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Research Article

Preliminary assessment of the jellyfish bycatch captured off southern and southeastern Brazil

Rafael Schroeder[1], Joaquim O. Branco[1], Felipe Freitas Jr.[1] & Charrid Resgalla Jr.[1]
[1]Centro de Ciências Tecnológicas, da Terra e do Mar, Universidade do Vale do Itajaí
Caixa Postal 360, Itajaí, SC, CEP 88.302-202, Brazil

ABSTRACT. Macromedusoid forms of Hydrozoa, Scyphozoa and Cubozoa captured by different fishing gears active in south and southeast of Brazil were recorded on board by scientific observers. After each fishing operation, catch composition was quantified and precise information about the position of the catch was taken between 2008 and 2011. Macromedusae records have been systemized in order to analyze the spatial-temporal distribution, the areas of concentration of the identified species and their relationship with other components of the bycatch. Catch composition analyzed in 986 fishing tows, demonstrated that the participation of these organisms ranged from 6-16%, and the hydromedusae *Rhacostoma atlanticum* L. Agassiz, 1851 and *Olindias sambaquiensis* Müller, 1861 were the most abundant and widely distributed species. *R. atlanticum* was recorded between 20 and 140 m deep while *O. sambaquiensis* presented registers in shallower waters between 10 and 70 m. No other identified species has been recorded in depths greater than 60 m. Areas of high concentration included the north-central coast of Santa Catarina and Paraná, the northern part of São Paulo and the north-central portion of Rio Grande do Sul State. Although the participation of the macromedusae has been relatively low, in areas of elevated concentration, the relative importance was high, making its participation almost exclusive among other zoological groups. Those registers of abundance and the respective areas of high concentration of macromedusae, which were associated to high primary production sites, may serve as a theoretical reference of the abundance of these organisms for future studies that aim to evaluate possible changes in jellyfish populations.

Keywords: macromedusae, *Rhacostoma atlanticum*, *Olindias sambaquiensis*, bycatch, southern and southeastern Brazil.

Evaluación preliminar de la captura incidental de medusas capturadas frente al sur y sureste de Brasil

RESUMEN. El registro de formas macromedusoides de las clases Hydrozoa, Scyphozoa y Cubozoa en su hábitat en el sur y sureste de Brasil se efectuó mediante observadores científicos. Después de cada salida de pesca, se cuantificó la composición de la captura y se registró la localización de cada uno de los lances efectuados entre los años 2008 y 2011. El registro de las macromedusas se sistematizó para analizar su distribución espacio-temporal, áreas de concentración y su relación con los demás componentes del descarte de la pesca. El análisis de la captura analizada en 986 lances de pesca mostró que el porcentaje de organismos varió entre 6 y 16%. Las hidromedusas *Rhacostoma atlanticum* y *Olindias sambaquiensis* fueron las especies más abundantes y más ampliamente distribuidas. *R. atlanticum* fue registrada entre 20 y 140 m de profundidad y *O. sambaquiensis* en aguas más costeras, entre 10 y 70 m. Ninguna otra especie fue registrada en profundidades superiores a 60 m. Las áreas de mayor concentración fueron el litoral centro-norte de Santa Catarina y el litoral de Paraná, sector norte de São Paulo y sector centro-norte de Rio Grande do Sul. A pesar que el porcentaje de estos organismos fue relativamente bajo, en áreas de elevada concentración, la importancia relativa fue alta, y su presencia fue casi exclusivo entre los demás grupos zoológicos. Estos registros de abundancia y las respectivas áreas de alta concentración de macromedusae, asociadas a los áreas de alta producción primaria, pueden servir como referencia teórica de la abundancia de estos organismos para futuros estudios cuyo objetivo sea evaluar los posibles cambios en las poblaciones de medusas.

Palabras clave: macromedusas, *Rhacostoma atlanticum*, *Olindias sambaquiensis*, pesca incidental, sur y sureste de Brasil.

Corresponding author: Rafael Schroeder (schroederrafael@terra.com.br)

INTRODUCTION

Belonging to the macro and mega-zooplankton, medusoid forms such as Hydrozoa, Scyphozoa and Cubozoa are only eventually registered in common zooplankton samples due to the size of individuals and their low density. One of the possibilities for information about the group is the unintended capture held by fishing, constituting components of the bycatch. Because these organisms do not have economic interest, the specimens are discarded after the separation of the catch. Thus, on board records of jellyfish would require the presence of scientific observers, since it could not be observed during the landing in fishing ports.

In Brazil there are about 22 species of Scyphozoa, 4 Cubozoa (Morandini *et al.*, 2005) and more than 20 morphotypes of Hydrozoa only in the southeast and south regions (Tronolone, 2008). The occurrence of jellyfish as bycatch in shrimp artisanal fisheries has already been highlighted by Branco & Verani (2006) in Armação do Itapocoroi bay in Santa Catarina. Similar reports were done on the coast of Paraná by Nogueira Jr. & Haddad (2006) and Nagata *et al*. (2009) while on the coast of São Paulo this occurrence was studied by Graça-Lopes *et al*. (2002). For industrial bottom gillnet fishing in Santa Catarina, macromedusoid forms were registered as bycatch in the fishery of the white-mouth croaker *Micropogonias furnieri* (Desmarest, 1823) (Schroeder *et al.*, unpublished data). It is important to say that those registers were only possible due to the presence of scientific observers on board.

Recent studies on the ecology of jellyfish has evidenced the increase of these organisms in various parts of the world for multiple reasons such as the removal of top predators, coastal pollution, invasions, global warming, overfishing (Mills, 2001; Purcell *et al*., 2007; Condon *et al*., 2013). This fact has prompted interest in these organisms, both ecologically and in terms of use in different segments of human activity, involving its use in food (Schiariti, 2008), obtaining bioactive products for pharmacology (Addad *et al*., 2011) as well as interest on public health due to poisoning of bathers (Resgalla Jr. *et al*., 2011).

The present study aimed to register the macromedusae occurring in different fishing gears active in southern and southeastern Brazilian waters generating a theoretical reference of the abundance including the spatio-temporal variability of occurrence of these gelatinous organisms in their own habitat that could be used in future studies aimed to evaluate possible changes in the populations of these organisms.

MATERIALS AND METHODS

The records of macromedusae were performed in a Scientific Observer Program funded by the Ministry of Fisheries and Aquaculture (MPA) aimed to analyze the catch composition of distinct fishing gears, that included 18 double-rig trawlers (DRT), 3 simple trawlers (ST) and 9 bottom gillnets (BG). Industrial fishing operations were monitored by scientific observers within the latitudes of 23.03-34.52°S and 8-445 m depth between April 2008 and April 2011 (Fig. 1). Additional records were also collected in a scientific program designed to monitor the catch composition of the sea-bob-shrimp *Xiphopenaeus kroyeri* (Heller, 1862) fishery off south Brazil. Biological samples in this program were collected by an artisanal double-rig trawler (ADRT) between the latitudes 26.40-27.24°S and 10-30 m depth within March 2008 and August 2010 (Fig. 1).

In industrial vessels, after every fishing operation monitored the retained catch and geographic information of the capture (*e.g.*, latitude, longitude and depth) were recorded. After the separation of the catch, a random sample (40-60 kg) was taken from the discard, and all organisms belonging to different zoological groups (*e.g.*, bony fishes, elasmobranches, crustaceans, echinoderms, mollusks). including macromedusae were "typified" (*e.g.*, assigned a common name) their total number in the sample recorded. The quantification of species caught in each fishing operation (N) was estimated in numbers of individuals (n) of each species (j) caught in fishing operation (i) by the following:

$$N_{ji} = \frac{P_{Ti}}{P_{Ai}} n_{ji}$$

where N_{ji} is the number of individuals of the species j captured in the fishing operation i; P_{Ti}, is the number of sampled stringed nets in gillnet vessels or the weight of the sample removed from the capture in trawling vessels of the fishing operation i and P_{Ai} is the number of total stringed nets in gillnet vessels or the weight of the total discard in trawling vessels of the fishing operation i for the analysis of the catch composition; and n_{ji} is the number of the individuals of the species j registered in the sample removed from the capture of the fishing operation i. Non-identified specimens were frozen and properly labeled for posterior identification on land. Photograph registers taken on board were also used in the identification of these organisms. Biological samples collected by artisanal double-rig trawler were also labeled and sent to the laboratory for further identification. Species

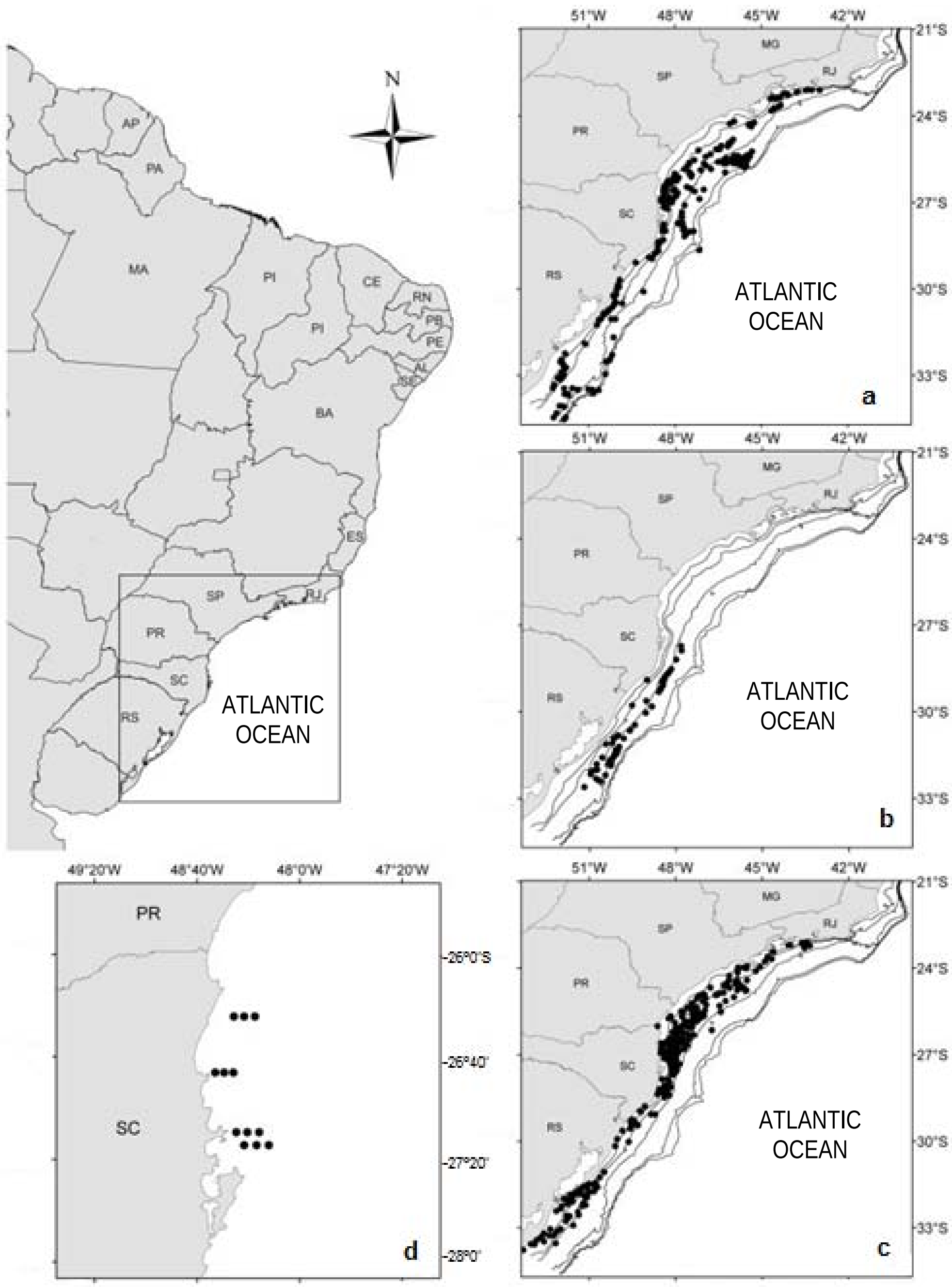

Figure 1. Fishing operation positions conducted by industrial fishing vessels. a) Double-rig trawlers, b) simple trawlers, c) bottom gillnet, and d) one artisanal double-rig trawler, in southern-southeastern Brazil, between April 2008 and April 2011.

identification involved the use of taxonomic guides such as Mianzan & Cornelius (1999), Bouillon (1999), Morandini *et al*. (2005, 2006) and others.

The numerical abundance of different macromedusae species estimated during catch composition analysis (*N*) was standardized in number of individuals per minute in each fishing operation for the distinct fishing gears. Abundance values were than structured in maps constructed from the position of the captured specimens in each fishing operation in order to analyze the spatial distribution of captured species and concentration areas. Temporal variability was also assessed by the abundance records separated in months for each identified species and how the main species behaved throughout the year in relation to depth. The interaction between macromedusae and other components of the bycatch was estimated to the industrial vessels only, by the simple ratio of the sum of all species from different zoological groups present by the sum of the main macromedusae species present, exclusively in tows where at least one macromedusae was recorded.

Finally, a visual taxonomic guide was designed from the pictures taken on the laboratory, and also from previous studies (Morandini *et al*., 2005), as to create a field guide for the identification of the macromedusoid forms interacting to both industrial and artisanal fishery in southern and southeastern Brazil. Additional photos of *Aurelia* sp. and *Chrysaora lactea* Eschscholtz, 1829 were respectively taken by the scientific divers Daniel R. Filgueiras and Pedro H.M.L. Marques at Ilha Escalvada, ES and Praia da Saudade, SC in 2013.

RESULTS

Species identification

In four years of the scientific observers program a total of 842 fishing tows were sampled on board at industrial vessels and 144 fishing tows from one artisanal double-rig trawler. Nine macromedusae species were recorded within the captures being the most abundant the hydromedusae *Rhacostoma atlanticum* (RA) and the joint occurrence of *Olindias sambaquiensis* (OS) and *R. atlanticum* (RAOS) (Fig. 2). In the records of the co-occurrence of these two species, *R. atlanticum* always predominated, with elevated participation in industrial double-rig and simple trawlers and in bottom gillnets (Fig. 2, Table 1). The species *Chiropsalmus quadrumanus* (F. Muller, 1859) (CQ) and *Lychnorhiza lucerna* Haeckel, 1880 (LL) showed greater abundance in the captures of artisanal trawling. The other species present, such as *Tamoya haplonema* F. Müller, 1859 (TH), *Aurelia* sp. (AUSP), *Chrysaora lactea* (CL), *Drymonema dalmatinum* Haeckel, 1880 (DD), *Aequorea* sp. (AESP) and unidentified species were less abundant in the catches (Fig. 2, Table 1).

Spatio-temporal distribution

The hydromedusae *R. atlanticum* and *O. sambaquiensis* were widely distributed in the southern and southeastern Brazil. *R. atlanticum* occurred in the whole studied area since the State of Rio de Janeiro to Rio Grande do Sul. *O. sambaquiensis* also showed a wide distribution pattern of occurrence but limited to the north portion of São Paulo State (Fig. 3). These two species presented three main areas of higher abundance (*i*) on the north-central coast of Santa Catarina, (*ii*) Paraná and (*iii*) the northern coast of São Paulo. *R. atlanticum* and *O. sambaquiensis* were more

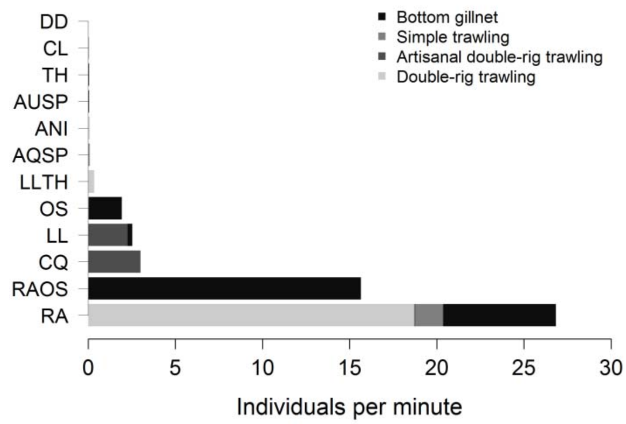

Figure 2. Main species caught by different fishing gears active in southern-southeastern Brazil between April 2008 and April 2011. RAOS: *Rhacostoma atlanticum* + *Olindias sambaquiensis*, RA: *R. atlanticum*, OS: *O. sambaquiensis*, LL: *Lychnorhiza lucerna*, CQ: *Chiropsalmus quadrumanus*, LLTH: *L. lucerna* + *Tamoya haplonema*, ANI: non-identified macromedusae, TH: *T. haplonema*, AUSP: *Aurelia* sp., CL: *Chrysaora lactea*, DD: *Drymonema dalmatinum*, AESP: *Aequorea* sp.

abundant between 30 and 80 m, wherein the first species was recorded between 20 and 140 m and the second in shallower waters (between 10 and 70 m).

L. lucerna was mainly observed in the north-central coast of Santa Catarina and in Rio Grande do Sul and *T. haplonema* was recorded in low abundance in both states. *Aurelia* sp., *C. quadrumanus*, *C. lactea* and *D. dalmatinum* have been caught in the same fishing trip by an industrial vessel that operated with bottom gillnets off the coast of Rio Grande do Sul. Non-identified specimens were collected mainly over 100 m depth by double-rig trawlers, while some of these records were obtained over 400 m (Fig. 3).

The main species observed within the samples collected by artisanal double-rig trawling on the coast of Santa Catarina were *C. quadrumanus* and *L. lucerna*. *Chrysaora lactea* were abundant in one month and the samples of *R. atlanticum* were composed of few individuals. One individual of *Aequorea* sp. was collected on the north coast of Santa Catarina (Fig. 3).

Temporally, the main species *R. atlanticum* and *O. sambaquiensis* showed high abundance between April and December. Although *L. lucerna* and *C. quadrumanus* have been reported as only occasional within the catches of industrial vessels, in the artisanal trawling these species occurred throughout the year with great variability. The other species were sparsely recorded at low densities (Fig. 4). During the first semester, between January and May, that comprise

Table 1. Abundance records of macromedusae captured by different fishing gears active in southern-southeastern Brazil between April 2008 and April 2011 standardized in individuals per minute per fishing trip. Mean: mean value of abundance, SD: standard deviation of the mean, N ind. total, number of individuals captured during the study. RAOS: *Rhacostoma atlanticum* + *Olindias sambaquiensis*, RA: *R. atlanticum*, OS: *O. sambaquiensis*, LL: *Lychnorhiza lucerna*, CQ: *Chiropsalmus quadrumanus*, LLTH, *L. lucerna* + *Tamoya haplonema*, ANI, non-identified macromedusae, TH: *T. haplonema*, AUSP: *Aurelia* sp., CL: *Chrysaora lactea*, DD: *Drymonema dalmatinum*, AESP: *Aequorea* sp., FG: fishing gear, DRT: double-rig trawling, ST: simple trawling, BG: bottom gillnet, ADRT: artisanal double-rig trawling.

Species	Month												FG	Mean	SD
	J	F	M	A	M	J	J	A	S	O	N	D			
ANI					0.030			0.131					DRT	0.080	0.072
ANI								0.019					BG	0.019	-
AUSP											0.168		ADRT	0.168	-
CL							0.044						ADRT	0.044	-
CL											0.012		BG	0.012	-
CQ	0.189		0.115	0.189	0.322	0.017	0.081	0.044	0.250	0.106	0.159	0.056	ADRT	0.139	0.093
CQ											0.056		BG	0.056	-
DD											0.019		BG	0.019	-
LL											0.0004	0.001	DRT	0.001	0.000
LL	0.300	0.011	0.044	0.044	0.196	0.144	0.061	0.033	0.122	0.111	0.067	0.011	ADRT	0.096	0.086
LL											0.409		BG	0.409	-
LLTH							0.106	0.085					DRT	0.096	0.015
OS					0.022		0.044						ADRT	0.033	0.016
OS		0.001			0.449						0.039	0.027	BG	0.129	0.214
RA				2.980	0.787							3.409	DRT	2.392	1.407
RA											0.028		ADRT	0.028	-
RA					2.846								ST	2.846	-
RA		0.010			0.507				0.016	0.015	0.109	0.006	BG	0.110	0.198
RAOS								0.293	2.177				BG	1.235	1.332
TH										0.023	0.015		BG	0.019	0.005

summer and autumn, the records of the most abundant species occurred in deeper extracts of the continental shelf in comparisons to those in the second semester, between August and December, during the winter-spring period. In the first half of the year abundance records fluctuated around 74 m depth oscillating between 40 and 110 m while during the second half the mean depth was around 47 m, varying between 35 and 70 m (Fig. 5).

Interaction with fishing

Macromedusoid forms showed generally low occurrence with occasional peaks of high abundance. The percentage of these organisms ranged from 6-16% of total sampled tows. In the double-rig trawling the main species were present in 28 from a total of 473 tows (6%); 12 from a total of 74 tows for simple trawling (16%) and 47 in a total of 295 tows for bottom gillnet (16%). The relative importance of the most abundant macromedusae, *R. atlanticum* and *O. sambaquiensis*, in relation to other zoological groups present in the fishing tows was high. The results demonstrated that 3.86 fish were captured for each macromedusae captured. For the other groups in the catches, this importance was even greater, with less than one individual for each macromedusae.

DISCUSSION

Macromedusae compete for at least 200 million years for the same planktonic resources consumed by many commercial fish species (Parsons & Seki, 1995;

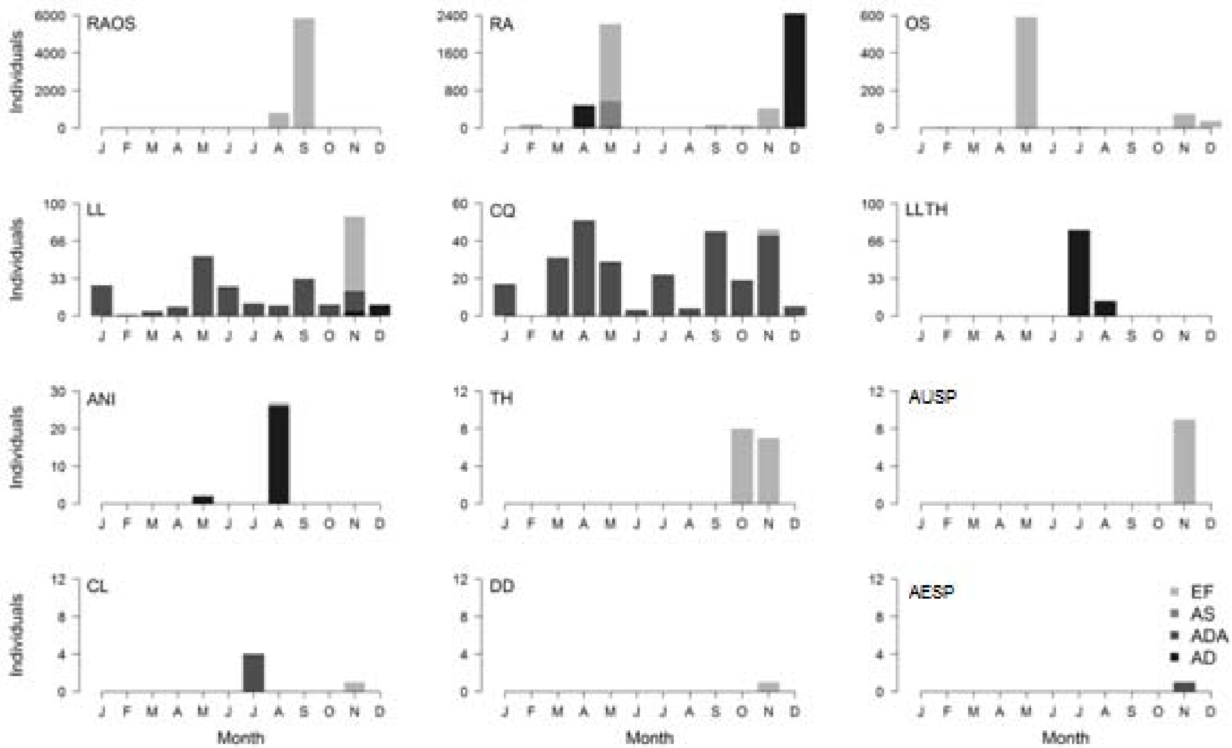

Figure 3. General spatial distribution of all macromedusae captured by different fishing gears active in southern-southeastern Brazil between April 2008 and April 2011. Separated distributional patterns are indicated on the map. RAOS: *Rhacostoma atlanticum* + *Olindias sambaquiensis*, RA: *R. atlanticum*, OS: *O. sambaquiensis*, LL: *Lychnorhiza lucerna*, CQ: *Chiropsalmus quadrumanus*, LLTH: *L. lucerna* + *Tamoya haplonema*, ANI: non-identified macromedusae, TH: *T. haplonema*, AUSP: *Aurelia* sp., CL: *Chrysaora lactea*, DD: *Drymonema dalmatinum*, AESP: *Aequorea* sp.

Mianzan & Cornelius, 1999). However, in some cases, the fishery is affected by large concentrations of macromedusae (Möller, 1984; Rottini-Sandrini *et al*., 1985; Mianzan, 1986; Hay *et al*., 1990; Mianzan & Cornelius, 1999; Graça-Lopes *et al.*, 2002; Nagata *et al*., 2009). Large aggregations of these gelatinous organisms constitute an essential part of the life cycle of some fish species that control their biomass (Boero, 1991) and may also be associated with local environmental patterns (Mianzan & Cornelius, 1999; Mianzan & Guerrero, 2000). The study of the main species interacting to the fishery is the first step in the study of population dynamics of these gelatinous organisms.

Rhacostoma atlanticum is recorded since the 1970's in the western South Atlantic Ocean (Bouillon, 1999) with several records for south Brazil (Mianzan & Guerrero, 2000; Tronolone, 2001; Migotto *et al*., 2002; Nogueira Jr. & Haddad, 2006; Nogueira Jr. *et al*., 2010; Cristiano, 2011; Schroeder *et al.*, unpublished data). Until 2000, however, this species has not been previously reported in high densities for this region (Mianzan & Guerrero, 2000). In samples collected at Cape Santa Marta Grande, south coast of Santa Catarina, *R. atlanticum* dominated the macroplanktonic biomass in coastal waters, between 20 and 40 m. These aggregations were associated with high primary production in November in spring, which was supported by chains of diatoms (Odebrecht & Djurfeldt, 1996) controlled by enriched cold upwelling waters induced by NE winds (Mianzan & Guerrero, 2000). In North Bay in Florianopolis, *R. atlanticum* occurs throughout the year, with an abundant peak in autumn, comprising 45% of the biomass and 50% of the sampled individuals (Nogueira Jr. *et al*., 2010). On the coast of Rio Grande do Sul, the largest concentrations were observed during autumn (Cristiano, 2011). In the present work, picks of abundance observed between autumn and spring seemed to be in agreement with other works mentioned here, indicating a possible preference of this species for colder waters. However, there were few fishing trips monitored during the summer to assess this hypothesis.

Simultaneously with the occurrence of *R. atlanticum*, another hydromedusae *Olindias samba-*

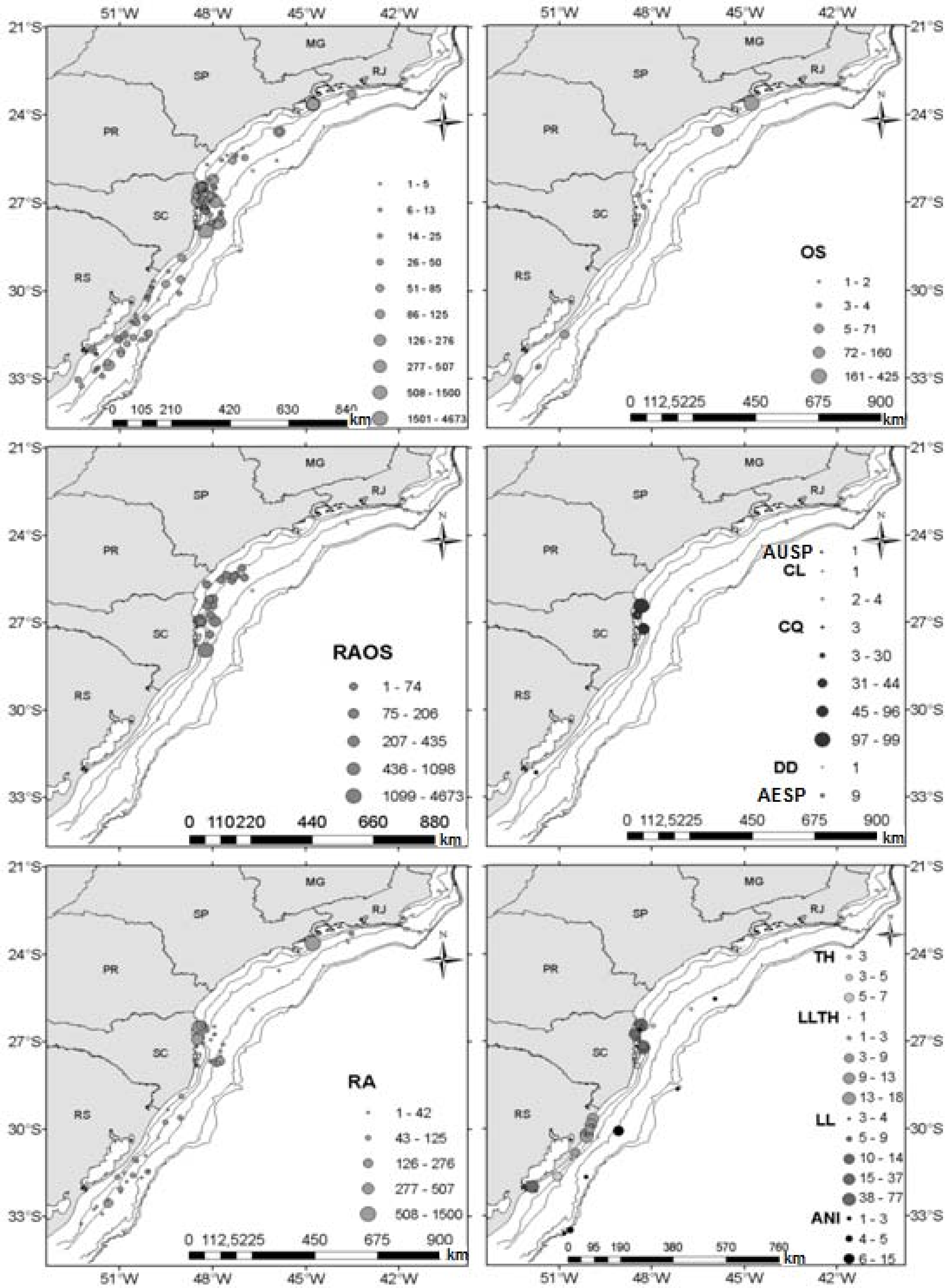

Figure 4. Temporal distribution of the macromedusae collected in southern-southeastern Brazil between April 2008 and April 2011. RAOS: *Rhacostoma atlanticum* + *Olindias sambaquiensis*, RA: *R. atlanticum*, OS: *O. sambaquiensis*, LL: *Lychnorhiza lucerna*, CQ: *Chiropsalmus quadrumanus*, LLTH: *L. lucerna* + *Tamoya haplonema*, ANI: non-identified macromedusae, TH: *T. haplonema*, AUSP: *Aurelia* sp., CL: *Crysaora lactea*, DD: *Drymonema dalmatinum*, AESP: *Aequorea* sp.

quiensis has been observed mainly between autumn and spring. *O. sambaquiensis* is found from São Paulo to Argentina (Migotto *et al*., 2002). As the above-mentioned species, at least in North part of distri-

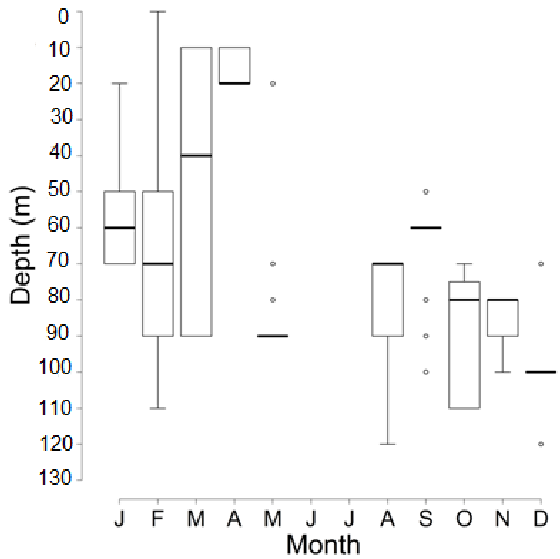

Figure 5. Bathymetric distribution of the main species (*Rhacostoma atlanticum* + *Olindias sambaquiensis*) collected throughout the year in relation to depth in southern-southeastern Brazil between April 2008 and April 2011. The stressed line represents the median and the upper and lower hinges the lower and upper quartiles respectively. Lines represent the whiskers and open circles the outliers.

bution, it also appears to have a preference for colder waters, since it presents greater abundance during the winter months. The species occurs throughout the year, but at least on the coast of Paraná and São Paulo, higher concentrations were observed between winter and spring (Vannucci, 1951; Nogueira Jr., 2006; Ale, 2008). The simultaneous recording of *O. sambaquiensis* and *R. atlanticum* have been demonstrated in other studies (Mianzan & Guerrero, 2000; Schroeder *et al.*, unpublished data), although the quantities of *O. sambaquiensis* never exceeded *R. atlanticum*'s. However, the distributional pattern of this specie is likely to that of *R. atlanticum*, since both species frequently co-occur.

Lychnorhiza lucerna is endemic to the Atlantic coast of South America (Mianzan & Cornelius, 1999) and is distributed from the Rio Grande do Sul to Amapá in Brazilian waters (Migotto *et al*., 2002). In estuarine areas this species increases in numbers between October and March between spring and summer (Soares *et al*., 2009). On the coast of Paraná this species is found throughout the year, but especially between August and November (late winter to early summer) (Nogueira Jr., 2006). In the State of Rio Grande do Sul this species also occurred throughout the year, performing a main peak of abundance in spring and a secondary in summer (Cristiano, 2011). The results obtained in this study corroborate this trend with a major peak in May (autumn) and another in November (spring).

Chiropsalmus quadrumanus is distributed on the whole Atlantic coast of America (Mianzan & Cornelius, 1999) being found in Brazilian waters from Santa Catarina to Amapá (Migotto *et al*., 2002). Abundant peaks were recorded between late spring and early summer on the coast of Paraná, being found until early winter (Nogueira Jr., 2006). In this study *C. quadrumanus* presented a main peak in April (autumn), followed by two others in September and November between late winter and spring. An interesting point was that three specimens of this cubozoa were found on the coast of Rio Grande do Sul, what has not being previously reported in the literature (Migotto *et al*., 2002).

Tamoya haplonema occurs from Rio Grande do Sul to Amapá (Migotto *et al*., 2002). Nogueira Jr. (2006) collected specimens along the years between February and May (summer and autumn), but always in low density. On the coast of Rio Grande do Sul, Cristiano (2011) collected specimens between May and February (autumn to summer) also in low density. In this study, individuals were collected in winter and spring months also in low density.

Aurelia sp. is found from Rio Grande do Sul to Bahia (Migotto *et al*., 2002). This species, formerly classified as *Aurelia aurita* is being object of taxonomic review, wherein the separation of species can often only be recognized by molecular characters (Dawson, 2003, 2004). Nogueira Jr. (2006) found elevated concentrations during May (autumn). In the present work, the species was present in one sample composed by nine individuals in the State of Rio Grande do Sul during November (spring).

Chrysaora lactea is found from Rio Grande do Sul to Amapá (Migotto *et al*., 2002). This species was recently re-described by Morandini *et al*. (2006) that analyzed south Atlantic collected individuals and a new neotype was created (Soares *et al*. 2009). In the State of Paraná two main abundant picks were present along the year, the first between August and November between winter and spring and the second one in April in autumn (Nogueira Jr., 2006). In the north part of Rio Grande do Sul State Cristiano (2011) observed this species to be abundant between spring and summer in November, January and February.

Drymonema dalmatinum has been recorded in the States of Santa Catarina, São Paulo and Rio de Janeiro (Migotto *et al*., 2002). This species is rarely found in Brazilian waters (Morandini *et al*., 2005) however there is a resident known population in Argentine

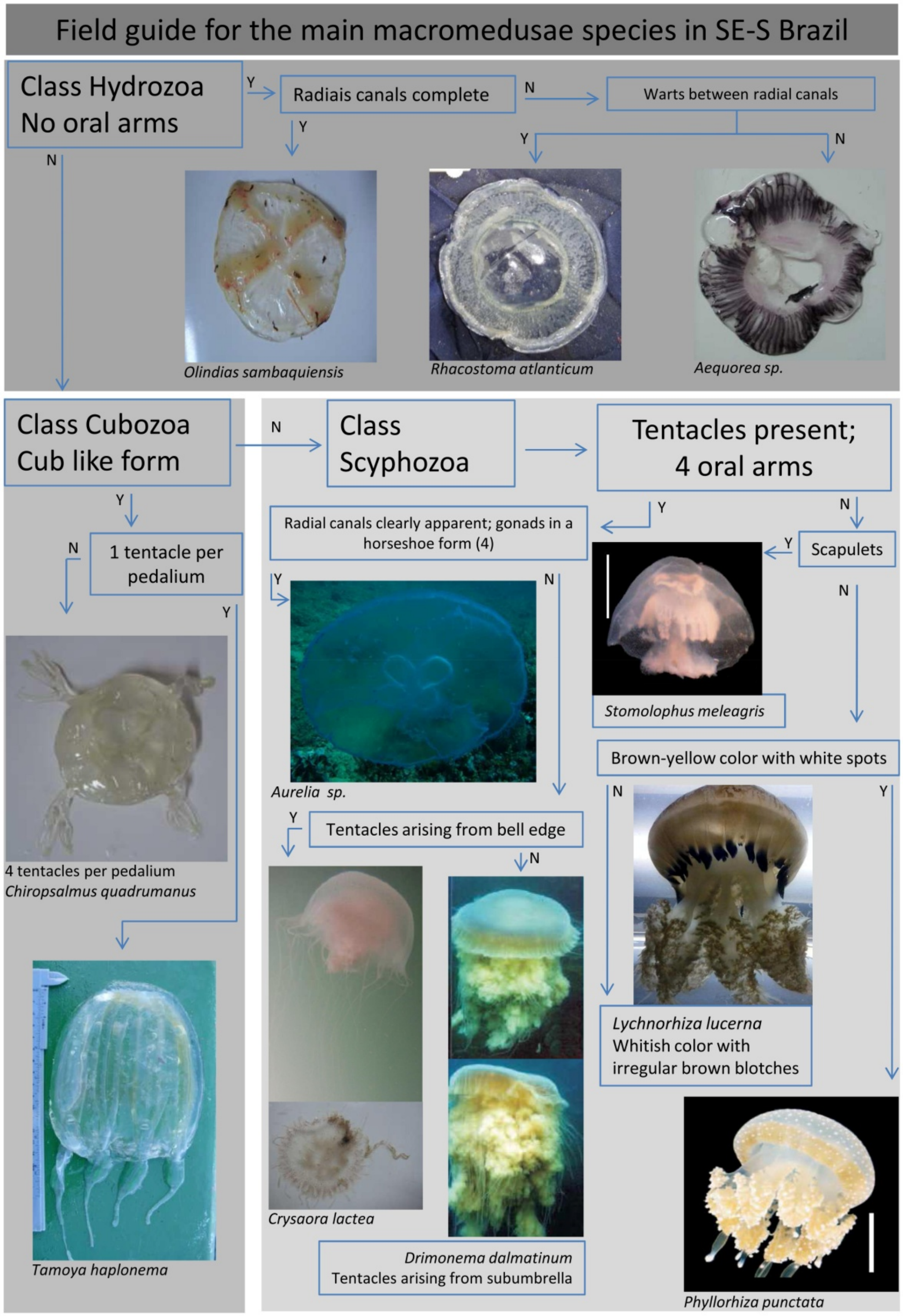

Figure 6. Field guide for the identification of the macromedusae in southern-southeastern Brazil. The photos of *Stomolophus meleagris* and *Phyllorhiza puntata* were adapted from Morandini *et al*. (2005). The photos of *Aurelia* sp. and *Chrysaora lactea* were taken by Daniel R. Filgueiras and Pedro H.M.L. Marques, respectively.

waters (Mianzan, 1989). One individual was registered on the coast of Rio Grande do Sul in this study. The specimen was collected during the spring in November.

Considering the spatial distribution of macromedusae observed in this work and its respective values of abundance, the southern-southeastern region of Brazil could be divided into three distinct areas: (*i*) the north-central coast of Santa Catarina including the coast of Paraná, (*ii*) the north coast of São Paulo and (*iii*) the coast of Rio Grande do Sul. Mianzan & Guerrero (2000) found elevated abundance of *R. atlanticum* and *O. sambaquiensis* around Cape Santa Marta Grande sustained by elevated primary production of diatom chains in this region during the spring-summer period between October and March (Odebrecht & Djurtfeldt, 1996) while the north region of Santa Catarina Island can be strongly influenced by the discharge of terrigenous material that would be quite high in autumn and even more in winter (Brandini, 1988).

Sea water temperature in upwelling sites like the north coast of São Paulo and Cape Santa Marta Grande is typically low, due to the ascent of cold deep water to the coastal region, caused by the coastal morphology and action of the northerly wind, particularly the northeast winds, which are more intense during summer (Hille *et al*., 2008). The opposed pattern, induced by southerly winds, more intense during winter, favor the convergence of shelf waters on the beach regions, due to Ekman transport, thus moving the organisms that are further out to sea towards the coastline (Mann & Lazier, 1991). The occurrence of jellyfish in shallower waters, closer to the shoreline may, likewise, be associated with winds from the South quadrant, which would probably promote their close proximity to the coast, as observed by Resgalla Jr. *et al*. (2005), when 76% of the incidents with bathers occurred with southerly winds on the north coast of Santa Catarina (Resgalla Jr. *et al*., 2011).

The results demonstrated that at least the main species seemed to respond to water mass movements off SE-S Brazil and large aggregations of hydromedusae may be related to productive areas and can negatively affect the fishing activity in terms of capture failure. Although global changes including warming temperatures (Purcell *et al*., 2007; Purcell, 2012), which enhance production, feeding, and growth rates of jellyfish (Purcell, 2005), may provide satisfactory conditions for jellyfish blooms, overfishing of jellyfish competitors (Daskalov *et al*., 2007) would also contribute to that. Combined, this factor attests against the health of ocean (Condon *et al*., 2013). In this sense, the registers of abundance and the respective areas of high concentration of macromedusae described in the present work may serve as an important theoretical reference of the abundance of these organisms for future studies that aim to evaluate possible changes in jellyfish populations.

In addition, the field guide developed could be attached to the species identifications guides for on-board observers, which will be useful for the identification of the macromedusae in southern-southeastern Brazil (Fig. 6).

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