Preliminary Findings of a Zooplankton Study on the Southern Coast of Grand Bahama Island

William W. Schroeder
University of Alabama
Dauphin Island, Alabama
Frank D. Ferrari and Jeanne E. Snider
Texas A&M University
College Station, Texas

INTRODUCTION

The role zooplankton play in the coral reef ecosystem has not generally been agreed upon. Whether or not the zooplankton represents a source of food to the coral reef community has yet to be clearly demonstrated. Sargent and Austin (1949, 1954) conclude that the reef's own primary productivity can supply all the energy requirements for subsistence. However, the contribution from the incoming or offshore zooplankton to the energy cycle was never determined in their study. Bakus (1964) reports differences in the offshore and inshore zooplankton populations and concludes that the lagoon is a food reserve for plankton-feeding animals of the reef. Odum and Odum (1955) report zooplankton volume gain equal to loss and conclude that the reef derives no net gain from the offshore zooplankton. Emery (1968) suggests that offshore zooplankton probably represents a net energy gain to the reef. He comments on the work of Odum and Odum (1955) by pointing out that even though there were equal volumes of zooplankton in front of the reef and behind the reef, the character of the zooplankton had changed and offshore organisms had been filtered out by reef plankton feeders.

Johannes et al (1970) report that data collected in a coral reef community on the Bermuda platform show that the energy requirement of the corals is an order of magnitude or more greater than the energy the sparse zooplankton from the surrounding waters could provide, and therefore, suggest that corals can exist in the absence of sufficient zooplankton. However, the method of sampling zooplankton in this study negates any decisive interpretation. Goreau et al (1971) question a wholly autotrophic mode of feeding in reef corals. They suggest a large degree of specialization in food procurement of reef corals, some of which, acting as carnivores, feed primarily on zooplankton.

The unresolved status of this question coupled with the opportunity to carry out studies on a coral reef complex while living underwater on the reef prompted

us to seriously begin looking at the problem. As a result, a study to investigate the zooplankton communities found off the southern coast of Grand Bahama Island was initiated in late 1971.

This paper will discuss some of the preliminary findings from that study. The study site is the coral reef-sand flat complex and surface waters immediately adjacent to Hydro-Lab (see Seafloor Panorama, Hydro-Lab Jour. 1(1), 1972). Surface and sub-surface collections were made during three saturation missions (December 4-9, 1971, August 11-18, 1972, and October 26-November 2, 1972). Plankton samples were successfully taken by a scientist/aquanaut utilizing nets attached to a hand-held underwater diver propulsion vehicle. A paper dealing with the techniques of collecting and handling zooplankton samples taken underwater will appear in a future publication. All

	D-OPC Samples		
	No. 5 Dec. 6-Noon	*No. 10* Dec. 7-Noon	*No. 15* Dec. 7-Midnight
Copepods			
Candacia pachydactyla	——	Scarce	——
Clausocianus furcatus	——	Abundant	Abundant
Euchaeta sp.	Conspicuous	——	——
Nannocalanus minor	Abundant	Scarce	Scarce
Undinula vulgaris	Scarce	——	Scarce
Chaetognaths			
Sagitta hispida	Abundant	Scarce (adult) Conspicuous (juvenile)	Conspicuous
S. enflata	Conspicuous	Abundant	Scarce
S. sp.	Scarce	——	——
Amphipods			
Hyperiids	——	——	Abundant
Pteropods			
Creseis acicula	Conspicuous	——	——
Diacria sp.	Scarce	Scarce	Scarce
Limacina trochiformis	Scarce	Scarce	——
Tunicates	Scarce	Scarce	Scarce
Ostracods	Scarce	——	——
Polychaetes	——	Scarce	Scarce
Medusae	Conspicuous	Scarce	Scarce
Siphonophores	Scarce	Scarce	Scarce
Mysids	Scarce	Scarce	Scarce
Decapod larvae	Conspicuous	Conspicuous	Conspicuous
Fish larvae	——	——	Scarce
Larvaceans	Scarce	Conspicuous	Conspicuous
Plant debris	Conspicuous	Scarce	——

Table 1. Composition of D-OPC Samples.

surface samples were standard oblique tows utilizing half-meter nets with a mesh aperture of 0.333 mm.

PRELIMINARY ZOOPLANKTON SURVEY: December 4-9, 1971

DIVER-OPERATED PLANKTON COLLECTOR (D-OPC) SAMPLES

The results of three samples taken over both the sand flat and reef study areas are presented in Table 1. Sampling depths were 8-9 m with a bottom depth range of 14-20 m. Sample Nos. 5 and 10 were taken at noon while No. 15 was taken just before midnight. These data indicate a number of differences in the composition of these samples. The copepods, chaetognathas and pteropods illustrate this best. The copepod *Euchaeta* sp. and the pteropod *Creseis acicula* are only found in sample No. 5, while the copepod *Candacia pachydactyla* is only found in sample No. 10. Also, the relative numbers of the copepod and chaetognath species vary between the three samples. The pteropod *Limacina trochiformis* found only in the day samples and the amphipods and fish larvae found only in the night samples best illustrate day-night differences.

NIGHT-LIGHT STATIONS

Hand-held net samples were taken at two night-light stations. Station No. 1 was located below the large observation window on the base of the habitat and a hand-held divers light (109,000 candlepower) was utilized while the habitat light was off. Station No. 2 was taken just above the observation window using the habitat light.

At night-light station No. 1 (Table 2) there were many forms that are normally associated with the nearshore environment. Most striking, though not in a numerical sense, were the cumaceans which are not true planktonic organisms. Usually, they are associated with the benthos and are known to swim up off the bottom into the water column, especially at night. Males of the genus *Iphinoe* were very common; also present were members of the genus *Pseudocuma*. Other groups collected that are associated with the benthos were large gammarid amphipods and isopods. The oceanic hyperiid amphipods were poorly represented.

The overwhelmingly dominant copepod form at this station were males of the species *Calanopia americana*. Dominant decopod larvae belonged to the family Alphaeidae. Some members of the family Hippolytidae were also present. Chaetognatha in the sample were represented by *Sagitta enflata* and *S. hispida*. Mysids were also present.

Night-light station No. 2 was dominated by two copepod species, *Candacia pachydactyla* and *Clausocalanus furcatus*. *C. furcatus* was the most abundant organism in the sample. Other copepods present were *Undinula vulgaris* and the epiplanktonic *Nannocalanus minor*. Of these forms *C. pachydactyla*, *C. furcatus* and *N. minor* are more typically oceanic, while *U. vulgaris* and *C. furcatus* are ubiquitous open water forms. Amphipods were well represented by the planktonic hyperiids. The most common genus was *Hyperia*. Decopod larvae of the family Nematocarinidae were scarce. *Sagitta hispida* was the predominate chaetognath. Mysids were represented by a few adults and numerous immature forms. Cumaceans were totally absent from this sample.

WINDOW OBSERVATIONS

Observations of zooplankton made from inside the habitat looking out through its large window are outlined in Table 3.

The results of the preliminary survey helped serve as criteria for designing a study that would look at the role zooplankton play in the coral reef-sand flat ecosystem. The first objective of this new study was to determine the composition and distribution of the planktonic and epibenthic organisms found both at the Hydro-Lab site and in the northern waters of the Northwest Providence Channel. Because of the close relationship between planktonic organisms and the water

	Station 1 Dec. 5	Station 2 Dec. 7
Copepods		
Calanopia americana	Abundant	—
Candacia pachydactyla	—	Conspicuous
Clausocalanus furcatus	—	Abundant
Monstrilla sp. 1	Conspicuous	—
M. sp. 2	Conspicuous	—
Nannocalanus minor	—	Scarce
Undinula vulgaris	—	Scarce
Amphipods		
Gammarids	Conspicuous	Scarce
Hyperiids	Scarce	Conspicuous (Genus *Hyperia*)
Cumaceans		
Iphinoe sp.	Abundant (mostly male)	—
Pseudocuma sp.	Conspicuous	—
Decapod larvae		
Alphaeidae	Conspicuous	Scarce
Hippolytidae	Scarce	Scarce
Nematocarinidae	—	Scarce
Mysids	Scarce (adults, —juveniles)	Scarce Conspicuous
Chaetognaths		
Sagitta hispida	Scarce	Conspicuous
S. enflata	Scarce	Scarce
Isopods	Present	—
Ostracods	Present	—
Medusae	—	Present
Siphonophore parts	—	Present
Polychaetes	Present	Present
Fish larvae	—	Present

Table 2. Composition of Night-light Samples.

masses they live in, a current and hydrographic study was initiated simultaneously in August 1972. A paper dealing with this study will appear in a future publication.

The diversity found within the samples taken during both the August and October-November missions far exceeded our estimates. This forced us to reevaluate our plans for analyzing the data. Shortly thereafter we also recognized the immense complexity of the zooplankton versus epibenthic relationship. As a result we have chosen to present in this paper only the data pertaining to the copepod and chaetognath component of the samples.

ZOOPLANKTON MISSION I: August 11-18, 1972

D-OPC AND SURFACE SAMPLES

D-OPC samples for zooplankton missions I and II were taken at 1 and 3 m above the bottom at either noon or midnight. Surface samples were standard oblique tows utilizing a half-meter net.

The water over and around the reef usually contained from 300-800 copepods per cubic meter of water. There was no discernible difference quantitatively or qualitatively in the day and night surface samples. Three species dominated the samples: two calanoids, *Clausocalanus furcatus* and *Temora turbinata* and the cyclopoid *Farranula gracilis*. These species made up over 70% of the total number of copepods per sample. Due to mesh size (0.333 mm) only adults of the latter species were found. However, many Stage IV and V copepodids, as well as adults of the calanoids, were present. Other less common species included *Oncaea venusta*, *Acartia spinata* and late copepodids of *Undinula vulgaris*.

In samples taken immediately above the reef complex with the D-OPC, there were from 80-200 copepods per cubic meter of water. *C. furcatus* was still found to be one of the dominant constituents along with *T. turbinata*. Another calanoid, *Acartia spinata*, was also found to be abundant here. In the D-OPC samples taken over the sand flat, the dominant species were *C. furcatus* and *A. spinata*. The latter was the most abundant and in some cases the only copepod of note in these samples. Copepod numbers were in the same range as given previously except on the night of August 16, when over 1000 copepods per cubic meter were collected. The sample was made up exclusively of *A. spinata*. There were no differences between the D-OPC samples taken at 1 or 3 m above the bottom.

The chaetognaths ranged in abundance from less than one to 48 per cubic meter. Interestingly, both of these maximum and minimum values were found in samples taken over the sandy bottom with the D-OPC. These collections exhibited the greatest fluctuations in numbers on both days, very few chaetognaths being caught during the noon sampling, while maximum abundances were found at night. The dominant species was *Sagitta hispida*. This species also predominated in the reef and inshore surface samples. In the oceanic 30-m surface tows (taken 1.5 mi offshore in 200 m of water), *S. enflata* and *S. serratodentata* equalled or slightly exceeded the number of *S. hispida*. These other species, as well as *S. helenae*, were found in smaller numbers inshore. *S. serratodentata* was found only in the inshore 10-m surface tows, whereas *S. enflata* and *S. helenae* were present in both the D-OPC samples and the inshore surface tows.

NIGHT-LIGHT STATIONS

Lights placed around the reef complex on certain nights were allowed to shine for ten minutes before the water around the lights was sampled with a small hand net. Generally, these lights attracted copepods of the family Pontellidae. *Calanopia americana* was the most abundant copepod in these night-light samples. Other pontellids that were attracted and captured included *Labidocera wilsoni* and *Pontella mimocerami*. Of the species discussed in the D-OPC and Surface Sample section, only *Temora turbinata*, a non-pontellid copepod, was collected around the lights. Night lights set in the surface

Observation 1. Plankton
December 4: 2000-2400 h

- Copepods
- Chaetognaths
- Polychaetes (*Sagitella*)
- Stomatopod larvae
- Decapod larvae
- Medusae
- Siphonophores (Diphyidae) and Siphonophore parts
- Tunicates
- Mysids

Fish (mainly *Caranx ruber, Inermia vittata* and *Emmelichthyops atlanticus*)

Observation 2. Plankton
December 5: 1300-1430 h

- Copepods
- Tunicates (solitary)
- Medusae
- Siphonophores

Fish (*Scarus coeruleus* and *S. croicensis* or *taeniopterus*)

Observation 3. Plankton
December 5: 2130-2400 h

- Copepods
- Chaetognaths
- Polychaetes
- Stomatopod larvae
- Decapod larvae
- Medusae
- Siphonophores and siphonophore parts
- Tunicates (mostly solitary)
- Mysids
- Ostracods

This plankton population is basically the same as Observation 1.

Fish (see Observation 1)

Observation 4. December 6: 2035-2350 h
Very dirty water; large amounts of plant debris; visibility with light 6 to 9 meters.

Plankton

- Copepods (numerous Cyclopoids)
- Chaetognaths (at least two different species)
- Polychaetes (*Sagitella* and *Tomopteris*)
- Stomatopod larvae
- Decapod larvae
- Medusae
- Siphonophores (Diphyidae and Physonectae) and Siphonophore parts (Nectophores of *Agalma* sp.)
- Tunicates (many chain forms)
- Mysids
- Pteropods
- Heteropods
- Leptocephalus larvae

This plankton population is very different from the past two nights.

Fish (numerous small adults and juveniles)

Squid

Observation 5. December 7: 2200-2400 h
Great deal of bioluminescence coming primarily from Siphonophores, Ctenophores and the feces of Bar Jack.
December 7: 2200-2400 h

Plankton

- Copepods (completely different composition from previous observations; one conspicuous species has very dark legs-*Candacia pachydactyla*)
- Chaetognaths
- Polychaetes (Sagitella only)
- Stomatopod larvae (in great numbers)
- Decapod larvae
- Medusae
- Siphonophores and Siphonophore parts (very different composition than previous observations).
- Tunicates (virtually lacking)
- Mysids (large numbers which appear to be schooling)
- Amphipods (*Hyperia* sp.) first time these have been observed.

Totally different plankton populations from last night and previous nights.

Observation 6. December 8: 2030-2330 h
Same population as last night with the exception of an occasional solitary tunicate; some new fish and one leptocephalus larvae.
December 8: 2030-2330 h

Table 3. Notes Made During Observations from Window in Hydro-Lab.

waters above and away from the reef were very unproductive in attracting copepods.

Although *Clausocalanus furcatus* was present in the water and found during normal sampling, it was not collected around the lights during these later missions, contrary to the data collected on December 7, 1971 (Table 2). This apparent discrepancy can be explained in that the sample taken on December 7 was collected around the habitat light which had been shining for a long period of time. This would seem to indicate that there is a variable time lag in this exogenous response by different species of copepods.

As for the chaetognaths, the night-light stations revealed no differences when compared with the D-OPC and surface samples. *S. hispida* was still the dominant chaetognath. *S. enflata* and *S. helenae* were present in the samples collected on the reef and also in the light at the surface. *S. serratodentata* and *Krohnitta pacifica* were found in small numbers only around the light at the surface. Owre (1972) reports similar findings from night-light stations off Bimini.

ZOOPLANKTON MISSION II: October 26 - November 2, 1972

D-OPC AND SURFACE SAMPLES

Samples of water taken over and around the reef during this period contained between 100-250 copepods per cubic meter of water. Dominant constituents of the copepod group included *Clausocalanus furcatus, Temora turbinata* and many Stage III, IV and V copepodids of *Undinula vulgaris*. These three species made up at least 70% of the copepods in the samples. Other less common species were *Oncaea venusta* and *Farranula gracilis*. Samples close to the bottom also had fewer copepods per cubic meter than in Mission I. As in Mission I, the dominant species included *A. spinata, C. furcatus* and *T. turbinata*. Another cyclopoid, *Oithona plumifera*, was the dominant species at one reef station.

Chaetognaths were less abundant during the second mission, numbers ranging from less than one to 24 per cubic meter. *S. hispida* was still the most abundant species. The increase in numbers observed during the previous mission was likewise found in those samples collected over the sand. During the day less than one individual per cubic meter was collected, while at night 23 were taken per cubic meter, the maximum for all samples taken that night. During the day 24 individuals per cubic meter were caught in the inshore 10-m surface-oblique tows. *S. helenae* and *S. enflata* were fairly common, as was *S. serratodentata*, with *Krohnitta pacifica* and *Pterosagitta draco* also present in small numbers. These latter three species reached their greatest numbers at the oceanic surface-oblique tow stations.

NIGHT-LIGHT STATIONS

Night lights around the reef and sand flat again attracted pontellids almost exclusively. The dominant copepod species were *Calanopia americana* and an unidentified species of *Labidocera*. *Labidocera wilsoni* was also present. *S. hispida* was the dominant chaetognath species in these collections. One unidentified species of *Spadella* was collected for the first time.

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