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Short communication

Salps: possible vectors of toxic dinoflagellates? [1]

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Abstract

The mortality of the Argentine mackerel *Scomber japonicus* during the spring of 1993 was studied by analyzing their stomach contents. All dead specimens contained salps. This study suggests that the salps contained high concentrations of the toxigenic dinoflagellate *Alexandrium tamarense*, and constituted herbivorous vectors of toxicity, causing the death of the mackerel.

Keywords: Gelatinous macrozooplankton; *Scomber japonicus*; Predation; *Iasis zonaria*; Red tides; PST vector; Southwestern Atlantic Ocean

1. Introduction

Mortality in marine fishes due to algal blooms has been recently discussed by Taylor (1990). White (1981) suggested that fish incorporate toxins through branchiae, by the ingestion of toxic cells, or through herbivore zooplankters that concentrate them. In the Argentine Sea, *Alexandrium tamarense* is the principal dinoflagellate responsible for red tides (Carreto et al., 1985; Carreto et al., 1993a). Studies carried out during 1992 by Carreto et al. (1993b) indicated the presence of paralytic shellfish toxins (PST) in the liver of Argentine mackerel *Scomber japonicus*.

During the spring of 1993 many commercial ships reported large quantities of dead *S. japonicus* on the sea surface, in the southern province of Buenos Aires. In the same area, a density of 2.5 per 100 m^2 dead *S. japonicus* was estimated during the cruise Capitán Oca Balda, in October 1993. Subsequent analysis identified the presence of *Alexandrium tamarense* in the stomach contents, and PST in both the stomach and liver of *S. japonicus* (Montoya et al., 1996). The processes involved in the incorporation of the toxin is still unknown.

The objective of this paper is to report on the herbivorous organisms identified in the stomach contents of *S. japonicus*, suggesting their possible role as vectors of toxigenic dinoflagellates.

2. Materials and methods

A total of 92 dead individuals (Group 1) of *S. japonicus* was collected from the sea surface during September and October 1993 by local fishermen, research vessels of INIDEP and the Coastguard (Table 1, Fig. 1: St. 5–8). Forty-two specimens (Group

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Table 1
Biological samples source ($n = 134$)

Source	Date	*n*	Station no.	Sampling method
Local fishermen	17/09/93	1	5	
Local fishermen	22/09/93	2	6	Surface
Coast Guard 'Thompson'	7/10/93	82	8	Collection
R.V. 'C. Oca Balda' 11/93	25/10/93	7	7	
Local fishermen	9/12/93	4	3	
R.V. 'E. Holmberg' 14/93	10/12/93	12	1	Fishing
R.V. 'E. Holmberg' 14/93	12/12/93	8	2	
Local fishermen	10/01/94	18	4	

2) were collected from fishing activities during December 1993 and January 1994 by research vessels of INIDEP and Commercial Ships (Table 1, Fig. 1: St. 1–4). *S. japonicus* specimens were frozen on board and stomach contents were analyzed using binocular microscopy. Salps were recognized by the remaining muscle bands and nucleus, and were identified according to Esnal (1981).

3. Results and discussion

Partially digested salps were identified in dead specimens collected from the sea surface (Fig. 2A). Stomach contents consisted of a compact yellow-green mucous. As digestion is fast, the identification of gelatinous organisms is difficult after a short period of time. On binocular examination, salps were identified in all gut contents because muscular bands and 'stomach nucleus' were present. Amphipods, copepods and crustacean larvae were occasionally observed (Fig. 2A). Microscope observations of *S. japonicus* stomach contents revealed the presence of cells of dinoflagellates retained by the salp mucous net. Our results are consistant with those of Montoya et al. (1996), who identified the dinoflagellate *Alexandrium tamarense* in the same *S. japonicus* stomach contents samples.

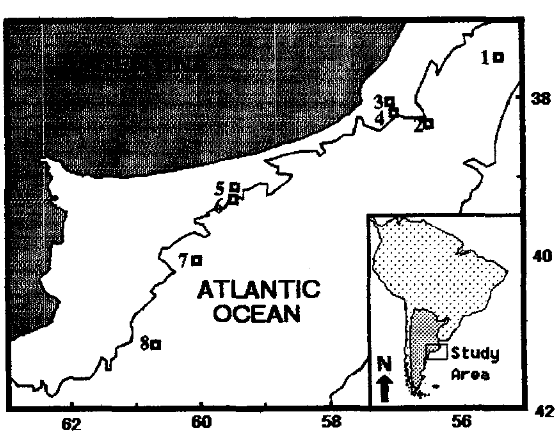

Fig. 1. Position of the sample stations within the study area.

In Group 2, 38% of the stomachs were empty. Copepods were the primary food item (50%), followed by euphausiids (28%) and salps (24%) (Fig. 2B). The presence of the tunic permitted the positive identification of the salps as *Iasis zonaria*. Eggs, adult fishes (primarily *Engraulis anchoita*) and shrimps were occasionally found.

The presence of gelatinous prey in the stomach contents of fishes is a common phenomenon (Runge et al., 1987; Arai, 1988; Ates, 1988; Mianzan et al., 1996). Although it was previously thought that this type of prey was not a significant food item because of its high water content, it is now observed that their role in trophic webs is important, both as food and as vectors of parasites ending their life cycle in fishes (Arai, 1988; Girola et al., 1992). Salps constitute an important fraction of gelatinous macroplankton and serve as prey for numerous fish species. Among them, *Notothenia microlepidota* (61%), *Argentina elongata* (76%), *Coelorinchus aspercephalus* (13%), *Stromateus brasiliensis* (14%), *Helicolenus d. lahillei* (6%–72%), *Seriolella porosa* (3%) *Seriolella coerulea* (25%), *Squalus acanthias* (10%), *Micromesistius australis* (5–23%), can be cited (Clark, 1985; Kashkina, 1986; Mianzan et al., 1996; Velazco pers. comm., 1995).

S. japonicus was previously known to consume salps of the genus *Iasis* occasionally (Angelescu, 1979; Cremonte, 1994). Our results agree with previous references and confirm the opportunistic behaviour of *S. japonicus* (Angelescu, 1979). These observations indicate that large aggregations of salps could serve as an alternative or occasional food source for *S. japonicus* when energetically preferent food is absent. This behaviour was defined by Kashkina (1986) as 'feeding on survival food'.

Salps have high growth rates and a short generation period (Heron, 1972a; Heron, 1972b). *Iasis zonaria*, for example, produces 400 blastozooids during every asexual generation (Esnal et al., 1987). High salp densities may be associated with algal blooms (Humphrey, 1963; Silver, 1975). They are non-selective filter feeders of particles taken through a mucous net segregated by the endostylum, which

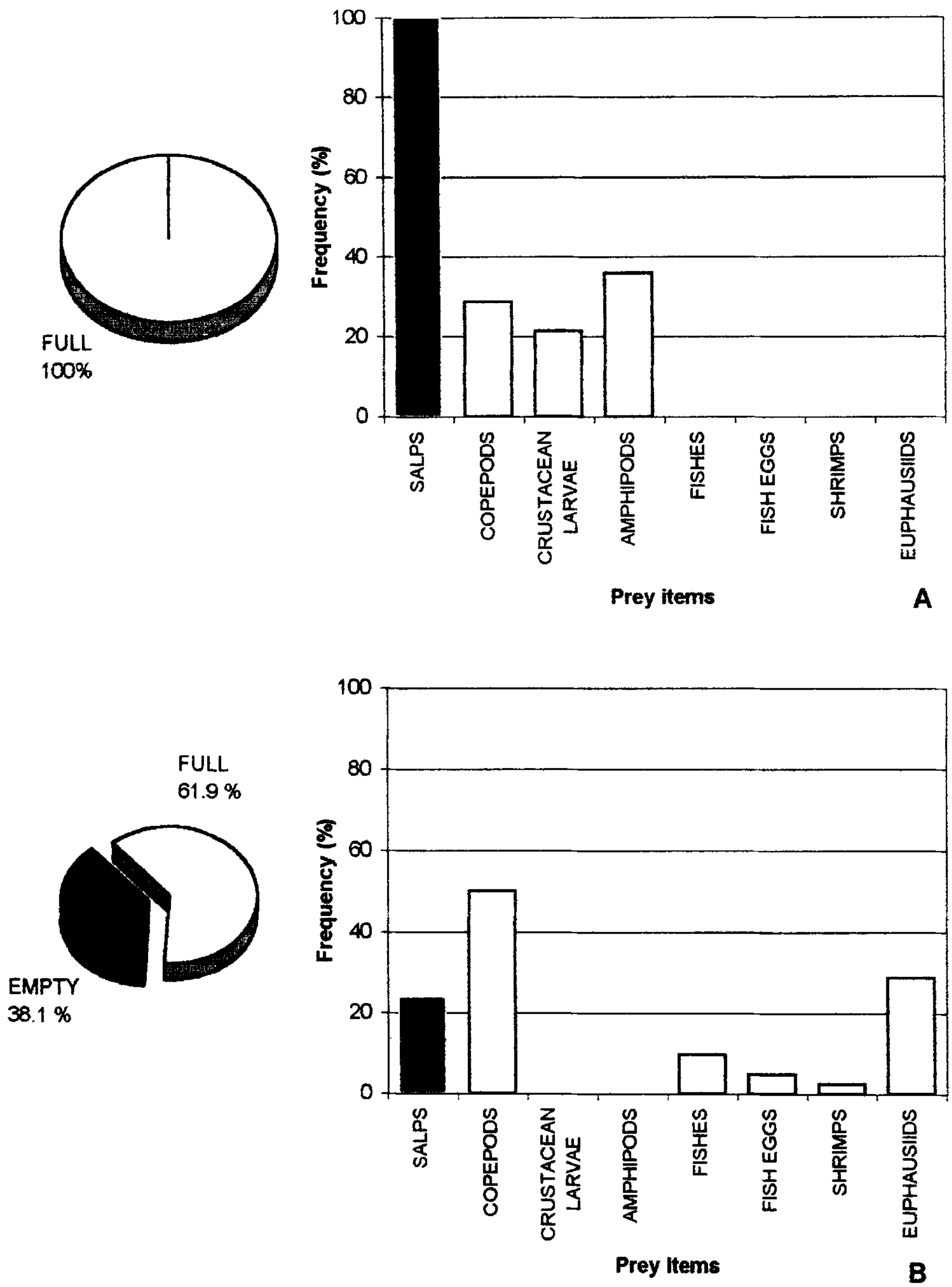

Fig. 2. Percent occurrence of different prey items in the stomach of *Scomber japonicus* (Argentine mackerel). (A). Stomach content of dead specimens collected on sea surface (Group 1) (B). Stomach content of live specimens collected from fishing (Group 2).

mainly consist of phytoplankton, and other microzooplankters (Madin, 1974; Silver, 1975; Esnal, 1986). In previous studies of salp stomach contents from the South Western Atlantic Ocean, many dinoflagellates, including *Gonyaulax spp.* were observed (Machinandiarena, unpublished data, 1993).

The presence of a toxigenic phytoplankton bloom could constitute a main food resource for salps, which, due to a high filtration rate (Andersen, 1985; Deibel, 1985; Reinke, 1987; Harbison and Gilmer, 1976), could thrive on the bloom.

This study suggests that the ingested salps contained high concentrations of the dinoflagellate *Alexandrium tamarense* in their nucleus, which may cause the death of *S. japonicus*. Other fishes from the Argentine continental shelf that feed on salps could be similarly affected. We suggest the need for further studies related to pelagic trophic webs, to assess the role of salps and other herbivore prey as toxigenic vectors.

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