Rogers, Biggs and Cooper. 1978.

Best wishes, Phil
DCB
see you this summer - 19-II
arrives Plymouth 18 July 1978

NOTES

AGGREGATION OF THE SIPHONOPHORE *NANOMIA CARA* IN THE GULF OF MAINE: OBSERVATIONS FROM A SUBMERSIBLE

Large concentrations of a physonect siphonophore, *Nanomia cara* Agassiz 1865, were present in the Gulf of Maine during fall and winter of 1975. These gelatinous, colonial coelenterates were sufficiently abundant that they clogged trawl nets and occasioned considerable losses of time and money to commercial fishermen at several New England ports (Rogers in press). During October and November 1975, scuba divers on the *Helgoland* habitat in 30-m shoals off Rockport, Mass. (Figure 1), noted concentrations of *N. cara* reaching 1 colony/m^3 throughout the water column (R. A. Cooper and H. W. Pratt unpubl. data). Off Rockport again in late March 1976, divers estimated densities of 1 to 2 colonies of *N. cara*/m^3 in water only 9 m deep (H. W. Pratt pers. commun.). In April and again in early May 1976, a series of 100-m to surface oblique plankton tows was taken in the Gulf of Maine along a transect from the Wilkinson Basin to Cape Ann, Mass., by *Albatross IV*, a fisheries research ship of the Northeast Fisheries Center. In these deeper water areas, as well, high densities of *N. cara* apparently persisted through the winter months and were present at each station occupied, although the aggregations were somewhat less numerous and colonies appeared smaller than those encountered during fall 1975 (Rogers in press).

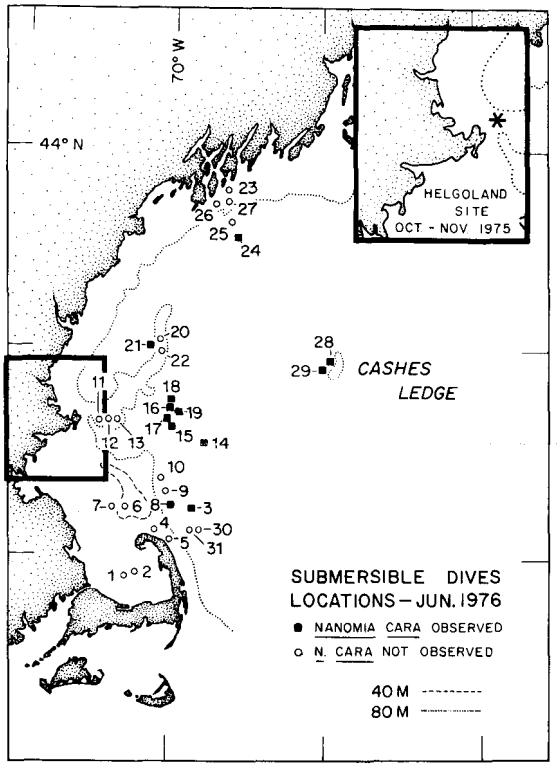

FIGURE 1.—Distribution of siphonophores at dive sites of the submersible *Nekton Gamma* and the position of the *Helgoland* habitat (insert).

The difficulties and limitations inherent in using plankton nets to sample quantitatively populations of siphonophores and other fragile gelatinous zooplankton have been reviewed by Hamner et al. (1975), who suggested in situ scuba observations as an alternative method for studying gelatinous taxa. In the present study we used the two-man research submersible *Nekton Gamma* to estimate the size and density of the *N. cara* aggregations and to evaluate some of the biotic and abiotic factors which might influence their distribution below depths easily accessible to scuba divers. In June 1976 we made six dives along a transect from Provincetown, Mass., to Cape Ann (Table 1, Figure 1). Dives were of 90 to 160 min duration during which we surveyed the water column from surface to bottom. Other observers made 25 additional shorter dives to look for siphonophores at adjacent stations. Observations were narrated and recorded on tape throughout each dive. The submersible pilot relayed information on temperature and depth and this was combined with comments on siphonophore colonies such as size, density, swimming speed, associated species, and other factors of interest. Photographs were taken with a 35-mm camera and a video tape camera with a sound track was also used to record and verify visual observations and estimates. After each dive information was transcribed from the tapes and videotapes were reviewed and discussed by the observers.

Observations

Gulf of Maine surface temperatures in mid-June 1976 ranged from 12.5°C in the Wilkinson Basin

TABLE 1.—Station locations of *Nekton gama* dives to observe depth distribution and density of the siphonophore *Nanomia cara*, 15-28 June 1976.

Dive station	Position		Station depth (m)	Bottom temp. (°C)	Depth (m) where siphonophores were observed	Estimated density (no./m³) of siphonophores
	Lat. N	Long. W				
1	41°56.4′	70°19.7′	38	7.0		
2	41°56.4′	70°18.6′	33	6.6		
3[1]	42°12.8′	69°54.2′	207	7.5	67,101-205	1-2
4	42°05.6′	70°12.0′	37	11.1		
5	42°04.7′	70°06.1′	24	8.0		
6[1]	42°11.4′	70°20.1′	34	5.5		
7	42°11.4′	70°21.9′	46	5.5		
8[1]	42°12.6′	70°03.5′	128	6.0	88-126	0.1
9	42°15.1′	70°07.0′	122	6.9		
10	42°18.8′	70°11.1′	55	6.0		
11	42°38.0′	70°27.6′	107	5.5		
12	42°38.0′	70°28.5′	85	5.0		
13	42°38.0′	70°27.6′	85	6.0		
14[1]	42°28.0′	69°52.6′	201		122-128	1
15[1]	42°36.6′	69°58.4′	180	6.8	146-177	2-4
16	42°38.5′	69°58.0′	136		91-120	1-2
17	42°38.2′	70°00.5′	183	7.0	120-181	7-8
18	42°39.1′	70°00.0′	168	5.5	140-166	
19	42°39.1′	69°58.9′	192	7.0	82-183	0.1
20	43°01.9′	70°05.4′	107	5.5		
21	43°00.5′	70°06.5′	146	5.5	107-122	0.1
22	43°01.0′	70°04.5′	53	6.5		
23	43°45.2′	69°00.0′	58			
24	43°32.0′	69°35.5′	152	6.8	149-150	1
25	43°38.6′	69°38.4′	84	6.8		
26	43°43.1′	69°41.2′	51			
27	43°44.1′	69°40.5′	76	9-10		
28[1]	42°55.0′	69°00.0′	72	7.3	45-70	0.05
29	42°54.4′	69°00.0′	98	7.0	76-85	<0.1
					91-98	1.1
30	42°07.1′	69°50.9′	124	6.0		
31	42°07.3′	69°51.1′	122	7.1		

[1]Dives conducted by authors.

(Figure 1, Station 3) to 17°C off Cape Ann (Station 15). Bottom temperatures at stations deeper than 100 m ranged from 5.5° to 7.5°C (Table 1). In general, the thermocline shoaled from about 75 m off Cape Ann to about 30 m in the Wilkinson Basin (Stations 3, 8, 14-16); the estimated zone of twilight visibility extended to about 135 m. Lateral visibility on most dives exceeded 5 m both above the twilight zone and below it where the lights on the submersible were used.

Large numbers of *N. cara* were observed at all dive stations deeper than 125 m; they were also present, though less dense, at two shallower stations, 28 (72 m) and 29 (98 m) (Table 1). During daylight, siphonophores were observed only below the thermocline. No dives were made at night so it was not possible to predict if transthermocline movement occurs during expected diurnal migrations. They appeared to be distributed in patches both horizontally and vertically. We estimated that patch diameters ranged from 5 to 30 m. At depths where *N. cara* was locally abundant, colonies could be seen out of every viewport (Figure 2). The densest concentrations often occurred between 3 and 45 m above the bottom where we estimated that their densities ranged between 1 and 7 colonies/m³. At Station 29 siphonophores occurred in two distinct layers: sparsely distributed from 76 to 85 m where concentrations were usually <0.1 colony/m³, and more densely aggregated above the bottom where concentrations were about 1 colony/m³. We found no correlation between colony density and substrate type.

Colonies ranged in size from 0.2 to 3.7 m when suspended in fishing posture with the stem and tentacles relaxed. In this configuration the distance between adjacent stem groups ranged from 10 to 15 mm. The largest colonies had over 200 salmon-colored feeding polyps (gastrozooids) and 30 to 40 swimming bells (nectophores). Unless swimming, most colonies oriented with the apical gas-filled float (pneumatophore) and nectophores upward. The rest of the flexible stem, which appeared neutrally buoyant, hung in three-dimensional series of loops and arcs.

In high density localizations of *N. cara*, colonies of several different sizes were often present. In areas of the aggregation peripheral to the highest densities of siphonophores, however, colonies were generally small, i.e., 20 to 40 cm long. Smaller colonies were also found higher in the water column than the larger ones, or occurred singly. All

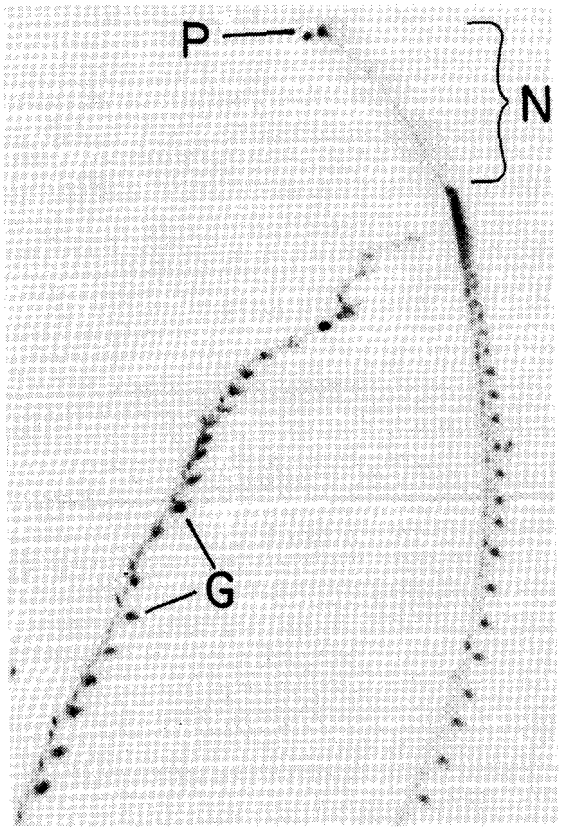

FIGURE 2.—The siphonophore *Nanomia cara* photographed from a viewport of the submersible: p, pneumatophore; n, nectophore; g, gastrozooid. An excellent schematic drawing of this species can be found in Mackie (1964).

colonies of *N. cara* were extremely fragile and isolated pieces of stem were not uncommon. When siphonophores came into contact with the submersible, their tentacles frequently adhered while stem and nectophores fragmented and floated away.

Most colonies were negatively phototactic and contracted their stem and tentacles as they drifted into the radius of the submersible's lights. Contraction usually initiated an escape swimming response. The siphonophores could move rapidly away at any orientation, and some were observed swimming with pneumatophore and nectosome pointed directly downward. We estimated that escape speeds exceeded 20 to 30 cm/s.

The most numerous invertebrates among or adjacent to the densest localizations of *N. cara* were the euphausiids, *Meganyctiphanes norvegica* and *Thysanoessa inermis*; mysids, principally *Neomysis americanus*; and hyperiid amphipods, principally *Parathemisto gaudichaudii* and *Hyperia galba*. We observed one siphonophore which had recently ingested an euphausiid; the others had no prey of this size in their feeding polyps.

Calanoid copepods, among them the large species *Calanus finmarchicus* and *Euchaeta norvegica*, were also locally abundant among the aggregations of *Nanomia cara*. Plankton samples taken in June 1976 showed that these calanoids were rich in lipids, as a heavy slick of oil droplets formed after they were preserved in 4% Formalin.[1] The copepods were apparently being eaten by *N. cara* as fragments of siphonophores removed from the same plankton samples were distended by lipids droplets inside feeding polyps and palpons, where lipids would concentrate during digestion of prey.

Discussion

The density of siphonophore colonies in the Gulf of Maine was considerably greater than Barham's (1963) estimate of the abundance (300 colonies/1,000 m^3) of a congeneric species (*N. bijuga*) in the San Diego Trough. Barham concluded that the gas-filled floats of *N. bijuga* were of adequate dimensions to act as strong sound scatterers and that at these densities this siphonophore could contribute significantly to scattering layer formation. The pneumatophores of *N. bijuga* and *N. cara* are similar in dimension, and aggregations of *N. cara* should be equally effective sound scatterers. In fact, in fall and winter 1975-76, fishermen in the Gulf of Maine reported near-bottom, dense layers of sound-reflecting organisms in areas where trawl nets were being clogged with *N. cara* (F. E. Lux pers. commun.).

The cause of the aggregation of *N. cara* in the Gulf of Maine has not been determined. It is conceivable that widespread reproduction of *N. cara* occurred in fall and winter 1975-76 and that local patterns of circulation aided in concentrating and maintaining the aggregation and prey items. It is clear, however, that localization of siphonophores like *N. cara* at densities exceeding 1 colony/m^3 will interfere with commercial fishing efforts by clogging the meshes of nets trawled for shrimp, silver hake, and redfish. Aggregations of siphonophores

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

may produce serious indirect effects as well. Biggs (1976) has shown that siphonophores like *N. cara* can eat prey ranging in size from zooplankton nauplii to small fish. As Fraser (1962) and Zelikman (1969) have proposed for aggregations of other gelatinous carnivores capable of eating zooplankton and larval fish, areas or seasons in which siphonophores are locally abundant could conceivably suffer dramatic reductions of ichthyoplankton. Lough[2] cited indirect evidence of possible heavy predation by siphonophores upon Atlantic herring larvae based on changes in population densities and distributions of the two species during winter 1975-76 in the Nantucket Shoals-Georges Bank area. Since the Gulf of Maine historically has been an important commercial fishing ground, future research on interaction between siphonophores and ichthyoplankton could lead to a better understanding of the regional food chain and the factors which influence year class success of ichthyoplankton.

Summary

Aggregations of the physonect siphonophore *Nanomia cara* were observed at several dive sites in the Gulf of Maine from *Nekton Gama*. This siphonophore occurs throughout the Gulf of Maine although the vertical and horizontal distribution is patchy. Densities as high as 1 to 7 colonies/m^3 were observed. Colony length ranged in size from 0.2 to 3.7 m and most aggregations included several different sizes. *Nanomia cara* was negatively photoactic and initiated escape swimming response at speeds which exceeded 20 to 30 cm/s. All siphonophores were observed below the thermocline and generally occurred only where water depth was >128 m.

Euphausiids, mysids, and hyperiid amphipods were observed among populations of siphonophores, but we observed only one colony which had eaten prey of this size. In seasons and areas of maximum abundance, siphonophores could conceivably influence the success of a year class of ichthyoplankton by heavy predation as well as cause losses of time and money to commercial fishermen by clogging trawl gear.

[2]Lough, R. G. 1976. The distribution and abundance, growth and mortality of Georges Bank-Nantucket Shoals herring larvae during the 1975-76 winter period. Int. Comm. Northwest Atl. Fish. Res. Doc. 76/VI/123, 30 p.

Acknowledgments

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