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A New Plankton Sampler for Coral Reefs

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With 3 figures

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Abstract. A new self-contained Horizontal Plankton Sampler (HOPLASA) collects near-reef plankton that is not captured by conventional net tows and emergence traps. An electrical motor-propeller assembly inside a large acrylic cylinder drives water past an in-line flowmeter and through a rigidly attached plankton net. When positioned in the coral reef environment this sampling gear filters known quantities of bottom water. Larvae and developmental stages of many invertebrates and some fishes that never migrate to upper water layers but constitute an important fraction of the food chain are captured. Larvae of sponges, corals, and gorgonians, the most important animal reef builders, are obtained live and undamaged and can be cultured in the laboratory for identification after metamorphosis.

Problem

In a recent survey of zooplankton over a Caribbean coral reef and in a lagoon near Carrie Bow Cay, Belize (FERRARIS, in press), many groups of reef-associated organisms, or their larval stages, were rare or absent from the samples even though tows had been made during day and night (before and after sunrise and sunset), during all phases of the moon, and at depths of 0.5 and 3 meters. Anticipating, however, that many medusae, particularly large forms, would escape or not survive capture by the small (29 cm diameter) and relatively dense (250 μm mesh) net used in routine sampling, a more specialized survey of the medusae fauna in the same area employed a net with 0.5 m^2 opening and 560 μm mesh diameter (LARSON, in press).

The capture of many interesting benthic organisms by stationary plankton nets suspended in steady tidal or wind currents running across the Carrie Bow Cay reef flat convinced us that if currents could be induced, stationary nets might be used elsewhere, particularly where nets are difficult to tow through the water. We therefore designed, built, and tested a horizontal plankton sampler ("HOPLASA") that induces currents and therefore independently catches near-bottom plankton over irregular three-dimensional substrates, such as those of coral reefs.

Many workers, recognizing the low production of tropical seas, have long wondered about the origin and fate of plankton available to the large community of

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benthic filter feeders that build the framework of a coral reef and dominate its biomass. The most common approach to this problem has been the comparison of samples from inside (lagoon) and outside (open ocean) atoll and barrier reefs, and those from tidal currents between these two environments, allowing conclusions about the origin of zooplankton populations and their contribution to coral reef nutrition (MOTODA, 1940; JOHNSON, 1949, 1954; ODUM and ODUM, 1955; TRANTER and GEORGE, 1972; RENON, 1977; FERRARIS, in press). On a smaller scale, but with higher resolution, plankton depletion in water flowing over a reef flat community dominated by a coral *(Porites furcata)* was studied by GLYNN (1973).

With the increased accessibility of compressed air (SCUBA) diving research focused on coral reef studies and it became evident that plankton taken by surface or subsurface tows differed at least qualitatively from that observed within the three-dimensional structure of the reef. Some notable methods developed for plankton research in reefs include EMERY's (1968) hand-towed nets, his suction device for sampling caves, and his plankton-attracting light for night work, all used in sampling two reefs in the Florida Keys. Subsequently, PORTER (1974) pushed nets with flow meters about one meter above the bottom contour during his study of the multitrophic capabilities of reef corals in Panama. He caught planktonic larvae (including coral planulae) and demersal adult zooplankton and later found the same components in the gut contents of the coral *Montastrea cavernosa.* The existence of a special near-reef plankton community on the Great Barrier Reef was recognized by SALE et al. (1976, 1978), who compared reef, water surface above the reef, and open water samples taken by light traps at night. More recently, HAMNER and CARLETON (1979) used diver-held plankton nets and plastic bags to sample copepod swarms in coral biotopes; they also photographed these swarms *in situ.*

Further improvements in sampling gear – based on the phenomenon that many zooplankters live in or on the substrate during the day and rise into the water column at night – were modeled on equipment used by limnologists for capturing emerging insects (MORGAN, 1971; MUNDIE, 1971). PORTER and PORTER (1977), for example, collected demersal plankton rising from coral substrates in a Philippine reef by cone-shaped, clear polyethylene traps with a catch bottle on top. Rigid plexiglass boxes enclosing a funnel trap in similar manner were used by ALLDREDGE and KING (1977) on Great Barrier Reef habitats.

A recent evaluation of these and other methods for sampling the resident reef plankton concluded that this highly diverse and abundant endemic plankton undergoes marked vertical migration at night, and thus becomes available to predators (PORTER et al., 1978). Although HOBSON and CHESS (1979) support this general conclusion, they have expressed concern about the reliability of data from the early traps, that allowed nearby holoplanktic and meroplanktic forms to enter through gaps between the lower edges of the sample cones and the sea floor. HOBSON and CHESS therefore caution that the contents of these traps should not be used as a measure of the organisms emerging from a given substrate area. They solved this particular problem during their study of meroplankton in the Hawaiian Archipelago by introducing a double cone that was well sealed around the base.

Our motive for introducing yet another device for sampling near-reef plankton was our disappointment with emergence traps in shallow (2–5 m) habitats mo-

derately exposed to waves. It was impossible to keep soft or rigid plastic cones, or even cones made of plankton netting, in place or sealed to the bottom except during periods of exceptional calm. Our goal was to sample close to the reef contour and to collect living specimens by day and night and over extended periods without overcrowding plankton in stagnant collection jars. Suction collecting systems were dismissed because of their high degree of sampling mortality.

Our sampler was designed to assess only the quality (origin) and quantity of zooplankton available to suspension feeders in the near-reef water layer. It does not take into account quantitative aspects of diurnal migration patterns.

Sampler Design

A plexiglass cylinder (18.5 cm in diameter and 40 cm long) serves as water intake and houses the motor and flow meter (Fig. 1). This basic unit rests on weighted plastic (rigid PVC) pipes that resemble a sled. In a newer version of the sampler the propulsion unit is mounted on a watertight battery case that provides the required weight. A standard zooplankton net (250 μm mesh and 0.8 m long) with sample basket is clamped to one end of the plexiglass tube, opposite to the motor-propeller assembly, and is supported in horizontal position by four aluminum tubes or four brass rods. A steady water current created by the motor-driven propeller is measured by an in-line flowmeter as it passes through the net with basket. A powerful epoxy-enameled electric motor used in diver tow vehicles (Shakespeare, Kalamazoo, Michigan, U.S.A.) was introduced after a less expensive 12 V outboard model failed when the shaft seal leaked water below a depth of 2 m. This motor is a permanent magnet, 12 V D.C., 18 A type, wired for low (6.5 A), medium (9.5 A) and high (18 A) range. To reduce speed and conserve electricity we usually operate at half voltage (6 V), on the low range. Two 6 V, 20 Ah gel/cell® batteries (Globe-Union Inc., Milwaukee, Wisconsin, U.S.A.), wired in parallel, supply the power. The batteries are enclosed watertight in plexiglass together with an ampere meter, a variable resistor (8 Ω), a range-on-off switch, and catalysts that prevent accumulation of an explosive hydrogen-oxygen gas mixture. Controls are sealed by 0-rings, and connection with the motor is made by rubber-insulated waterproofed cable. The motor-driven two-bladed propeller is made of glass-reinforced polycarbonate and measures 15 cm in diameter. A model 2030 digital flowmeter (General Oceanics, Inc., Miami, Florida, U.S.A.) equipped with a low velocity two-bladed rotor is suspended in the center of the water intake tube, between motor and net. The large rotor, which almost touches the tube wall with the outer edges of its blades, is calibrated between 3 cm/s and 100 cm/s water flow.

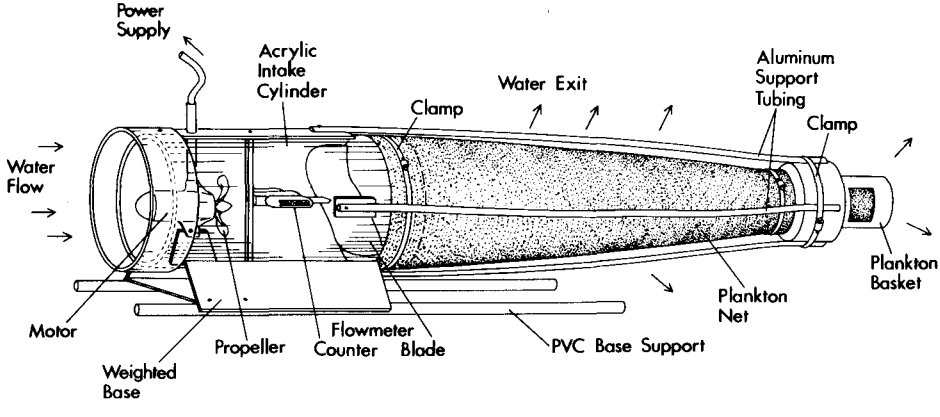

Fig. 1. Design of the near-reef plankton sampler. Total length, 110 cm; intake diameter, 18.5 cm. Power can be supplied from an anchored boat or by submersed batteries.

Discussion

We installed our sampler on top of and within the coral formation of a patch reef 4 m deep (Fig. 2), and in the 4–6 m spur-and-groove zone of the barrier reef near Carrie Bow Cay, Belize (for biotope descriptions refer to RÜTZLER and MACINTYRE, in press). Six day runs and two night runs of 5–8 h duration were completed. At a rheostat setting of 2.5–3.5 A (at 6 V) the motor generated a current flow of 20.6–30.1 cm/s. With 269 cm^2 of net aperture, 20–30 m^3 water were filtered per hour. Maximum unattended operating time was about 10 h, but this value depends on ambient temperature and battery conditions.

The first samples contained numerous organisms that have been absent or rare in surface plankton tows over the same areas (Fig. 3). The gentle but steady current flow originating at the entrance of the sampler is nonetheless sufficient to confine trapped plankters to the net and allows them to survive up to several

Fig. 2. Diver installing HOPLASA on a coral-gorgonian-sponge patch reef near Carrie Bow Cay, Belize.

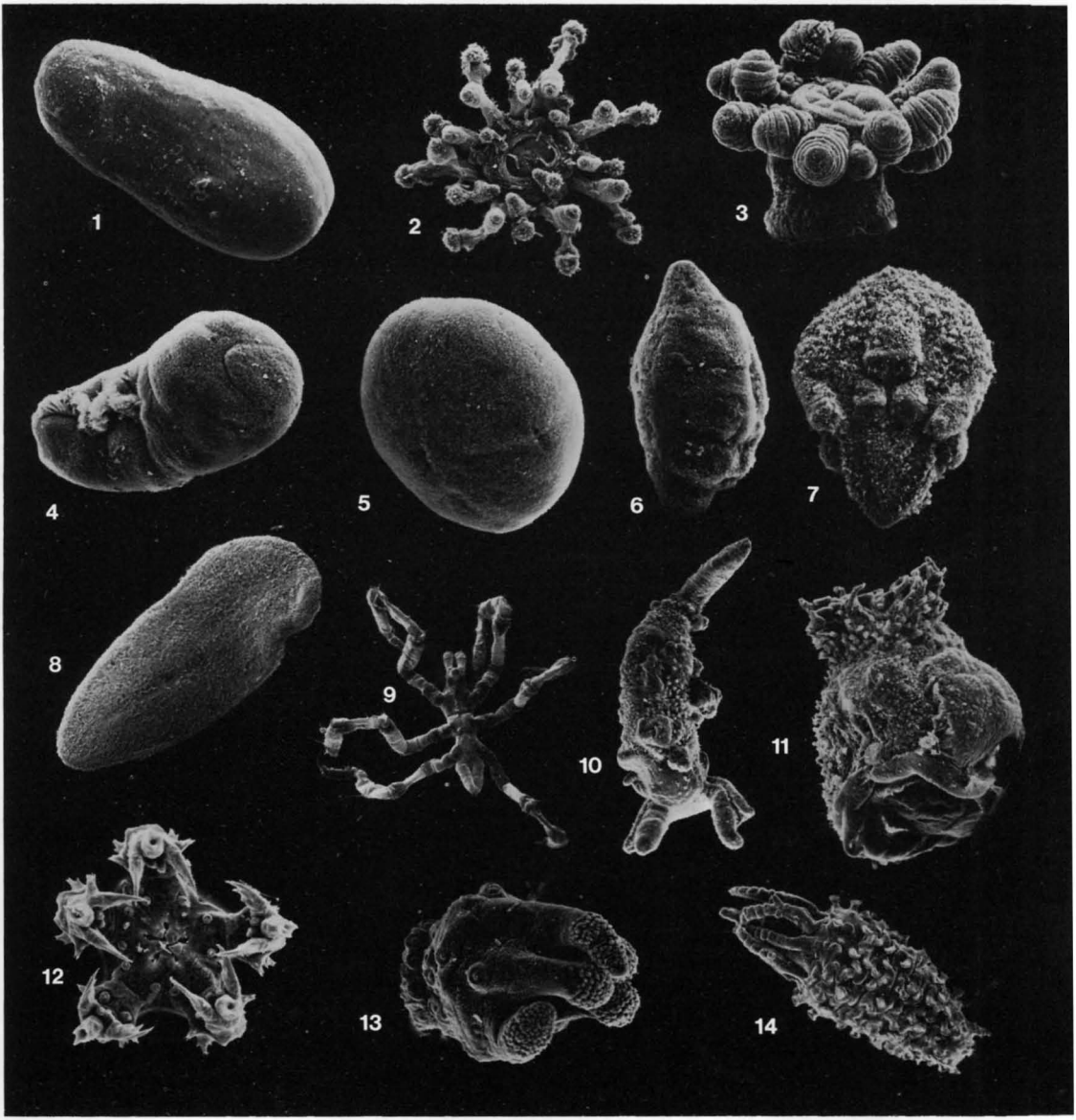

Fig. 3. Scanning electron micrographs of near-reef plankters captured by HOPLASA on a coral-gorgonian-sponge patch reef near Carrie Bow Cay, Belize. 1: Parenchymula of the sponge *Desmacella* sp., identified from a morphologically identical duplicate specimen reared to a 5 mm incrustation with two oscula (47 x). 2: Hydromedusa *Staurocladia vallentini* (Browne) (63 x). 3: Young unattached actiniarian (35 x). 4: Zoanthid planula; these characteristic larvae, known as epiplanktonic, were either freshly released or ready to settle when caught (35 x). 5: Scleractinian planula, identified from duplicate specimen reared to one-polyp stage (35 x). 6: Gorgonian planula, identified from duplicate specimen reared to one-polyp (130 x). 7: Turbellarian (Müller's) larva (94 x). 8: Turbellarian (47 x). 9: Larval pycnogonid *Anoplodactylus* sp. (16 x). 10: Saccoglossan opisthobranch (47 x). 11: Octobrachian cephalopod (63 x). 12: Ophiuroid (78 x). 13: Postlarval synaptid holothurian (70 x). 14: Holothurioid (28 x).

hours of unattended running time. Concentration of the sample into the basket does not take place until the net is drained. Thus parenchymula larvae of sponges and planulae of corals and gorgonians could be obtained in good condition and could be raised in the laboratory until the metamorphosed organisms became identifiable.

In summary, the HOPLASA device traps meroplanktonic and holoplanktonic forms, as well as reef-dwelling demersal migrators that constitute a food source for the suspension-feeding benthos that abounds in this environment. By allowing trapped organisms to remain alive and in good condition this sampler provides specimens for studies on development in many benthic groups. Our sampler does not replace emergence traps in studies of migration of demersal plankton from specific substrates, but it has definite advantages over diver-towed nets because it permits unattended long-term collecting by day and night, under most weather conditions, and without stirring up fine bottom sediments. Its limitations include low battery capacity and clogging of the net. The net should be cleaned after about 12 hours of running time. A more efficient low thrust motor could decrease the battery drain considerably, and net clogging could be reduced by using a larger net.

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