Infaunal Polychaetes of Reef Crest Habitats at Heron Island, Great Barrier Reef

RUSSELL REICHELT

Zoology Department, University of Queensland, St. Lucia, Queensland 4067, Australia

Abstract.—Three samples from each of two microhabitat types (one was sand/rubble under dead coral rocks, the other was solid limestone with a thin layer of algal-bound sand) were collected from Heron reef crest (23°27′S, 151°55′E), southern Great Barrier Reef. In total, 931 polychaetes representing 20 families were recovered by seiving through an 0.1 mm mesh. Mean polychaete density for the 3 loose sand samples was 28 individuals/liter whereas it was 480 individuals/liter for the 3 solid limestone samples. For the solid substratum this is approximately 24,100 polychaetes/m^2. Of the 6 samples, 2 were sorted to species level and four to family level only. The loose sand sample sorted to species level contained 26 individuals, 16 species and species diversity $H' = 2.65$. The single solid limestone sample sorted to species level contained 239 individuals, 41 species and $H' = 2.85$. The 3 solid limestone samples were more similar to each other than to the three loose sand samples, which were also more variable. The 3 loose sand samples shared only 2 families, Syllidae and Eunicidae, while the 3 solid limestone samples shared 8 families—Syllidae, Eunicidae, Nereidae, Chaetopteridae, Capitellidae, Amphinomidae, Terebellidae and Maldanidae. The Heron reef limestone samples were very similar in general characteristics to the polychaete assemblages in truncated reef limestone samples from East Indian Ocean and Guam with respect to the mean density, the numerical predominance of Syllidae and the abundance of Eunicidae.

Introduction

Polychaete annelids are known to be extremely abundant in intertidal solid reef limestone habitats in the tropical Indo-West Pacific (Kohn and Lloyd, 1973a; Kohn and White, 1977). Predatory gastropods are also abundant in these habitats (Kohn and Leviten, 1976; Kohn and Nybakken, 1975) and at Heron Island, analysis of dietary data for 20 cooccurring gastropods has revealed that at least 13 gastropods prey on polychaetes (unpublished data). Certain reef fishes are also known to be important predators of polychaetes (Randall, 1967; Vivien, 1975). Because the predators are relatively mobile compared with their prey, distribution and abundance of polychaetes are potentially important components of prey availability for the vermivores.

The aim of this study was to investigate the degree of variation in distribution and abundance of polychaete annelids within and between two of the most common microhabitat patch types on the seaward platform of the reef crest at Heron Island. These microhabitats are: loose sand under dead coral boulders (referred to hereafter

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as 'loose sand' or #1 habitat) and solid limestone with a thin layer of algae-bound sand (referred to as 'solid limestone' or #2 habitat).

Quantitative data for southern Great Barrier Reef polychaete assemblages are available for a number of subtidal habitat types at One Tree reef (Hutchings, 1974) and for a clump of the coral *Pocillopora damicornis* from Heron reef (Grassle, 1973). There are no other published quantitative data on diversity and abundance of infaunal polychaete annelids from intertidal reef crest habitats in this region.

Study Area

Heron Reef (23°27′S, 151°57′E) is a lagoonal platform reef with a vegetated sand cay (Flood, 1977) in the Capricorn Group, southern Great Barrier Reef. Two reef crest microhabitats were sampled at each of the three sites A, B and C (Fig. 1), approximately 15 m inshore, and less than 50 cm vertically above, mean low water. Since sample surface area, volume, substratum hardness, and epifaunal cover are probably important determinants of the composition of infaunal polychaete assemblages (Hutchings, 1974; Vittor and Johnson, 1977), an attempt was made to collect samples from areas of similar physical appearance.

Methods

The sand/rubble mixture from beneath dead coral rocks was scooped up, the chief collection criterion being that most of the sand beneath the rock be included in the sample. The smooth limestone substratum including the layer of sand bound by the algal mat, was collected using hammer and chisel. Both the loose and solid substratum samples were fixed in 10% formalin immediately after collection and preserved in 70% alcohol after 24 hours.

After reducing all solid fragments with hammer and chisel to particle sizes of less than 1 cm^3, each sample was washed over a 0.1 mm sieve. All polychaetes and other invertebrates visible at magnifications of up to $\times$ 50 of a Wild M5 stereomicroscope

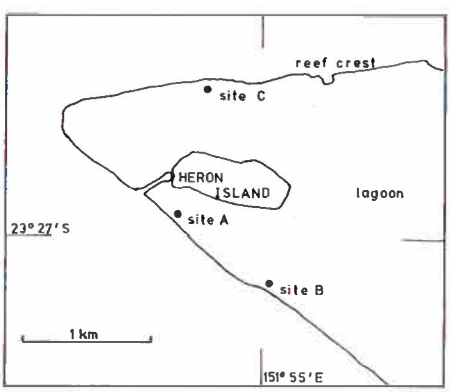

Fig. 1. Map of Heron reef showing sample sites.

were removed and stored in 70% alcohol. Reference sources for polychaete identification were Day (1967) and Kohn and Lloyd (1973a). Detailed taxonomic work has not been undertaken and the samples have been lodged at the Queensland Museum (site A- QM G12020; site B- QM G12021; site C- QM G12022).

The diversity index used was Shannon's H' since the samples were considered to be only a subset of the populations of the two microhabitat types (Pielou, 1975). $H' = -\Sigma(n_i/N)$ ln (n_i/N) and evenness (J) is $J = (H'/\log s)$ where n_i/N is the proportion of individuals in the ith category and s is the number of categories (species or families). The overlap measure C_λ was calculated following Horn (1966). $C_\lambda = 2\Sigma x_i y_i/(\Sigma x_i^2 + \Sigma y_i^2)$ where x_i is the proportion of species i in sample x and y_i is the proportion of species i in sample y. When calculating overlap between two samples, those species were omitted that could not be compared with certainty between samples owing to nonspecific identification.

Results

The loose sand samples from sites A, B and C were 1 liter, 1 liter and 2 liter volumes and contained 27, 27 and 58 individual polychaetes, respectively. The solid limestone samples were 70 cm^2, 130 cm^2 and 180 cm^2 (all to approximately 5 cm depth). These solid samples contained 683 polychaetes/liter (34,100 individuals/m^2), 455 polychaetes/liter (22,200 individuals/m^2), and 323 polychaetes/liter (16,100 individuals/m^2), respectively.

Species lists with abundance figures for samples A1 (that is, site A habitat #1) and A2 are given in Table 1, with abundance and diversity data summarized for A1 and A2 in Table 2. When calculating overlap between these two samples, four species of the 41 present in A2 and none from A1 were omitted because of nonspecific identification. The resultant C_λ value was 0.54.

Samples from sites B and C were sorted to family level only and the relative abundance and diversity data on polychaete families for all six samples are presented in Figure 2. The overlap values for all possible combinations of the six samples (lowest taxa being families) were calculated (Fig. 3).

Discussion

Diversity and Abundance

Comparison of diversities (Fig. 2) revealed no clear pattern except that the sand #1 habitat collections showed greater variation in values of H' than did the solid #2 samples. This results directly from the large fluctuations between samples in relative abundance of polychaete families in the loose sand samples (Fig. 2).

For those samples sorted to species level, that is, A1 and A2, it is noted that species diversity of A2 ($H' = 2.85$, 41 species, 241 individuals) was slightly greater than that reported for Eastern Indian Ocean samples (Kohn and Lloyd, 1973a—Banjak Island, Indonesia, $H' = 2.55$, 32 species, 643 individuals). Sample A1 from

Table 1. Frequency of polychaete species in samples A1 (loose sand under rock, site A) and A2 (solid limestone, site A).

	Sample	
	A #1	A #2
Eunicidae		
Eunice (Palolo) siciliensis Grube, 1840	2	9
Eunice cincta (Kinberg, 1865)	1	—
Eunice ?australis Quatrefages, 1865	—	1
Lysidice collaris Grube, 1970	1	8
Nematonereis unicornis (Grube, 1840)	2	3
Marphysa ?corallina (Kinberg, 1865)	—	4
Eunicid sp. (?juvenile)	—	1
Lumbrinereid sp.	—	1
Nereidae		
Nereis trifasciata Grube, 1878	3	43
Nereis jacksoni Kinberg, 1866	—	2
Nereis sp. 1	—	13
Nereis sp. 2	—	1
Ceratonereis mirabilis Kinberg, 1866	—	13
Platynereis isolita Gravier, 1901	—	1
Glyceridae		
Goniadella sp.	—	1
Amphinomidae		
Pseudeurythoe sp.	4	1
Maldanidae		
Petaloproctus sp.	—	1
?*Axiothella* sp.	—	2
Micromaldane sp.	2	1
Terebellidae		
Trichobranchinae sp.	—	1
Polycirrinae sp.	1	—
?Pilargidae		
?Pilargid sp.	—	1
Chaetopteridae		
Chaetopterid sp.	—	6
Cirratulidae		
Dodecaceria sp.	—	1
Capitellidae		
Dasybranchus caducus Grube 1846	1	—
Pulliella sp.	1	—
Capitellid sp. 1	—	1
Capitellid sp. 2	—	1
Aphroditidae		
Thalenessa ?oculata (Peters, 1854)	1	—
Sigalioninae sp.	1	—
Syllidae		
Syllinae.		
Syllis (Syllis) amica Quatrefages, 1865	—	2
Syllis (Syllis) ?amica	2	46
Syllis (Typosyllis) armillaris (Müller, 1776)	—	4
Syllis (Typosyllis) vittata Grube, 1840	—	2
Syllis (Typosyllis) prolifera Krohn, 1852	1	—

Table 1. (continued)

	Sample	
	A #1	A #2
Syllis (Typosyllis) sp.	—	1
Syllis (Langerhansia) cornuta Rathke, 1843	2	11
Syllis (Langerhansia) ferrugina Langerhans, 1881	—	2
Syllis (Haplosyllis) spongicola Grube, 1855	—	24
?Trypanosyllis sp.	—	1
Opisthosyllis ?brunnea Langerhans, 1879	—	4
Exogoninae		
Brania rhopalophora (Ehlers, 1897)	1	12
Exogone verugera (Claparede, 1868)	—	1
?Pionosyllis sp. 1	—	1
?Pionosyllis sp. 2	—	4
?Pionosyllis sp. 3	—	1
?Sphaerosyllis sp. 1	—	1
?Sphaerosyllis sp. 2	—	2
unidentified Syllidae	—	2

Table 2. Abundance and diversity data for samples A1 and A2.
A1 — 1 liter sand/rubble from under dead coral rock.
A2 — $10 \times 7 \times 5\,cm^2$ smooth reef limestone with
a thin layer of algal-bound sand.

Sample	A1	A2
No. of species	16	41
No. of individuals	26	239
Density (no. liter^{-1})	26	683
Shannon diversity index (H')	2.65	2.85
Evenness (J)	0.96	0.77
First 3 species ranked in order of abundance with relative abundance as per cent of sample and no. of individuals in brackets.	*Pseudeurythoe* sp. 15.4% (4) *Nereis trifasciata* 11.5% (3) *Eunice siciliensis* 7.7% (2)	*Syllis ?amica* 19.2% (46) *Nereis trifasciata* 18.1% (43) *Syllis spongicola* 10.1% (24)
Percent of sample composed of first 3 ranks	34.6%	47.4%

sand under rocks contained only 16 species, although the species diversity ($H'=2.65$) did not differ greatly from A2, owing largely to the high evenness value ($J=0.96$) for A1.

The numerical dominance of the Syllidae in all samples is apparent in Figure 2. This result is consistent with samples from One Tree Reef, near Heron Reef (Hutchings, 1974) and from a number of widely distributed sites in the Indo-Pacific

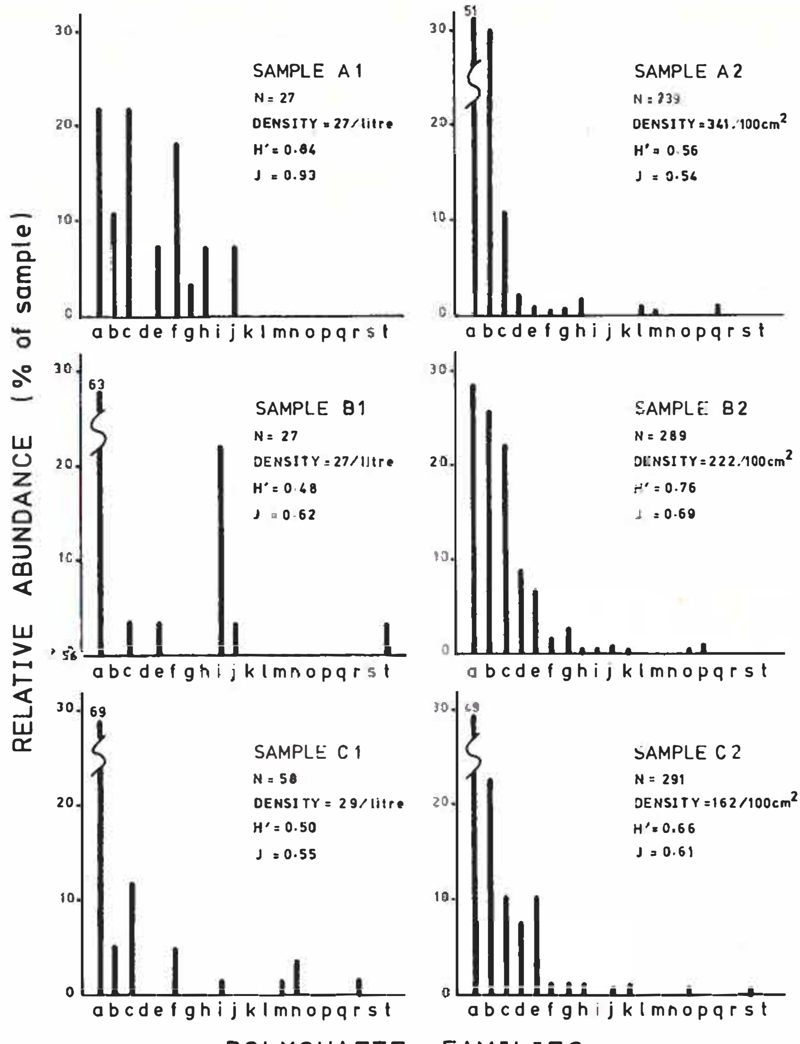

Fig. 2. Relative abundance of polychaete families for samples from loose sand under rock habitats (A1, B1 and C1) and solid limestone habitats (A2, B2 and C2). Families: a = Syllidae; b = Nereidae; c = Eunicidae; d = Chaetopteridae; e = Capitellidae; f = Amphinomidae; g = Terebellidae; h = Maldanidae; i = Palmyridae; j = Aphroditidae; k = Sabellidae; l = ?Pilargidae; m = Cirratulidae; n = Opheliidae; o = Scalibregmidae; p = Spionidae; q = Glyceridae; r = Phyllodocidae; s = ?Magelonidae; t = Alciopidae.

region (Kohn and Lloyd, 1973a; Kohn and White, 1977). The family Eunicidae was represented in all six Heron Reef samples also. As expected, the very small Syllidae are relatively more abundant in the loose sand habitat compared with the solid limestone samples although the overall polychaete density in the sand habitat is surprisingly low (approximately 28 individuals/liter). This could be a result of many factors (for example, more frequently disturbed and physically unstable substrata; low structural heterogeneity providing little refuge from predators).

A major difference between the One Tree polychaete assemblages (Hutchings, 1974) and Heron reef crest polychaetes is the relatively high abundance of Cirratulidae (present in 95 out of 100 samples) reported in the One Tree Reef samples whereas there were only 2 individuals present in a total of 931 polychaetes from the Heron reef crest samples. Hutchings (1974) mentioned an association between Cirratulidae and the presence of coralline algae. This association was reported earlier by Brander et al. (1971), although in a study of tubicolous polychaetes from the Hawaiian Islands, Bailey-Brock (1976) made no reference to such an association. The degree of cover by coralline algae was not assessed for the Heron Reef samples and this factor may account for the small number of cirratulids in the samples. Insufficient data preclude further speculation.

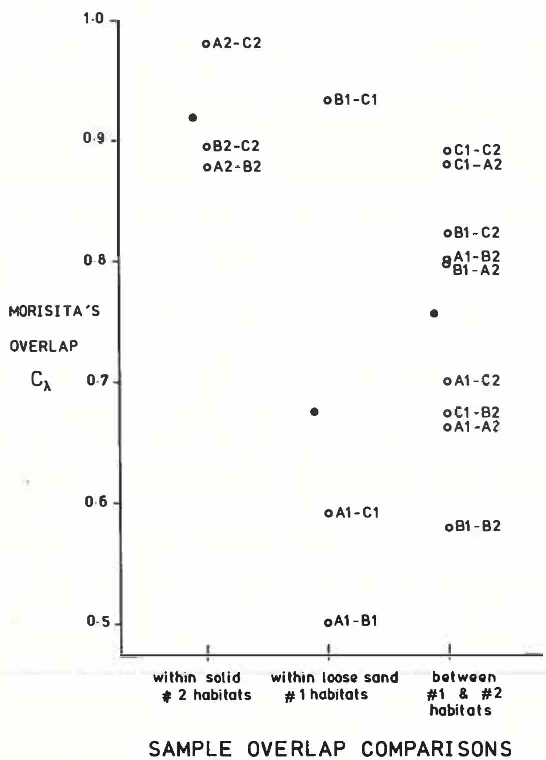

Fig. 3. Sample Overlap comparisons (with families as lowest taxa) of within and between habitats for loose sand under rocks #1 habitat and solid limestone #2 habitat, with sample pairs (circles) and means (solid dots).

Sample Overlap

The lack of constancy in the loose sand samples is apparent from the overlap data in Figure 3. Overlap between smooth limestone samples is consistently high, in contrast with the sand under rock samples which varied greatly in the degree to which they overlapped with each other. In the loose sand habitat, only Syllidae and Eunicidae occurred in all three samples. This contrasts markedly with the solid limestone samples which shared 8 families—Syllidae, Eunicidae, Nereidae, Chaetopteridae, Capitellidae, Amphinomidae, Terebellidae and Maldanidae.

The overlap between samples A1 and A2 ($C_\lambda = 0.54$) is much less than the overlap values obtained by Kohn and Lloyd (1973a) for three samples from a single station (Sanding Island, Indonesia) of a substratum type similar to A2. The overlaps between Kohn and Lloyd's three samples (at species level) were 0.93, 0.98 and 0.90. This led them to conclude that "populations of benthic polychaetes are highly predictable from place to place on a truncated reef limestone bench with a substrate of rather uniform appearance". The overlap data for solid limestone habitats on Heron reef crest (Figure 3) strongly support this suggestion (although in the present study, samples were compared at the family level). The opposite trend appears to be the case for the sand under rock habitats which seem to be highly unpredictable in composition from place to place on Heron reef crest.

Patchiness

On Heron reef crest the loose sand habitat is distributed as patches surrounded by algal/sand covered limestone and is likely to be more frequently disturbed by rough weather than the solid limestone habitat. Although the size and intensity of perturbations of the rocks covering the loose sand habitat is such that if the rock were moved the patch of sand would be destroyed, the time scale of such disturbances (*sensu* Connell and Slatyer, 1977) is unknown. The time scale is also likely to be variable for each patch since no two rocks are the same size, shape and weight. Consequently it is impossible to speculate on the degree to which the loose sand polychaetes are represented by recent adult immigrants from surrounding solid limestone areas rather than by worms recruited as larvae or juveniles to that patch.

Comparison of relative abundance of polychaete families (Fig. 2) indicates that the loose sand polychaete fauna has no large component which is distinct from that of the solid limestone habitat with the possible exception of the Amphinomidae and Palmyridae, relatively much more abundant in the loose sand habitat. The sedentary, tubicolous polychaetes are significantly fewer in the loose sand samples [2 × 2 Contingency Table, $\chi^2 = 4.94$, $p(\chi^2) = 0.026$], with Chaetopteridae absent from all three samples of loose sand habitat.

The low overlaps between the loose sand samples (Fig. 3) indicate that the polychaete fauna from one patch is less likely to be highly similar to that of another, compared with the polychaetes in solid limestone habitat samples. Patchy distribution of loose sand habitat and concomitant patchiness of the polychaete fauna of these habitats has potential consequences for any worm-eating predator. Important factors include the preferred foraging space of the predator, the mobility and size of the predator and the predator's preferred prey species (e.g. Emlen, 1973; Oaten, 1977). Of the two families present in all six samples, Syllidae and Eunicidae, the relatively much larger Eunicidae form a significant component of the diet of a number of neogastropod prosobranch molluscs (Kohn and Nybakken, 1975; Taylor, 1978) and some fishes (Vivien and Peyrot-Clausade, 1974). There are few data on sources of predation on Syllidae. There is evidence that the larger-ambit polychaetes (*sensu* Jumars, 1975) emerge from the substratum nocturnally (Vivien and Peyrot-Clausade, 1974; Alldredge and King, 1977) and this would reduce the effect that daytime habitat differences in polychaete distribution would have on nocturnal predators.

Zoogeography

The numerically predominant infaunal polychaete species on Heron reef crest (*Syllis ?amica, Nereis trifasciata* and *Syllis spongicola*) are different from those reported for Eastern Indian Ocean reefs, with the exception of *Syllis spongicola* which was the most abundant polychaete in a sample from Thailand (Kohn and Lloyd, 1973a). The predominant polychaetes from an intertidal limestone bench in Guam also differed from those on Heron reef (Kohn and White, 1977). However in all three areas, East Indian Ocean, Guam and Heron Reef, Syllidae feature prominantly in the three most abundant polychaete species from solid limestone habitats. Although differences exist in the dominant polychaete species of these areas, the Heron Reef samples have a number of species in common with other Indian and Pacific Ocean areas. These are as follows: 15 species—East Indian Ocean (Kohn and Lloyd, 1973a); 8 species—Guam (Kohn and White, 1977); 9 species—Solomon Islands (Gibbs, 1971); 10 species—Easter Island (Kohn and Lloyd, 1973b).

Although larger samples sizes are required to make a detailed analysis of zoogeographic affinities, the Heron reef crest data support Kohn and Lloyd's prediction that many species of polychaetes are probably more widely distributed than is evident from presently available data. For example, *Brania rhopalophora* (Syllidae) and *Syllis (Langerhansia) ferrugina* (Syllidae) were both present in sample A2. Previously, *B. rhopalophora* was reported by Kohn and Lloyd (1973a) as being then known only from high latitude, southern oceans and from their Indian Ocean sites. The distribution of *Syllis (L) ferrugina* was recorded by Day (1967) as "Atlantic from North Carolina and Ireland .... to Angola ...". The occurrence of these two species at Easter Island (Kohn and Lloyd, 1973b) and in the present study at Heron reef considerably extends their known distribution, supporting Kohn and Lloyd's prediction.

Acknowledgments

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