PLANKTONIC TUNICATES (CHORDATA, TUNICATA) OF THE RTMA "EVRIKA" IN THE SOUTHWESTERN ATLANTIC OCEAN (1988)

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ABSTRACT

The planktonic tunicates from the samples collected by the RTMA "EVRIKA" in the southwestern Atlantic in 1988 were studied. For the salps *Ihlea magalhanica* (Apstein, 1894) and *Salpa thompsoni* Foxton, 1961 a clear association with waters of subantarctic origin was once more found, while *Ciclosalpa bakeri* Ritter, 1905, *Iasis zonaria* (Pallas, 1774), *Ritteriella retracta* (Ritter, 1906); the aggregates of *Thalia democratica* (Forskal, 1775) group, the doliolidae nurses and the appendicularia *Oikopleura albicans* (Leuckart, 1854) were found associated with subtropical waters. For the salps *Salpa aspera* (Chamisso, 1819) and *S. fusiformis* Cuvier, 1804, species previously considered associated with Brazil current waters, the distribution is extended further South in mixed subtropical-subantarctic waters or with predominantly subantarctic features, which shows a wider tolerance to environmental change. *Thetys vagina* Tilesius, 1802 extends its southern limit of distribution in the Atlantic Ocean from 5° S to 40° S. In only one station specimens were found which could be attributable with high probability to *Pegea socia* (Bosc, 1802) species which had not been previously mentioned for the southwestern Atlantic. Since only fixed specimens were available a trustworthy identification is not possible so we refer to the taxon as *Pegea* sp. and the corresponding morphometric data are included.

KEYWORDS. Zooplankton, Pelagic tunicates, Thaliacea, Appendicularia, Southwestern Atlantic.

INTRODUCTION

The study of the distribution and abundance of pelagic tunicates increases in importance every day on account to their well known key role in the marine food webs. Their value relies on their ability to filter small particles that span from micro and nannoplankton up to "dissolved" organic carbon (DOC) in the colloidal size range down to about 0,2 μm in diameter (FLOOD **et al.**, 1992). Their filter-feeding rates are among the highest registered in planktonic animals (HARBISON & GILMER, 1976; ALLDREDGE, 1981).

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The knowledge of the distribution of these plankters in the southwestern Atlantic is still fragmentary since the available data are, in general, qualitative, simply mentioning presence or absence of species and not their densities, and come from isolated expeditions restricted to coastal areas or in the case of larger areas the stations are very scattered (HERDMAN, 1866; KRUGER, 1939; FOXTON, 1961; AMOR, 1966 a, b, 1969; ESNAL, 1968, 1970 a, b, 1973, 1978; SOEST, 1975).

The collection of planktonic tunicates performed by the research vessel RTMA "EVRIKA", during the first Sovietic-Argentine expedition to the southwestern Atlantic, in 1988, has permitted us to study the distribution in a very wide area which is very complex from the hydrological point of view, characterized by the presence of different water masses (subantartic, subtropical and shelf waters) and by dynamic process resulting from the interaction of the Malvinas (Falkland) and Brazil currents (PETERSON & STRAMMA, 1991). Moreover the sampling was quite intensive and it was possible to estimate densities.

MATERIAL AND METHODS

Plankton samples obtained in 60 stations performed in 4 stages from 30.VII to 24.X.1988, in an area extending 36°30' and 50° S and between 60°33' and 42°05' W were studied. Oblique tows from 50 meters depth were performed with a Bongo net of 60cm of mouth diameter and 500 µm mesh in both nets. The volume of filtered water was determined with a digital flowmeter DF-2030. Samples were fixed with 4% formaline. The position of the stations where tunicates appeared (fig. 1) and the corresponding oceanographic data (Table I) are presented, including densities expressed as number of individuals in 1000 m^3 of filtered water. Specimens were counted in most cases as whole samples, when densities were high subsamples of 1/4 and 1/16 obtained with a Folsom plankton sample splitter (MC EWEN **et al.**, 1954) were used.

RESULTS AND DISCUSSION

Species: Specimens corresponding to 12 taxa of Tunicata were found. From the class Appendicularia: *Oikopleura albicans* (Leuckart, 1854) . From the class Thaliacea: non identified nurses of Doliolidae; *Ciclosalpa bakeri* Ritter, 1905 (Salpidae, Ciclosalpinae) and *Iasis zonaria* (Pallas, 1774), *Ihlea magalhanica* (Apstein, 1894), *Pegea* sp., *Ritteriella retracta* (Ritter, 1906), *Salpa aspera* Chamisso, 1819, *S. fusiformis* Cuvier, 1804, *S. thompsoni* Foxton, 1961, *Thalia* sp., *Thetys vagina* Tilesius, 1802 (Salpidae, Salpinae).

General features of the distribution of the fauna: the 500 µm mesh of the net used for sampling is not appropriate to obtain appendicularians since a large number of specimens of most species may go through it. This may be one of the reasons why only one species, *Oikopleura albicans*, appears in these samples, another reasons may be that most stations were away from the platform, since in a previous study (ESNAL & CASTRO, 1985). *Oikopleura albicans* was observed to be more abundant in the pelagic than in the neritic environment, being absent in nearshore stations. Its frequency was relatively high (26,6% of the stations) being the third species in importance after the two best represented salpids: *Ihlea magalhanica* and *Salpa fusiformis*. *Oikopleura albicans* was also very abundant, reaching densities up to 775 ind. per 1000 m^3. In fig. 5 the distribution of this species is represented against the thermohaline parameters, the highest abundances being observed in waters between 14 and 17° C and salinities over 35.2%.

Referring to the salpids, *Ihlea magalhanica* was the species found with the highest frequency (50%) and also the most abundant (between 3 and 50.000 ind. per 1000 m^3). In the T-S diagram (fig. 3) the highest densities observed appeared at lower temperatures and salinities (5-7°C and under 34.2%). *Salpa fusiformis* is next to *Ihlea magalhanica* both in frequency (38.3%) and abundance, but in this case densities were much lower (from 2 to 235 ind. per 1000 m^3). The T-S diagram (fig. 4) shows that the highest desities appeared between 11 and 15°C in a very wide salinity range. *Salpa aspera* and *S. thompsoni* follow in impo . unce with very similar values both in frequency and abundance. Both appeared in 8.3% of the stations in low densities (2-43 ind. per 1000 m^3 the former and 2-39 ind. per 1000 m^3 the latter). In the T-S diagram (fig. 6) the highest values can be seen associated in both cases with low temperature and low salinity waters. With lower frequencies (5%) and lower densities (2-4 ind. per 1000 m^3) there appeared *Ritteriella retracta* and aggregates of *Thalia democratica* group which could, according to their aspect belong either to *T. democratica* or *T. cicar* or *T. orientalis* (ESNAL, 1981). Due to the absent of solitaries of these species a more precise determination was impossible. *Tethys vagina* was found with a frequency of 3% in densities ranging from 2-7 ind. per 1000 m^3. SOEST (1975) included this species among those which presented a clinal variation of the number of fibres per muscular band, which would increase with an increase in latitude but he had only one datum available for the south Atlantic (an aggregate with a total number of fibres in muscles I-IV=268). In our case 4 aggregates were found in a station located at 38°58'S and 47°18'W in which the mean number of fibres was 241 and one solitary (40°28'S and 43°46'W) with 195 fibres in MV-VI. *Iasis zonaria* and *Ciclosalpa bakeri* appeared only once, the former with a much higher density 110 vs 9 ind. per 1000 m^3. Except *Thethys vagina* which appeared in waters of 10-11° C and low salinity, the rest of the group of species formerly mentioned, *Ritteriella retracta, Iasis zonaria, and Ciclosalpa bakeri,* was found associated with warmer and more saline waters (fig. 6,7). In only one station situated at 43°35'S and 43°21'W three aggregates appeared which fitted the characterization of MADIN & HARBISON (1978) for *Pegea socia*, species that had not been previously mentioned for the southwestern Atlantic. According to SOEST (1974) this would be only individuals at the end of the clinal variation of *Pegea confoederata* in warm waters, but MADIN & HARBISON (1978), suggest, that this would be a misinterpretation originated in the observation of fixed specimens which lose features such as form and color which permit a rapid differentiation. In our case we only have fixed specimens so we cannot give a definitive conclusion, therefore we refer to the taxon as *Pegea* sp. Anyhow we believe it is important to include the data referring to our specimens, since this is a taxonomic problem that has still to be solve. These data which would correspond to *Pegea socia* are: (a) Cylindrical body without a pronounced thickening around the nucleus and a mean of total length/body width= 2.42 ($\overline{X}$ = 1.85 for *Pegea confoederata* according to MADIN & HARBISON (1978)); (b) Two groups of muscles shaped as an X. Muscles I + II and III + IV barely close without dorsal fusion. Muscle IV laterally extended more than the rest. Mean of muscular fibres: MI=29.6; MII= 31.0; MIII=30.3; MIV=24.6. Total mean (MI-IV)= 115.6. The data for *Pegea confoederata*, are according to MADIN & HARBISON (1978) MI=14; MII=14; MIII=13; MIV= 12; MI - IV= 58.

Nurses of Doliolidae could not be assigned to a particular species. They appeared with a frequency of 13.3% and in low densities (1-4 ind. per 1000 m^3). In the T-S diagram (fig. 7) they are shown associated with high temperatures and high salinities.

Table I. Oceanographic data of planktonic tunicates (Chordata, Tunicata) of RTMA "EVRIKA" in the southwestern Atlanctic Ocean (1988)

STATION	DATE	POSITION		T°C	S%.	SPECIES	DENSITY ind/1000 m³
1	01/08	36°30'S	50°31'W	14.00	35.187	*S. fusiformis*	120
						I. zonaria	120
						R.retracta	2
						Thalia sp.	4
						O.albicans	118
						Doliolidae	1
2	02/08	36°30'S	49°51'W	12.64	34.538	*S.fusiformis*	2
3	03/08	36°30'S	48°30'W	16.66	35.908	*S.fusiformis*	78
6	03/08	37°30'S	47°30'S	15.06	35.590	*S.fusiformis*	163
						I.magalhanica	3
						C.bakeri	9
						O.albicans	5
7	04/08	37°27'S	48°00'W	15.20	35.666	*S.fusiformis*	103
						O.albicans	775
						Doliolidae	1
						R.retracta	3
						Thalia sp.	6
8	04/08	37°30'S	48°30'W	14.80	35.647	*O.albicans*	7
10	04.08	37°31'S	50°59'W	14.03	35.356	*S.fusiformis*	245
						O.albicans	182
						Doliolidae	3
11	05/08	37°31'S	51°28'W	14.64	35.526	*S. fusiformis*	13
						O. albicans	3
						Doliolidae	1
12	05/08	37°30'S	51°52'W	14.81	35.598	*S.fusiformis*	5
						R.retracta	3
						O.albicans	9
						Doliolidae	1
13	05/08	37°52'S	52°33'W	14.94	35.660	*S.fusiformis*	4
14	05/08	38°50'S	53°09'W	12.20	34.829	*O.albicans*	2
17	06/08	39°00'S	52°06'W	14.70	35.558	*O.albicans*	2
18	06/08	39°02'S	51°15'W	15.02	35.658	*S.fusiformis*	57
19	07/08	39°00'S	50°39'W	15.00	35.696	*S.fusiformis*	2
20	07/08	39°00'S	50°10'W	15.06	35.664	*S.fusiformis*	20
						S.aspera	2
						O.albicans	135
22	07/08	38°58'S	48°26'W	14.88	35.751	*S.fusiformis*	68
						Doliolidae	4
23	08/08	39°00'S	48°00'W	14.74	35.693	*S.aspera*	3
						O.albicans	11
27	08/08	39°00'S	47°17'W	10.43	34.691	*T.vagina*	7
30	11/08	40°28'S	43°44'W	10.94	34.822	*T.vagina*	2
32	11/08	40°28'S	44°53'W	14.27	35.593	*S.aspera*	3
						S. fusiformis	3
33	12/08	40°28'S	45°57'W	11.20	34.895	*I.magalhanica*	7
34	13/08	40°30'S	47°00'W	9.78	34.642	*S.aspera*	4
39	17/08	40°28'S	51°44'W	11.35	35.642	*S.fusiformis*	2
						I.magalhanica	20
						O.albicans	2
42	18/08	40°29'S	54°27'W	7.00	34.113	*I.magalhanica*	41

Cont.

Tab. I (cont.)

STATION	DATE	POSITION		T°C	S%	SPECIES	DENSITY ind/1000m3
46	21/08	41°58'S	55°27'W	7.00	34.113	*I.magalhanica*	1268
47	22/08	42°00'S	54°30'W	6.96	34.089	*I.magalhanica*	5715
						S.aspera	
50	23/08	42°00'S	51°37'W	9.30	34.319	*S.fusiformis*	3
						I.magalhanica	5
51	23/08	42°00'S	50°30'W	9.37	34.504	*I.magalhanica*	21
52	23/08	42°00'S	49°35'W	9.85	34.595	*I.magalhanica*	107
53	24/08	41°58'S	48°31'W	14.35	35.550	*O.albicans*	3
55	25/08	42°00'S	45°00'W	9.05	34.574	*O.albicans*	5
61	04/09	47°30'S	54°33'W	5.83	34.238	*I.magalhanica*	141
62	04/09	45°59'S	54°28'W	6.13	34.141	*I.magalhanica*	4227
65	05/09	46°01'S	58°01'W	5.74	34.105	*S.thompsoni*	17
						I.magalhanica	5710
66	06/09	45°59'S	58°31'W	4.32	34.068	*S.fusiformis*	33
						I.magalhanica	100
67	06/09	45°59'S	58°59'W	4.14	34.063	*I.magalhanica*	10
75	08/09	45°00'S	57°41'W	5.04	----------	*I.magalhanica*	386
76	09/09	45°00'S	57°07'W	6.20	34.067	*I.magalhanica*	50048
77	09/09	45°00'S	56°38'W	9.04	34.595	*I.magalhanica*	503
80	10/09	42°02'S	54°37'W	11.71	35.029	*S.fusiformis*	30
						I.magalhanica	181
85	11/09	43°30'S	50°25'S	10.72	34.911	*S.fusiformis*	12
86	12/09	43°29'S	50°52'W	11.74	35.122	*I.magalhanica*	5
88	12/09	43°30'S	53°04'W	9.20	34.750	*I.magalhanica*	6
90	14/09	43°28'S	58°27'W	4.49	34.090	*I.magalhanica*	44
92	28/09	47°01'S	52°57'W	7.21	34.275	*I.magalhanica*	57
98	30/09	41°12'S	52°56'W	15.24	35.425	*S.thompsoni*	3
99	01/10	40°30'S	53°03'W	13.42	33.832	*S.thompsoni*	2
						I.magalhanica	65
100	01/10	39°41'W	53°00'W	12.37	33.847	*S.fusiformis*	133
						I.magalhanica	1136
101	01/10	39°18'S	53°03'W	9.78	33.589	*S.thompsoni*	39
102	05/10	40°00'S	50°00'W	15.32	35.587	*I.magalhanica*	18
106	07/10	43°42'S	50°00'W	8.31	34.588	*I.magalhanica*	6
						Doliolidae	1
108	07/10	45°09'S	50°00'W	8.26	34.483	*O.albicans*	13
111	09/10	50°00'S	50°01'W	3.71	34.045	*S.thompsoni*	17
114	10/10	48°29'S	47°10'W	8.67	34.482	*I.magalhanica*	41
115	11/10	47°50'S	46°01'W	7.70	34.482	*I.magalhanica*	11
121	13/10	42°10'S	45°00'W	10.20	34.677	*S.fusiformis*	21
122	13/10	42°29'S	44°57'W	11.80	34.873	*I.magalhanica*	16
						O.albicans	2
123	13/10	41°01'S	45°00'W	11.80	34.873	*S.fusiformis*	182
124	14/10	40°27'S	44°58'W	14.60	--------	*S.fusiformis*	84
						I.magalhanica	8
						O.albicans	2
134	14/10	41°35'S	43°21'W	---------	---------	*Pegea sp.*	3

CONCLUSIONS

The results of the study of the distribution of the species confirms in great measure the general pattern presented in former studies (ESNAL, 1978, 1981) (see fig. 2). A clear association with waters of subantarctic origin was once more found for *Ihlea magalhanica* and *Salpa thompsoni*. The former was the most frequent and abundant species in this study. The high densities found surpassed the maxima mentioned by FOXTON (1971) for the Malvinas (Falkland) Current waters. *Iasis zonaria* was abundant in a station of waters with subtropical characteristics, but in previous papers (ESNAL **et al.,** 1983, 1987) its wide distribution also in subantarctic waters was remarked. *Ciclosalpa bakeri* also appeared in only one station within the distribution range previously established (subtropical waters).

The southern limit of distribution is extended further south for *Salpa aspera* and *S. fusiformis*. According to FOXTON (1961) such border would be marked by the subtropical convergence, term that has been recently modified as Subtropical Front (PETERSON & STRAMMA ,1991). They are species associated with Brazil Current waters. In coincidence with this, the highest abundances of *Salpa fusiformis* were found in waters with temperatures over 11° C but within a wide salinity range. Only in one opportunity during this expedition this species was found at very low temperatures (43° C) which is not surprising because it is a complex mixed area. SOEST (1975) also cited this species at temperatures of 6°C. For *Salpa aspera* the highest densities were found in low temperature and low salinity waters which would be indicating a higher tolerance of these species to environmental change. HARBISON & CAMPENOT (1979) studied the variation of the muscular contraction rhythm related to temperature in salps finding that these two species were not sensitive to temperature changes, maintaining the filtration rate at very low temperatures (3 to 5° C). This would be coherent with the observation of WIEBE **et al.** (1979) that *Salpa aspera* performs important vertical migrations. The *Thalia democratica* group appeared within the expected range of distribution as well as *Ritteriella retracta* which even if it appeared at slightly higher latitude than previously mentioned it was always associated with subtropical waters. The presence *of Thetys vagina* in the survey, in mixed watens at approximately 40° S widens its southern limit of distribution in the Atlantic Ocean since it had only been previously mentioned until 5° S (ESNAL, 1978).

The finding for the southwestern Atlantic of specimens attributable with high probability to *Pegea socia* reinstalls the hypothesis posed by MADIN & HARBISON (1978) who consider this to be a valid species and not a synonym of *Pegea confoederata* as proposed by SOEST (1974). SOEST (1975) explained differences in muscle fiber number among specimens identified as *P. confoederata* as due to latitudinal variation but MADIN & HARBISON (1978) suspect that this variation simply reflects the presence of two species, which these authors have been able to easily distinguish from the observation of living salps in the north Atlantic. The scarce number of specimens available and the impossibility of examining live material do not permit us to assure at present the presence of *P. socia* in the south Atlantic.

Oikopleura albicans, even if it appeared in stations slightly further south than those previously known, maintains itself associated with subtropical waters. The same association was observed for Doliolidae nurses.

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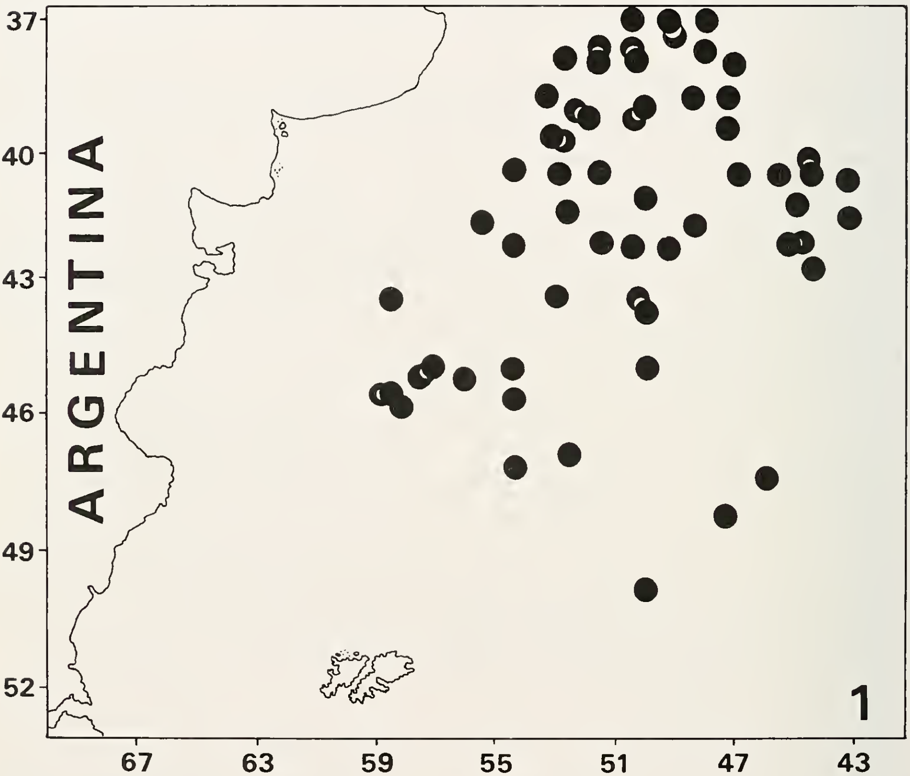


Fig. 1. Geographic position of the stations of planktonic tunicates of the RTMA "EVRIKA" in the southwestern Atlanctic Ocean (1988)

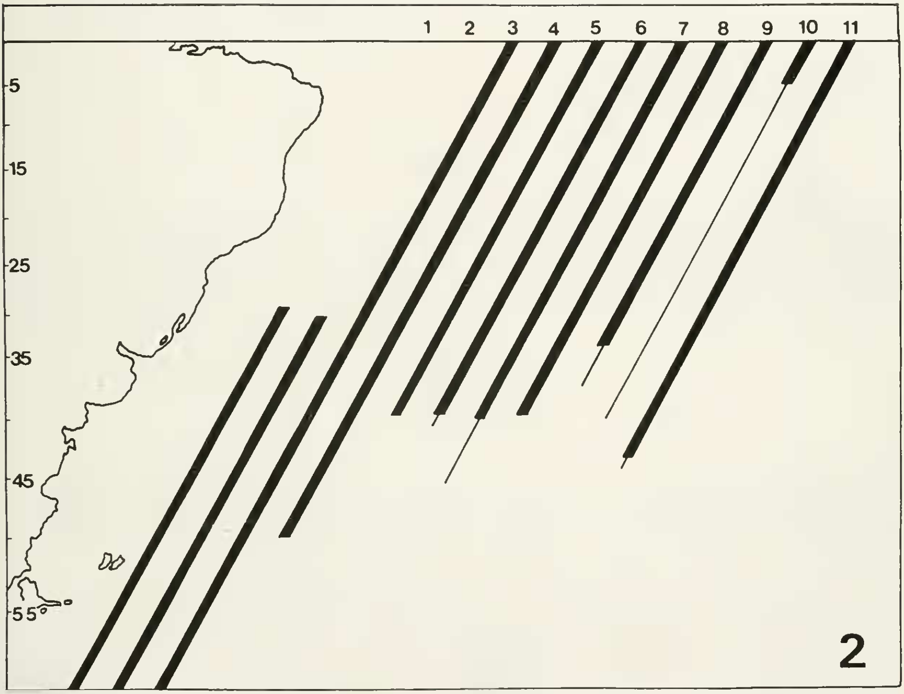
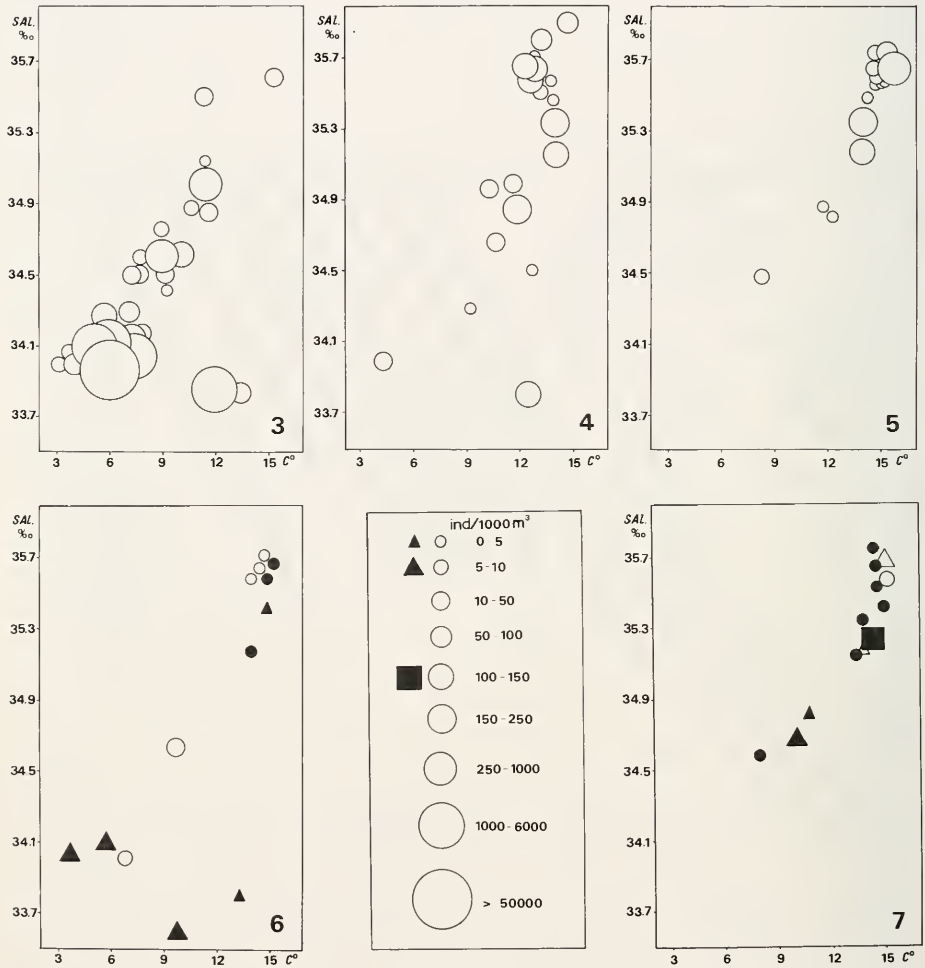


Fig. 2. Scheme of the latitudinal distribution of the Tunicata species studied. The thick bars show previously known distribution (ESNAL, 1978, 1981), the thin bars show the distribution observed (1. *Ihlea magalhanica*, 2. *Salpa thompsoni*, 3. *Iasis zonaria*, 4. *Pegea* sp., 5. *Ciclosalpa bakeri*, 6. *Salpa aspera*, 7. *Salpa fusiformis*, 8. *Thalia democratica* group, 9. *Ritteriella retracta*, 10. *Thetys vagina*, 11. *Oikopleura albicans*).



Figs. 3- 7. Tunicata species representation on the T-S diagram from area between 36°30'50°S and 60°33'-42°05' W in 1988. 3. *Ihlea magalhanica;* 4. *Salpa fusiformis*; 5. *Oikopleura albicans*; 6. *Salpa aspera* (○), *S. thompsoni* (▲), *Ritteriella retracta* (●); 7. *Ciclosapa bakeri* (○); Doliolidae (●), *Thetys vagina* (▲), *Thalia democratica* group (△), *Iasis zonaria* (■).