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The siphonophores (Cnidaria, Hydrozoa) of Hansa Bay, Papua New Guinea

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ABSTRACT: From March 1987 to February 1988, thirty-one species of siphonophores were collected in Hansa Bay, Papua New Guinea, by means of monthly surface plankton hauls. The species collected during the whole year, which were also the most abundant, were those characteristic of the equatorial zone of the Indo-Pacific Ocean (e.g. *Diphyes dispar*, *D. chamissonis* and *Chelophyes contorta*). Other species collected throughout the year were less abundant and, in contrast, were clearly cosmopolitan in nature (e.g. *Abylopsis tetragona*, *A. eschscholtzi* and *Bassia bassensis*). During the monsoon season, samples of practically all the recorded species (95%) were obtained; during the tradewind period, the number of species sampled was smaller (65%). Most species collected only during the monsoon period were representative of oceanic forms; they were probably carried there by NE-SW oceanic currents.

1. INTRODUCTION

The siphonophoran fauna of the western Pacific Ocean has been widely studied both by expeditions that have covered the ocean as a whole, and by others more localized. During the Albatross Expedition, for example, siphonophores were collected from many tropical Pacific stations (Bigelow 1911), while in another similar, though somewhat later, expedition, hauls were made only in the Sea of Japan (Bigelow 1913). The Albatross Philippine Expedition was centred in the South China Sea (Bigelow 1919). Other major expeditions collected partly in the area, such as the Siboga Expedition (Lens & Van Riemsdijk 1908), or there alone, such as the Naga Expedition to the South China Sea and the Gulf of Thailand (Alvariño 1963). In monographs resulting from other expeditions, in particular the Deutsche Südpolar Expedition (Moser 1925), mention has been made of siphonophores collected from the west of Papua New Guinea.

Other studies of siphonophores have been carried out close to the coasts of Papua New Guinea, many of them resulting from expeditions to Philippine and Indonesian waters (Sears 1953, Alvariño 1964, Rees & White 1966). Others

have visited more limited zones or have collected among islands in this general area (Bedot 1896, Totton 1941, Leloup 1956). Mention should also be made of studies carried out around islands at a somewhat greater distance from the coasts of Papua New Guinea (Sears 1950, Alvariño 1977) and of another describing the species collected by the Great Barrier Reef Expedition (Totton 1932). Also relevant are studies carried out in Indian Ocean waters not far from the coasts of Papua New Guinea, outstanding among which were those of Daniel, summarized in his 1974 monograph; and others that included reports of hauls carried out in the westernmost part of the Indian Ocean (e.g. Totton 1954).

The vast majority of the numerous hauls that have taken place in the area of the western Pacific have been carried out in mid-ocean. Only in the studies of Kawamura (1954), in Japanese waters, is any reference made to hauls very near the coast. The irregular periodicity with which samples were collected in all these expeditions and studies is an important fact to underline.

Since 1976 the Léopold III Biological Station has been carrying out periodically plankton hauls around Laing Island in the Bismarck Sea. From these hauls it has been possible to undertake a monthly study of the siphonophores of Hansa Bay. Study of the samples collected has allowed us to acquire basic knowledge of the fauna composition and distribution of the shallow water siphonophores in the area.

Laing Island is located in the middle of Hansa Bay (4°10'30"S, 144° 52'47"E). Its maximum dimensions are about 800 m long by 150 m wide. It is completely surrounded by coral reefs, and to the west, where the plankton hauls were made, the maximum water depth was 20 m. Both surface water temperature (annual average 29.4°C) and the salinity (annual average 33.4‰) vary only slightly throughout the year. The regime of currents can be divided into two quite marked periods (Bouillon *et al.* 1986): one period from November to April, corresponding to the monsoon season, when the current flows from North to South due to the Northern Equatorial Current; a second during the trade wind season from May to October, when the Southern Equatorial Current flows in the opposite direction. The second is two or three times stronger than the first, which flows scarcely faster than 0.5 m/s.

2. MATERIAL AND METHODS

Plankton hauls were made monthly from March 1987 to February 1988, between the surface and a depth of one metre, using a net 30 cm in opening diameter, 150 cm long and with a mesh of 250 µm. The net was hauled slowly from an oar-powered canoe that followed the same itinerary each month, from inside the coral-reef lagoon of Laing Island to beyond the island along its eastern coast. The hauls took place between 7 and 10 a.m. and the samples were preserved in formalin immediately after capture.

3. RESULTS

The hauls carried out around Laing Island, throughout the roughly year-long period, included a total of 31 species of siphonophores, comprising 2 cystonectids, 6 physonectids and 23 calycophores (Table 1).

The sub-order Cystonectae was represented by *Physalia physalis* and *Rhizophysa eysenhardti*, the former being collected in August alone. The colonies were evidently young, since their pneumatophores measured between 1 and 2 cm at the base. *R. eysenhardti* was collected from April to September and in January and February, but few colonies as long as 3 cm were found.

Table 1. Species of siphonophores collected in Hansa Bay during the year sampling period. The numbers in columns represent the total number of individuals of each species per month. In some species, polygastric and eudoxid have been identified separately.

	1987										1988	
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Physalia physalis (Linaeus, 1758)	-	-	-	-	-	12	-	-	-	-	-	-
Rhizophysa eysenhardti Gegenbaur, 1859	-	2	1	9	2	3	2	-	-	-	19	30
Agalma elegans (Sars, 1846)	-	3	-	-	1	-	-	-	-	1	2	-
Agalma okeni Eschscholtz, 1825	-	-	-	-	-	-	-	-	1	-	-	-
Nanomia bijuga (Chiaje, 1841)	-	-	1	1	-	1	-	2	-	1	-	18
Erenna richardi Bedot, 1904	-	-	-	-	-	-	-	-	-	-	1	-
Athorybia rosacea (Forskal, 1775)	-	-	-	-	-	-	-	-	-	-	2	7
Amphycarion acaule Chun, 1888	-	-	-	-	-	-	-	-	-	-	-	1
Amphycarion ernesti Totton, 1954	-	-	-	-	-	-	-	-	-	-	1	-
Hippopodius hippopus (Forskal, 1776)	-	-	-	1	-	-	-	-	-	-	1	-
Sulculeolaria quadrivalvis Blainville, 1834	-	-	-	-	-	-	-	-	1	-	-	-
Sulculeolaria turgida (Gegenbaur, 1853)	1	4	3	-	3	-	1	1	-	-	3	2
Sulculeolaria chuni (Lens & Van Riemsdijk, 1908)	-	6	-	1	-	2	-	-	-	-	-	2
Sulculeolaria monoica (Chun, 1888)	-	2	-	-	2	-	-	-	-	-	-	-
Diphyes dispar (Chamisso & Eysenhardt, 1821) eudoxid	14	21	2	-	176	3	43	5	6	4	22	36
	19	6	-	-	280	-	116	-	17	-	30	41
Diphyes bojani (Eschscholtz, 1829) eudoxid	-	-	-	3	8	-	5	-	-	-	-	5
	-	-	-	-	12	-	-	-	-	1	-	-
Diphyes chamissonis Huxley, 1860	7	7	6	20	25	37	-	5	20	6	56	13

Table 1 *(continued).*

	1987										1988	
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Lensia campanella (Moser, 1925)	-	1	1	1	-	-	-	2	-	3	-	2
Lensia hotspur Totton, 1941	-	2	-.	-	-	-	3	-	-	-	-	-
Lensia subtiloides (Lens & van Riemsdijk, 1908)	-	-	1	14	-	4	-	13	7	2	-	-
Chelophyes contorta (Lens & van Riemsdijk, 1908)	-	32	24	60	67	19	71	22	10	7	41	28
Eudoxoides spiralis (Bigelow, 1911)	-	1	1	2	-	1	1	-	1	-	-	1
Eudoxoides mitra (Huxley, 1859) eudoxid	-	1	-	4	-	-	-	-	13	11	2	3
	-	-	-	-	-	-	-	-	1	-	-	-
Sphaeronectes gracilis (Claus, 1873)	-	3	-	-	-	-	-	-	-	-	37	8
Ceratocymba leuckarti (Huxley, 1859) eudoxid	-	-	-	-	-	-	-	-	-	-	5	3
	-	-	-	-	-	-	-	-	-	-	2	-
Abyla trigona Quoy & Gaimard, 1827	-	-	-	-	-	-	-	-	-	-	-	5
Abyla bicarinata Moser, 1925	-	1	-	-	-	-	-	-	-	-	1	1
eudoxid	-	1	-	-	-	-	-	-	-	-	2	3
Abylopsis tetragona (Otto, 1823) eudoxid	-	8	-	27	2	5	2	-	7	5	4	23
	3	14	-	11	21	-	-	2	5	6	41	9
Abylopsis eschscholtzi (Huxley, 1859) eudoxid	2	12	8	7	33	6	5	-	-	5	8	135
	8	32	13	45	90	28	61	-	8	-	35	184
Bassia bassensis (Quoy & Gaimard, 1833) eudoxid	-	-	2	2	13	-	2	-	-	1	8	47
	-	-	5	8	48	8	11	3	2	1	27	54
Enneagonum hyalinum Quoy & Gaimard, 1827 eudoxid	-	7	1	2	-	-	-	-	10	1	-	6
	1	8	3	-	-	-	-	-	4	5	-	5

Species belonging to the suborder Physonectae were in general collected only sporadically. Only *Nanomia bijuga* showed any periodicity during the haul period, although its presence was by no means continual. *Erenna richardi* was collected occasionally, while a few samples of *Athorybia rosacea* were found in January and February. The suborder Calycophorae was best represented in terms both of number of species and of individuals collected. In addition to being the most abundant species, *Diphyes dispar* and *Chelophyes contorta* were found each month during the annual haul-period. The polygastric state of *D . dispar* was collected throughout the year, whereas the eudoxid appeared only sporadically, every two months, with a number of examples similar to that of the polygastric stage. In contrast, *C. contorta* was collected in the polygastric stage only.

Diphyes chamissonis, Abylopsis tetragona, Abylopsis eschscholtzi and *Bassia bassensis* were collected throughout almost all the haul months, and

represented a second group of abundant species. Samples were constantly found of both stages of development, although the eudoxid of *D. chamissonis* appeared only sporadically.

The three species of the family Abylidae were collected almost invariably in both developmental stages. During certain months the proportion of eudoxids was greater than that of polygastric colonies. *Enneagonum hyalinum* was collected in two periods, from April to June and from November to January, but the number of samples was always small.

Within the family Diphyidae as a whole, the subfamily Sulculeolariinae was represented by four species of the genus *Sulculeolaria*, but again only in small numbers: *S. quadrivalvis, S. turgida, S. chuni* and *S. monoica.* Only *S. turgida* was collected with a certain regularity during the haul period, while the remainder were found only sporadically. The species belonging to the subfamily Diphyinae, such as *Diphyes bojani, Lensia campanella*, and *L. hotspur*, were not consistently collected, although in certain months of the year well-developed individuals were found.

Eudoxoides spiralis was more or less constantly present during the months under study; but in contrast *Eudoxoides mitra* was collected only between November and February.

4. DISCUSSION

The species of siphonophores collected in Hansa Bay had previously been collected also in the eastern Pacific and or western Indian Oceans. In contrast to the rest of the species, *D. chamissonis* was very common, and has been found previously almost exclusively in the Indo-Pacific (Alvariño 1971). On the other hand, three other species were remarkable for their seasonality, namely *Erenna richardi, Athorybia rosacea* and *Amphycarion ernesti*, still all the species found in Hansa Bay were widespread in distribution many of them being considered cosmopolitan. This differs from the findings of Bouillon *et al.* (1986) from a study of the local hydromedusae, almost 25% of the species in which are so far unrecashed outside the waters of Papua New Guinea. Siphonophores are oceanic, and as a result in general considerably more nearly cosmopolitan than hydromedusae. But in the study by Bouillon *et al.* (1986), hauls took place over a period of twelve years, which increased the possibility of collecting rarer species. Another aspect that distinguishes Hansa Bay hydromedusae from the local siphonophores is the fact that all the species collected of the latter group were holoplanktonic, while 65% of the former were meroplanktonic, which means that part of their life cycle is benthic and their area of distribution is therefore more restricted.

All the species collected in Hansa Bay were epiplanktonic, and although quite a number of them were neritic, others were truly ocean-going. These included as

Rhizophysa eysenhardti, Amphycarion acaule, A. ernesti and *Athorybia rosacea*. Furthermore, it is surprising that given the type of haul made, no species characteristic of coastal zones was found, for example those of the genus *Muggiaea* (see Gili *et al.* 1988). Be that as it may, the oceanic origin of the predominant currents in the area and the shallowness of the bay influences the nature of the siphonophores collected, mostly being epiplanktonic and cosmopolitan. As Kramp (1968) explained as regards hydromedusae, since islands in the Pacific Ocean are far apart, species must somehow cross great distances and, as a result, the currents tend to transport oceanic rather than neritic species.

The most abundant siphonophore species represented in all the haul months were the ones most commonly encountered in the northern Indo-Pacific (*Diphyes chamissonis, D. dispar* and *Chelophyes contorta*). In addition to these, there were other species present almost all the year round which we might describe as being the most nearly cosmopolitan (*Abylopsis tetragona, A. eschscholtzi, Bassia bassensis* and *Eudoxoides spiralis*). None of these species showed significant changes in numbers throughout the year, especially if we consider the two most distinctive periods, the monsoons (November to April) and the trade-winds (May to October). However, it was possible overall to detect a tendency towards an increase in the number of species during the monsoons (Table 1). Of the thirty-one species collected, thirty were found during the monsoon season and twenty during the trade-winds period; only ten are found exclusively during the monsoons. This increase in the number of species seems to bear some relation to the current that flows along the coast of Papua New Guinea from NE to SW. This current would carry alochthonous species to the region of Hansa Bay, that is, species that normally would be more oceanic in distribution.

If these observations are compared with the results obtained in the same area by Bouillon *et al.* (1986), it can be seen that in the monsoon season the greater number of meroplanktonic (coastal) hydromedusan species was recorded. In contrast, it was during the period of the trade winds that the greatest number of holoplanktonic, and therefore more oceanic, species was recorded, the reverse of the pattern observed in the siphonophores. This could indicate that the distribution of siphonophores depends very much upon the dynamics of the water masses in a specific area (Mackie *et al.* 1987). Therefore, it might be expected that while both currents (NE-SW during the monsoons and SW-NE during the trade-wind period) will carry oceanic species to the Hansa Bay area, during the monsoons more species will be collected due to the fact that the speed of the current is three times slower than in the other period. The length of time the less common species stay will be longer, which will facilitate their approach to the coast due to local currents and, consequently, increase the frequency of their capture. The reason why hydromedusae have been found not to follow the pattern described here for siphonophores could be that, being meroplanktonic they are influenced more by local currents that are siphonophores which are brought to the area from the open ocean.

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