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Siphonophores of upwelling areas of the Campeche Bank and the Mexican Caribbean Sea

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Abstract

The siphonophore fauna off the Yucatan Peninsula and in the Mexican Caribbean Sea remains practically unknown. This communication describes the composition, abundance and distribution of Siphonophora during summer 1984 and spring 1985. The local distribution and abundance of siphonophores were found to be strongly influenced by upwellings, especially during the spring survey. Community analysis suggests that siphonophore populations around the upwellings are relatively homogeneous.

Introduction

The siphonophore fauna of some tropical regions of the North-western Atlantic is not well known. One such region includes the Mexican Caribbean Sea and the Campeche Bank, off the Yucatan Peninsula. In this area the composition, distribution and population dynamics of these coelenterates have hardly been studied. The only previous work is that of Gasca & Suárez (1989). Similar studies in adjacent regions include those of Moore (1953) and Moore *et al.* (1953) in the Florida Current; Alvariño (1972, 1974) in the Caribbean Sea, Gulf of Mexico and coastal Panama; Vasiliev (1974) and Burke (1975) in the Gulf of Mexico; and Juárez (1965) and Campos (1981) in the Cuban shelf waters.

The Caribbean coast of Mexico is not hydrographically homogeneous. Temperature and salinity vary along gradients which have been outlined by Bessonov *et al.* (1971). The dynamics of the surface layers are influenced by a rapid northward-flowing current, the Yucatan Current, moving through the Yucatan Channel (Emilsson, 1971). It contributes to upwellings along the north-eastern edge of the Yucatan Peninsula and the central portion of the Campeche Bank (De la Cruz, 1971; Rossov, 1967; Cochrane, 1966; Ruiz, 1988). Upwelling is strongest during the spring (Rossov, 1967). Its strength is proportional to the intensity and speed of the Yucatan Current (Cochrane, 1966). During the present study periods, physical and chemical data were used to identify the actively upwelling areas (Espinosa, 1989).

The composition and small-scale distribution of the siphonophore species collected off the Yucatan Peninsula during summer of 1984 and spring of 1985 are analyzed herein and related to the area's main oceanographic features.

Methods

Zooplankton was collected during an oceanographic program of the National University of Mexico (UNAM) named the PROSPECCION DEL CARIBE MEXICANO, cruises PROIBE II and PROIBE III. Collections were made from the B/O Justo Sierra. Bongo-type nets, mouth diameter 0.6 m, mesh aperture 0.5 mm, were towed between 200 m and the surface at 38 sampling stations in July, 1984 (cruise II) and at 44 stations in April, 1985 (cruise III) (Figs 1–2).

Zooplankton samples were fixed and preserved in 2% formalin. Siphonophores were sorted from a 25% aliquot, obtained using a Folsom splitter (McEwen *et al.*, 1954). The specimens were identified following Sears (1953), Totton (1965), Daniel (1974) and Alvariño (1981). Counting of the siphonophores was carried out according to the criteria established by Alvariño (1980). Density data were expressed as number of individuals in 1000 m^3, based on flowmeter data. Diversity (Shannon-Wiener's Index) (Krebs, 1978) and Redundancy Indexes (Patten's Index) (Parsons *et al.*, 1977) were obtained. The local distribution and abundance of siphonophores were determined and compared between sampling periods.

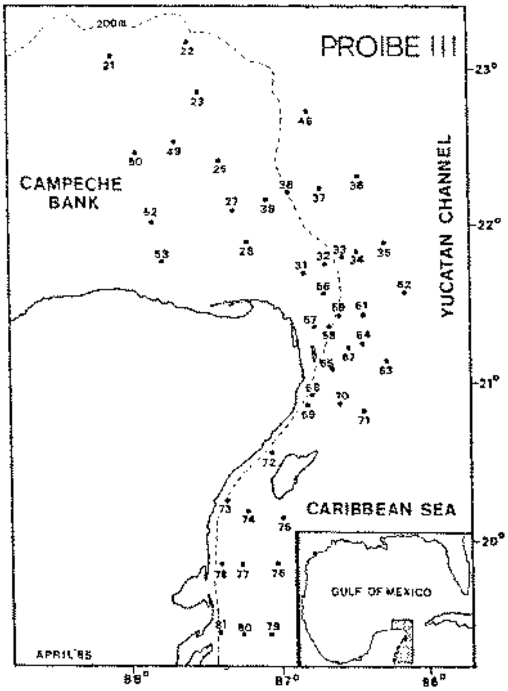

Fig. 2. Sampling stations during the PROIBE II (spring) cruise off the Yucatan Peninsula, April 1985.

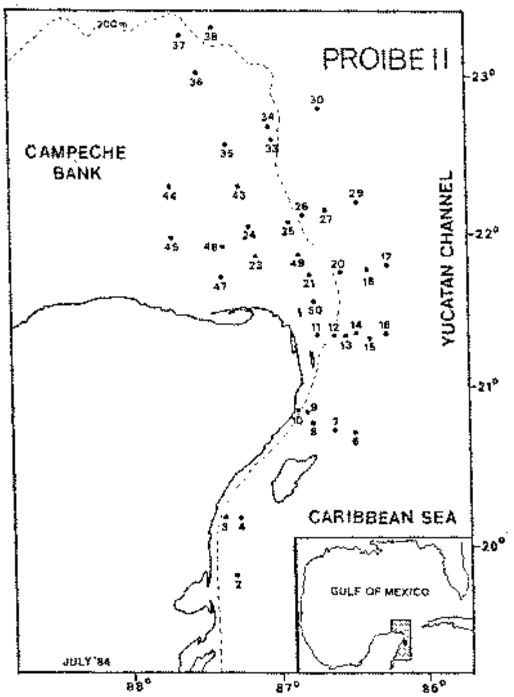

Fig. 1. Sampling stations during the PROIBE II (summer) cruise off the Yucatan Peninsula, July 1984.

Results

Thirty species were collected (see Table 1): 23 during summer and 24 in spring 1985. During the summer cruise the most abundant and widespread species were *Eudoxoides spiralis, Diphyes bojani, Abylopsis eschscholtzi, Chelophyes appendiculata* and *Eudoxoides mitra*. During the spring *Diphyes dispar, A. eschscholtzi, D. bojani, E. spiralis* and *A. tetragona* were the most abundant and widely distributed species. The total number of siphonophores in the study area was clearly greater during the spring than during the summer. The species composition, density and percent occurrence from both cruises are shown in Table 1.

During the spring cruise, the horizontal distribution of the siphonophores was evidently heterogeneous. Siphonophores were either scarce at or absent from several stations along the northeastern portion of the Yucatan Peninsula (Fig. 3). In contrast, during the summer cruise the area of

Table 1. Species composition, total numbers of individuals per station, and percentage of stations at which each species was collected, during the two PROIBE cruises.

Species	PROIBE II		PROIBE III	
	Total no. of specimens collected	Percentage of stations at which caught	Total no. of specimens collected	Percentage of stations at which caught
Agalma okeni Brandt	134	5.3	40	2.3
A. elegans (Sears)	183	10.5	321	14.0
Halistemma rubrum (Vogt)	–	–	32	4.7
Nanomia bijuga (Chiaje)	–	–	255	2.3
Amphicaryon sp.	167	15.8	–	–
Hippopodius hippopus (Forskål)	–	–	155	11.6
Vogtia glabra Bigelow	33	5.3	–	–
Sulculeolaria quadrivalvis Blainville	–	–	16	2.3
S. chuni (Lens & van Riemsdijk)	922	28.4	63	7.0
S. monoica (Chun)	–	–	36	4.7
Diphyes dispar Chamisso & Eisenhardt	1393	44.7	1501	27.9
D. bojani (Eschscholtz)	10344	84.2	5759	62.8
Lensia multicristata (Moser)	–	–	19	2.3
L. campanella (Moser)	522	26.3	180	11.6
L. cossack Totton	143	13.2	75	9.3
L. hotspur Totton	578	26.3	–	–
L. subtilis (Chun)	342	18.4	45	4.7
L. meteori (Leloup)	424	26.3	–	–
L. fowleri (Bigelow)	158	13.2	109	9.3
Muggiaea kochi (Will)	423	7.9	–	–
Chelophyes appendiculata (Eschscholtz)	6214	78.9	4050	65.1
Eudoxoides mitra (Huxley)	4908	65.8	2569	51.2
Eudoxoides spiralis (Bigelow)	15132	81.6	4621	55.8
Ceratocymba leuckarti Huxley	64	2.6	19	2.3
Abyla trigona Quoy & Gaimard	52	5.3	21	2.3
A. haeckeli Lens & van Riemsdijk	–	–	38	4.3
Abylopsis tetragona (Otto)	3284	71.1	5639	60.5
A. eschscholtzi (Huxley)	10132	89.5	10060	79.1
Bassia bassensis (Quoy & Gaimard)	4903	52.6	1428	41.9
Enneagonum hyalinum Quoy & Gaimard	169	13.2	–	–

upwelling was reduced and so the summer of localities from which siphonophores disappeared was also lower than in the spring. Near the north-eastern edge of the Yucatan Peninsula siphonophores were absent from only 2 stations, while the greatest abundances were observed mainly in the northern portion of the study area (Fig. 4).

The mean diversity value obtained during the spring cruise was 1.95. Five stations were found having a diversity of 0, mainly along the north-eastern edge of the Peninsula. The diversity of 45% recorded from the spring sampling stations ranged in value between 2 and 3. In summer mean siphonophore diversity was higher than in spring (2.29), with 68% of the stations having values between 2 and 3. Redundancy Index values (as a dominance measure) were low in both surveyed seasons (<0.25). Dominance was observed only

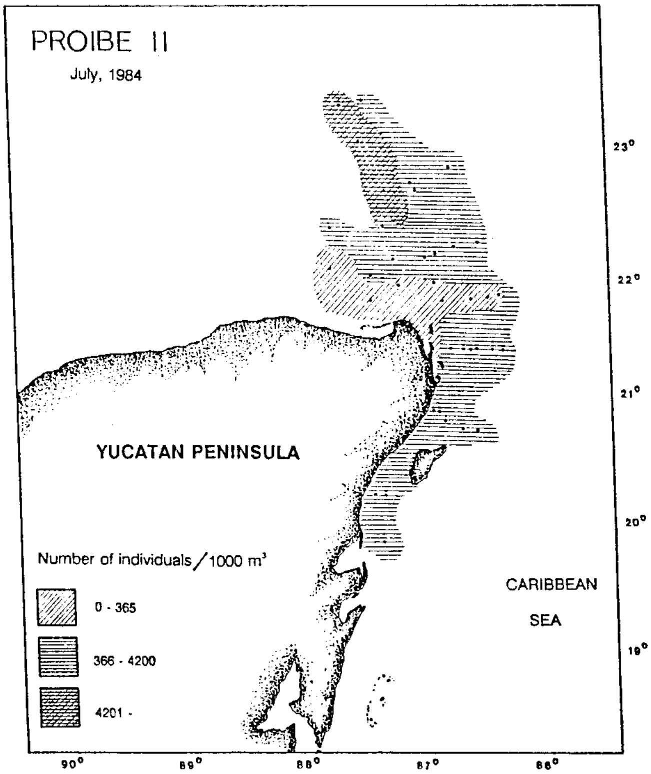

Fig. 3. Summer abundance distribution of siphonophores in the surveyed area.

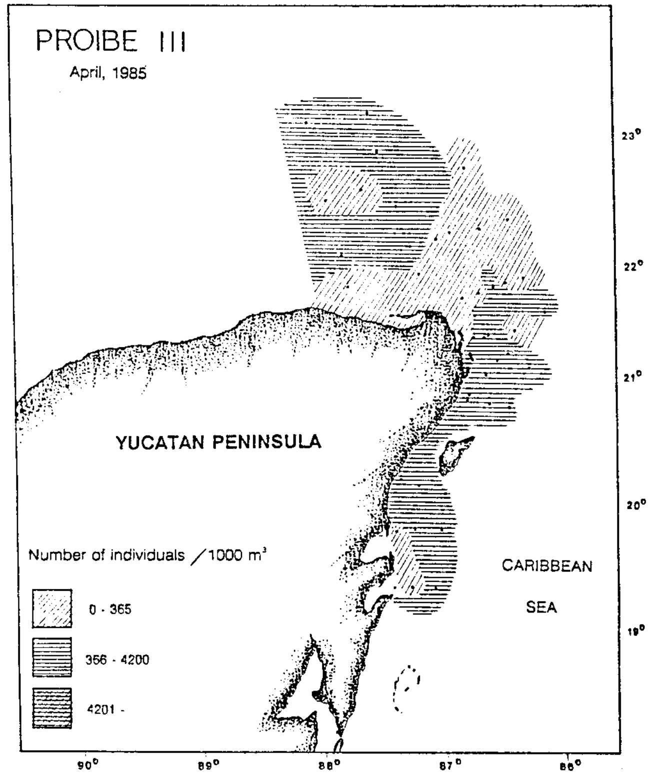

Fig. 4. Spring abundance distribution of siphonophores in the surveyed area.

at stations where only one species occurred, where it was of course inevitable.

Discussion

The species of Siphonophora collected from the study area during both periods are widely distributed in tropical waters and have all been reported from adjacent regions (Margulis, 1972; Daniel, 1974; Alvariño, 1981). Most of the species previously observed in the Yucatan Channel area (Gasca & Suárez, 1989) during May-June 1984 were found in this study, excepting *Sulculeolaria biloba* (M. Sars) and *Chelophyes contorta* (Lens & van Riemsdijk). The most abundant species observed in the area, *Eudoxoides spiralis*, *Abylopsis eschscholtzi*, *A. tetragona*, *Chelophyes appendiculata* and *Diphyes bojani*, were also the most abundant in the Yucatan Channel area (Gasca & Suárez, 1989). Species such as *Agalma elegans*, *Nanomia bijuga*, *Sulculeolaria chuni* and *S. quadrivalvis*, identified during this study, had not been collected previously from the region.

Spring samples showed a mean abundance of 864 organisms in 1000 m^3. Summer samples had a greater mean abundance (1596 organisms in 1000 m^3). The differences were related to the variation in strength and influence of the upwelling, which was stronger during the spring than in the summer.

Primary and secondary productivity is often promoted around upwellings by the nutrient-rich upwelled waters (Margalef, 1980). During spring 1985, high densities of herbivorous zooplankton were observed around the upwelling regions in the study area (Suárez, 1991). The increased density of siphonophores as predators was associated with the abundant herbivore populations observed here. The density of siphonophore reproductive stages (eudoxids) of *Eudoxoides mitra*, *E. spiralis*, *Abylopsis tetragona*, *A. eschscholtzi* and *Bassia bassensis* in the area was greater during spring than in summer. This could also have been associated with the upwelling and to the locally increased productivity.

In contrast, in the Spring, siphonophore populations of low densities, and even total absences, were associated with the upwelled waters. The strong spring temperature gradient present in the area of major upwelling could have been a significant factor causing low densities of epipelagic tropical species in such localities. This might explain the patchy distribution of the group during the survey. This effect was not evident during the summer cruise because of the decreased intensity of the upwelling.

Around the upwelling zone diversity and dominance showed little variation between the study periods, indicating a certain homogeneity in the siphonophore community in the survey area.

As Gili *et al.* (1988) observed, siphonophore populations respond as a group to local environmental changes in the western Mediterranean area. All siphonophores, including the most abundant and frequently collected species, were either scarce in or absent from the main areas of upwelling, while populations elsewhere remained relatively unaffected. Both their study and ours show that siphonophore distribution and abundance is strongly influenced by local upwelling.

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