanographic systems as frontal zones are characterized by a high primary productivity, driven mainly by the nutrient input and the high vertical stability

of the water column, which results in an increased secondary production (Bakun, 1996). Thus, frontal zones provide advantages for various types of organisms, but could be a disadvantageous zone for others due to nutritional stress (Olson, 2002) or predation (Bailey and Houde, 1989). However, both the availability and quality of food available for the early life stages are reflected in the larval condition.

Diaz et al. (2014) analyze the condition of *M. hubbsi* larvae employing field collected material by measuring the RNA/DNA index. These authors observed that the condition showed a clear ontogenetic pattern indicating that the transition between post-flexion and transformation stages might represent a critical phase along larval development. RNA/DNA index also showed significant differences between areas characterized by different chlorophyll "*a*" concentration and abundance of potential prey. Thus, the study of nutritional condition represents a useful tool for identifying favorable nursery areas, providing valuable information for a comprehensive management of a population subject to overfishing. Betti et al. (2014), working in the same species, observed that larval growth showed differences between breeding periods, which were attributed mainly to the availability of prey food for hake larvae in each season.

The study of the spatial distribution during the early life stages is of great importance, as evidenced by Costa et al. (2014), who investigate these aspects in a coastal species *Micropogonias furnieri* from the Patos Lagoon estuary (Brazil). These authors demonstrated that each developmental stage is correlated with an estuarine habitat and is associated with different environmental variables that influence their occurrence. Eggs were associated with coastal environments, whereas larvae were abundant in the estuarine channel area. On the other hand, juveniles showed a different spatial pattern depending on the size range. These results revealed complex estuarine habitat occupancy by *M. furnieri* during its early life stages, with implications to the knowledge of its biology, conservation and management actions. Regarding distribution patterns, Álvarez-Colombo et al. (2014) detected the existence of important pelagic schools of juvenile Argentine hake in the Patagonian waters during the daytime by means of acoustic techniques and corroborated by sampling nets. These authors obtained daylight echograms in the nursery ground of hake that showed horizontally extended aggregations of young-of-the-year noticeably separated from the seabed, beyond the bottom trawl nets routinely used in hake research survey to assess their abundance. Mean densities obtained with acoustic methods were one order of magnitude higher than those obtained by the swept-area method trawl research survey. The particular vertical distribution observed for the Argentine hake juveniles could explain the systematic underestimates of recruitment indices obtained by bottom-trawls research surveys and highlighted the importance of the knowledge of early life history dynamic and behavior.

5. Implications for fisheries management and assessment

The estimation of reproductive variables, as the extension of the spawning season, length and age at first maturity and reproductive potential are critical in the evaluation and management of fishery resources. In the traditional stock-recruitment models SSB is estimated using the maturity ogives, which depends on the sampling season, population size structure and sex ratio. For this reason, it is of great relevance the development of new methodologies in estimating reproductive variables to reduce costs by simplifying techniques, and increasing the accuracy of the estimates. For example, Claramunt et al. (2014) developed a quantitative method to obtain objective indicators of the spawning periods, constituting a useful tool for comparative studies between populations as well as to study the relationship of the extension of spawning seasons with other demographic variables affected by fishing or environmental variability. These authors observed changes in the duration of the maximum reproductive period of anchovy (*E. ringens*) and common sardine (*Strangomera bentincki*) from Chile, which were associated to environmental fluctuations.

As previously mentioned, the reproductive potential of a fish stock is strongly influenced by the size and age of spawning females and, thus, variation of demographic composition caused by fishing activity or by other source of mortality, would affect the number of eggs spawned at a population level. Cubillos et al. (2014) analyzed the effects of the selective fishing in a small pelagic species, the common sardine, off central southern Chile. These authors simulated fishery induced changes on the seasonal reproductive cycle of common sardine through an age-structured population dynamics on a monthly basis. They observed that fishing mortality removes fast growing fish or fish recruiting earlier, and thereafter the age structure tends to be truncated. A delayed peak in the reproductive cycle was observed in the gonadosomatic index during the period 2000–2010, as compared with the period 1993–1999. In addition, a change in the length composition of the catches was observed, supporting the results obtained with simulations. The authors suggest that fishery-induced changes on the reproductive cycle of common sardine can increase the sensitivity of the population to climate variability either matching or mismatching the reproductive cycle with favorable/unfavorable environmental variables for recruitment.

In species with sexual dimorphism in size, fishing activity can also bring changes in the sex ratio at the population level, which can generate in turn changes in reproductive behavior. Cerviño (2014) explored how the post-maturity changes in life history of European hake (*Merluccius merluccius*) may shape the patterns in sex ratio-at-length and analyze how this data may be used to estimate growth parameters. The results suggest that reproductive energy allocation leads to a lower growth rate in male hakes than in females. The sex ratio-at-length may also be useful information to estimate growth parameters in dimorphic species if additional information from other sources is available. Finally, these data can easily be incorporated into stock assessment models to provide an estimation of growth parameters and mortality rates.

Among the reproductive parameters that may be affected by fishing activity, one of the most important in stock assessment is the size and age at first maturation. There are different hypotheses about the effects of selective fishing activity on this reproductive variable. Some observations suggest that overfishing could have effects on the individual growth, associated with dense dependent processes at population level, which may affect age at maturity (Trippel, 1995; Pérez-Rodríguez et al., 2013). Another studies postulate that profound changes generated by the selective removal of individuals by size–age could induce adaptive changes in age and size at maturity (Rijnsdorp, 1993; Heino et al., 2002; Dieckmann and Heino, 2007). Cardoso and Haimovici (2014) analyzed the effects of fishing in the last 50 years on the population of *Macrodon atricauda* from southern Brazil, and observed that length (L_{50}) and age (A_{50}) at maturity of females and L_{50} of males decreased significantly during this period. The most plausible explanation is that the decrease occurred due to genetic changes by the harvest selective pressure of fishing implying lower fitness for individuals that mature at larger sizes. However, the changes in A_{50} may also have been driven by the decrease in the population abundance which relaxed density dependent effects responsible for delaying maturation. The authors also evaluated the effects of those changes, in conjunction with fishing mortality and growth changes, in the spawning biomass. The increase in fishing mortality would have reduced the female spawning biomass to 13% of the virgin biomass, however, the earlier maturation has resulted in a reduction of 28%,

which compensated in some extent the reduction of spawning biomass. However, this does not take into account the potential change in reproductive potential as earlier maturing individuals can produce less eggs and of poorest quality. Reduced spawning biomass combined with a decrease in the reproductive potential of the population, can make recruitment more vulnerable to environmental drivers and to any further increase in the fishing effort.

6. Concluding remarks

The II Ibero-American Symposium on Reproductive Ecology, Recruitment and Fisheries resulted in a significant number of presentations, which covered different topics, from aspects of gonadal maturation and reproductive cycle to estimates of reproductive parameters as fecundity, length–age at first maturity, spawning frequency, egg production, egg quality, etc. Moreover, biological processes as growing, feeding, predation and recruitment in aquatic organisms, associated with environmental variations or with the effects of fishing activity were analyzed.

These studies have provided new knowledge about the reproductive strategy of about 70 species of commercial vertebrates and invertebrates. During the meeting new methodologies to estimate the reproductive potential and how to incorporate them into stock assessment were also discussed. In fact, the presentations of the last session highlighted the importance of including reproductive potential in the assessment and management of fisheries. Certainly, the intense activity during the 4 days of the II SIBECORP were extremely positive, as it allowed the interaction of researchers specialized in different fish species, diverse ecosystems and thematic areas. The discussions and collaboration of researches of various disciplines led to achieve a balance between basic biological aspects of the marine and freshwater resources and its incorporation into assessment to improve the management of these fisheries. The discussions started in the I symposium back in 2009 at Vigo continued successfully during the II SIBECORP held in Mar del Plata in 2012, and we hope that will continue during the III SIBECORP to be held in Brazil in 2015.

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