The Sources, Dispersal and Utilization of Benthic Drifting Plants in the Salt River Submarine Canyon
NULS-1, Mission 80-2

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RESULTS: HABITAT STUDIES

The experiments and observations made by the aquanaut team and surface research divers during the mission focused on three objectives: drift movement in the Salt River canyon, drift clump distribution and composition, and utilization of drift material by animals. The results of these studies ire reported below.

A. Drift Movement in the Salt River Canyon

1. Artificial Drifters

Weighted plastic drifters were used to study the bottom currents near the head of the canyon, in the lagoon and within the canyon itself. In all, 200 drifters were deployed from March 28-30 and their positions plotted for the duration of the mission. Fifty drifters were deployed in the Salt River lagoon on either side of the barrier reef (EL and WL). Fifty drifters were deployed in the main channel entrance to Salt River lagoon (MC). At the immediate head of the submarine canyon in 20 feet of water, 25 drifters were set out on each side (WCH and ECH). Finally, a total of fifty drifters were deployed at the 40, 60 and 70 foot isobars within the canyon (CAN). During the mission, the aquanauts relocated 44 of the drifters with a total of 65 observations. Eighty-six percent of the observations were made during the first two days following deployment. The net drifter movement was down-canyon to deeper water, but some tidal activity was noted. The decline in observations after two days indicates a rapid dispersal, especially for those drifters deployed within the canyon. The percent recovery for drifters observed in the canyon is shown in Table 1. The recovery of east lagoon drifters indicates that bottom transport and potential drift movement occur between Salt River Bay and the submarine canyon. No west lagoon drifters were recovered in either the canyon or the lagoon and their movement remains uncertain.

TABLE 1: Recovery of bottom drifter in Salt River canyon by aquanauts.

Original Site of Deployment	Number Deployed	% Observed in Canyon After Deployment
East lagoon (EL)	25	16
West lagoon (WL)	25	0
Main channel to lagoon (MC)	50	22
East canyon head (ECH)	25	8
West canyon head (WCH)	25	12
Within canyon (CAN)	50	40

Locations of recovered drifters within the canyon are summarized in Table 2. Most of the drifters were observed along the eastern side of the canyon. From plots of drifters observed on more than one occasion, a general bottom current pattern became apparent. The drifters moved down the central axis of the canyon head and then toward the eastern slope. Those drifters observed along the 95-foot excursion line were found primarily between the C and B marker lines, indicating a bottom movement toward the west wall below the 65-foot isobar.

TABLE 2: Locations within the canyon where drifters were observed after deployment.

Location	% of Total Observations
Near habitat	18
A line	1
West wall	5
B line	12
C line	20
D line	20
East slope 50'	11
Lower excursion limit line	6
Other	6

Although the net current movement was toward deep water down the canyon, periods of reversed movement were observed. Observations from both the habitat window and the collecting nets indicated up-canyon currents associated with flooding tides and high swell conditions on the surface. However, only one canyon drifter was observed in shallower water in the east canyon head. Several drifters initially set in the east canyon head have been retrieved on shore, and response cards returned by the finders.

2. Net Collections

A second method used to measure drift movement was the placement of 1 X 3 m benthic nets at the canyon heads, the east slope and the 95-foot excursion line. The material trapped by the nets was collected at least once daily and sent to the surface for biomass determinations and species composition (Table 3). The largest amount of drift was collected in the excursion line nets during a period of strong down-canyon movement, primarily during the third day. The center net (C line) contained the

TABLE 3: Number of species and biomass of plants collected in the nets. Numbers are wet grams; number of species are in parentheses.

Net Location	Day (1980) 29 March	30 March	31 March	1 April a.m.	1 April p.m.	2 April a.m.	2 April p.m.
West Canyon Head	60.8 (3)	83.0 (4)	4.0 (5)	13.1 (5)	-	41.3 (9)	0
	87.2 (5)	171.8 (5)	134.3 (9)	69.6 (8)	-	318.0 (14)	0 (0)
East Canyon Head	6.2 (3)	391.0 (12)	125.0 (4)	18.2 (6)	-	147.6 (19)	10.4 (4)
East Slope	434.7 (2)	22.3 (4)	0 (0)	0 (0)	0 (0)	0 (0)	- (0)
D Line Deep	0 (1)	4.7 (3)	640.0 (16)	178.6 (15)	21.7 (4)	161.2 (10)	-
C Line Deep	315.0 (19)	60.7 (10)	1985.3 (27)	1348.4 (16)	10.7 (7)	64.4 (11)	-
B Line Deep	34.0 (10)	39.7 (4)	432.7 (16)	1154.6 (17)	23.2 (10)	16.1 (10)	-

greatest amount of material, which is consistent with the artificial drifter sightings. The amount of material collected was extremely variable and highly dependent upon time of collection. On five occasions, the nets were reversed by an up-canyon current and any prior material collected was lost. However, the net movement of drift biomass was down canyon, particularly at depths below 50 feet. Between 30 and 95 feet, the drift material appeared very mobile and it is suspected that the turnover time of material within the canyon is rapid.

The plants in the net collections were dominated primarily by turtle grass (*Thalassia testinudum*) and the manatee grass (*Syringodium filiforme*), but in some collections, various algae such as *Dictyota* spp., *Dictyoptera* spp. and *Dilophus* spp. were abundant. In 32 net collections of plant drift, 21 were dominated by _T. testinudum,_ 6 by _S. filiforma_ and the remaining 5 were dominated by algae. It was quite rare to find animals in these collections. Most were found in the excursion line nets. They were mostly crustaceans and echinoderms, but some gastropod molluscs were also collected.

B. Drift Clump Distribution and Composition

Transects were established throughout the canyon from the C line to either the west wall or east slope. A total of sixteen transects were completed between 65 and 130 feet. At depths between 50 and 65 feet, very few drift clumps were observed, and at shallower depths in the canyon, no clumps were found. Each transect consisted of a 2-m wide swath starting 20 m from the C line and extending 40-55 m toward either the east or west wall. The transect line was divided into 5 m segments so that each sampling unit was 10 W. Drift clumps were counted in each sampling unit and recorded as to size (< 10, 10-20 and > 20 cm in diameter) and to major species of drift present.

The distribution of drift material sampled in the canyon is given in Table 4. The most frequent size class for drift clumps was < 10 cm in diameter. Drift clumps of all sizes were most frequent at depths of 65-70 feet and over 110 feet. Most drift clumps were associated with either depressions in the sand bottom or upright debris such as dead gorgonian skeletons or artificial debris left from previous missions. Despite an apparent availability of bottom irregularities, fewer clumps were observed between 70 and 100 feet, particularly between C line and the east slope. At depths shallower than 65 feet, most of the drift material was scattered

TABLE 4: Distribution, size and composition of drift clumps in the Salt River Submarine Canyon (March 28 - April 2, 1980).

C to West Wall							
F	65	45	0.78	1.34	0.78	2.89	Syringodium/ Thalassia
A	65	50	1.80	0.90	0.20	2.90	Thalassia/ Syringodium
H	70	45	1.78	0.78	-	2.56	Thalassia
G	75	45	0.78	0.23	-	1.00	Thalassia
E	77	45	0.23	0.34	0.34	0.89	Thalassia
D	82	40	0.13	0.63	-	0.75	Thalassia
C	95	40	0.25	0.25	0.25	0.75	Thalassia
B	95	45	0.23	0.34	0.45	1.00	Thalassia
X	130	55	2.18	1.54	0.82	4.54	Syringodium
C to East Slope							
J	65	40	2.38	1.88	0.38	4.63	Thalassia
H	65	40	2.00	1.12	1.50	4.63	Thalassia
G	67	40	2.00	0.75	-	2.75	Thalassia/ Syringodium
E	67	40	1.38	1.00	0.38	2.75	Thalassia
K	67	40	0.88	0.12	-	1.00	Thalassia
C	70	40	-	-	-	-	-
Z	110	55	2.82	2.00	1.88	5.64	Syringodium

loosely on the bottom and few drift clumps were observed. Thalassia testinudum blades were the primary constituent of the drift clumps (Table 5). However, Syringodium filiforma blades dominated at the deepest depths sampled (110-130 feet). The primary component of the loose drift material at shallow depths (< 60 feet) was also S. filiforma blades.

TABLE 5: Data on depth, biomass and species composition of natural drift plant clumps.

	Size (diameter in cm)		
	< 10 cm	10-20 cm	> 20 cm
Number	9	14	7
Median depth (Range)	65 ft (65-67)	65 ft (65-120)	65 ft (65-130)
Mean number (Grams/clump) (Std. dev.)	24.5 (17.5)	55.1 (46.0)	87.9 (60.1)
Mean number (species/clump)	4.9	5.9	7.7
Dominant Species (mean - grams/clump)			
Thalassia	10.9	21.1	44.4
Syringodium	7.5	24.3	27.3
Dictyopterus	2.8	3.2	6.2
Dictyota	0.8	3.7	7.1
Dilophus	0.4	0.3	0
Sargassum	0	0.5	0
Total Number of Species	12	19	20

Relatively few small animals were found associated with natural clumps on the canyon floor. Only 167 individuals were found, and these were mostly polychaetes and crustaceans with a few gastropod molluscs also occurring.

Since few animals were collected in our samples, little can be concluded about their use of drift. However, those collected were usually quite small juvenile stages, suggesting a possible role as a nursery site for these invertebrates. Whether the drift clumps provide food and/or space for these invertebrates remains to be studied in the future mission. Our new sampling technique using airlift samplers will perhaps better sample these animals.

C. Utilization of Drift Material by Animals

1. Observations and Sampling

Frequent observations were made of drift clumps while diving. During the day, numerous animals, particularly crabs and small fish, could be observed within the clumps. As the divers approached, the animals often sought shelter within the clump. Larger animals such as hermit crabs, flying gurnards, stingrays and queen conchs were observed feeding in drift clumps. However, no strong association between feeding activity and drift clumps was observed. During night excursions, animal activity in drift clumps did not appear different from daytime activity.

2. *Strombus gigas* Distribution and Activity

One of the most obvious large herbivores in the canyon during both day and night was the queen conch, *Strombus gigas.* A sampling study in conjunction with the transect work was initiated. Both the number and size (as total length) were recorded for each transect. The majority of the conchs were observed between 90 and 100 feet between C and B lines near the west wall (Table 6). All the conchs observed were quite large, averaging about 25 cm in total length. The greatest number of conchs

TABLE 6: Distribution and size data for *Strombus gigas.* All animals found between C line and west wall.

Depth (ft)	Total Number	Frequency/10 m^2	Average Length (cm)
65	1	0.05	18
75	1	0.04	25
85	1	0.12	26
95	18	1.05	25±1.74 (SD)

occurred at depths where fewer drift clumps were observed. This relationship could indicate that the conchs were either utilizing drift material as it became available or, alternatively, that the conchs did not utilize or require drift material at all. Unfortunately, conchs are very wary animals and when a diver approached close enough to investigate the animal's activity, it invariably retracted into the shell, making feeding observations impossible. A fine red scum (tentatively *Oscillatoria*, a blue-green alga) was present on the sand bottom at the depth where conchs were most abundant, suggesting that this material may form part of the diet.

To follow the movement of conchs in relationship to drift clumps, approximately 25 individuals were tagged and their original positions marked with stakes. Movement was extremely variable and ranged from 0 to 66 m in 18 hours. Aquanauts observed no association or directional movement toward drift clumps. The experiment was discontinued after two days, but tagged *Strombus gigas* will be observed on the following mission.

ADDITIONAL EXPERIMENTS FOR THE SECOND SATURATION MISSION

1. Measurement of Community Metabolism Associated with Drift Clumps

The *rates* of animal activity associated with drift clumps cannot accurately be determined from numbers of species and biomass alone. Aquanaut observations during the first mission indicate that some animals actively swim and feed within the drift clumps, while others may only seek shelter from predators and remain immobile in the drift. In addition, the activity of bacteria in decomposing drift material can be important as a food source for detritivores associated with drift. A rapid, relatively simple technique to assess the metabolic activity associated with drift is the determination of oxygen uptake as a measure of respiration. Enclosed chambers in which oxygen concentrations are monitored over time are most commonly used. However, because infaunal organisms may also be associated with drift, oxygen uptake measurements need to include both drift material and the underlying sediments. Open-ended enclosures {e.g., bell jars, domes) can be used if controls are used to differentiate between chemical oxidation in sediments and biological activity.

For the second saturation mission, the following null hypothesis will be tested: there is no significant difference between the animal activity associated with drift clumps and that of the surrounding sand bottom. Experiments using clear plexiglass domes will be conducted to measure oxygen utilization by the benthic community. The domes will be fitted with portholes to remove water samples for oxygen measurements at regular intervals during incubation. Dissolved oxygen will be measured with a YSI dissolved oxygen electrode. Diel oxygen metabolism will be compared in experiments made under the following conditions: (a) enclosing natural drift clumps to determine net community metabolism; (2) drift removal from sand depressions to determine infaunal activity: (3) placement over flat sand areas lacking naturally occurring drift to assess activity outside drift clumps; (4) enclosure of drift material cleared of animals to estimate bacterial activity; and (5) formalin-treated areas and drift to estimate chemical oxidation. The enclosed drift clumps and infaunal samples will be collected at the completion of the experiments to determine plant and animal biomass. The data will be reported as oxygen utilization (uptake/min) for each treatment and be used to compare the metabolic activity in drift clumps with that on bare sand areas.

2. Sampling of Drift Plant and Animal Clumps

Since we feel that our sampling during the first mission allowed many organisms to escape or avoid the sampler, we will employ an airlift sampler with a fine-mesh bag attached. This will allow us to rapidly collect a larger quantity of drift and much of the sand associated with it. This technique has proven effective in our experience subtidally in California waters.

3. Artificial Drifters

In addition to the 200 plastic drifters, we will also deploy approximately 400 perforated and spray-painted ping-pong balls to monitor water movement (R. Dill, pers. comm.). We feel that these drifters will be more responsive to near-bottom currents, will not be as responsive to movements more than a foot above the bottom and will, therefore, better reflect what current might affect drift plant movement.

4. Net Collectors

We will monitor the catch of the seven net collectors at least twice a day, since tidal fluctuations in our first mission were found to affect water movement and direction, thus influencing the plant drift collections. Also, since we had no idea of the amount of water flowing through each net, we will install a General Oceanic flowmeter in the mouth of each net to monitor the flow. This way, we can better standardize the amount of drift per volume of water flow.

5. Feeding Observations of Herbivorous Fishes

Since much time is spent in the habitat, useful observations can be made on transplanted drift clumps in front of the window by herbivorous fishes. We plan to use this approach to study feeding preferences between fresh and old drift and among species of drift. Also, we will attempt to quantify the amount of plant material eaten by weighing the transplanted clumps before and after the feeding observations.