APPENDICES

Appendix 1

Phang, S. M., 1995. Distribution & abundance of marine algae on the coral reef flats at Cape Rachado, Port Dickson, Peninsular Malaysia. *Malaysian Journal of Science* 16A: 23-32

Phang, S. M., 1988. The effect of siltation on algal biomass production at a fringing coral reef flat, Port Dickson, Peninsular Malaysia. *Wallaceana* 51: 3-5

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bution and abundance of marine algae on the coral reef flats pe Rachado, Port Dickson, Peninsular Malaysia

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CT The species distribution and abundance of marine
d on three fringing coral reef flats at Cape Rachado, Port
on the west coast of Peninsular Malaysia) were investi-
sing line-transect and quadrat-sampling methods. Data
ver twelve months on the species composition, distribu-
omass are discussed in relation to environmental factors.
species were recorded, the dominant belonging to
, *Turbinaria* and *Padina*. Highest biomass (67, 103, 95
tes A, B and C) occurred during the inter-monsoon period,
ugust and March. Biomass and the total number of spe-
sed towards the reef edge. High levels of total suspended
g exposure periods, rainfall and strong wave action
ed biomass production. Site A, the most silted area had the
mass whereas Site B, the area most exposed to human
ce, had the highest.

K Kepelbagaian spesies alga marin di tiga sempadan
rumbu karang di Cape Rachado, Port Dickson (di pantai
enanjung Malaysia) telah dikaji dengan menggunakan
arisan transek dan persampelan kuadrat. Data yang
kan dalam jangka masa dua belas bulan bagi komposisi
aburan dan biojisim telah dibincangkan dan dikaitkan
ktor-faktor persekitaran. Enam puluh sembilan spesies
tat; kebanyakannya ialah *Sargassum*, *Turbinaria* dan
iojisim yang tertinggi (67, 103 dan 95 g m^{-2} untuk Kawasan
C) didapati di musim antara monsoon Ogos dan Mac.
dan jumlah spesies bertambah berdekatan tepi terumbu.
an jumlah pepejal terampai yang tinggi, masa terdedah
jang, hujan dan kesan ombak yang kuat mengurangkan
an biojisim. Kawasan A, di mana terdapat kelodak yang
anyak, mempunyai biojisim yang terendah manakala
B, yang paling banyak terdedah kepada gangguan manusia,
ai biojisim yang tertinggi.

lgae, coral reefs, biomass, environment)

INTRODUCTION

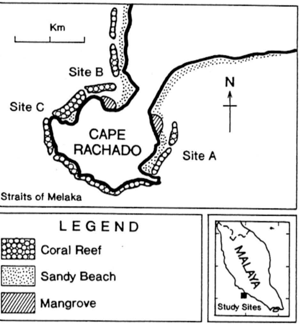
ian coral reefs have been little studied and early
consisted mainly of taxonomic enumerations of
ecies found in Sabah [1-3], Pulau Redang [4],
Paya [5] and the other islands of Peninsular
ia [6-8]. The most recent reports dating back
han ten years describe the coral community
re of the fringing coral reef [9] at Cape Rachado,
ckson, and its epiphytic algae [10].

The distribution and ecology of marine algae of Peninsular Malaysia [4,10-16] and Sabah [17] have been documented in several reports. Physiological and biochemical studies have also been conducted on selected species of marine algae [18-20], and environmental factors such as light, temperature, nutrients and photoperiod have been shown to control both reproduction and vegetative growth in these algae [21]. The studies also confirmed that seasonal behaviour in other temperate algal species are more marked compared with those of the tropics. However, other observations [22] showed that the macro class of algae, i.e., the seaweeds, that grow on the rocks and coral reefs in Townsville, Australia, exhibit somewhat marked seasonal patterns in growth and reproduction. For this particular tropical locality, the patterns could be attributed to both temporal differences and variations in habitats.

Cape Rachado in Port Dickson (on the west coast of Peninsular Malaysia) is a segment of a stretch of beach that has been earmarked for the construction of tourist resorts. Such construction would, unfortunately, adversely change its coral reef formation. This paper documents the species distribution and biomass (dry weight) estimates of the marine algae found on three fringing coral reef flats, and discusses the effects of silt content in the water, exposure period, wave action and temperature and seasonal growth patterns on the algal distribution and abundance.

MATERIALS AND METHODS

Study site Cape Rachado faces the Straits of Melaka and the fringing coral reef flats (Fig. 1) extend out for about 50 m; beyond this distance, they gently slope towards the reef edge. Here, they slope off to a depth of about 8 m [9]. Three sites were selected for the study. Site A has a reef flat extending to a maximum of about 140 m to the reef edge and is about 200 m wide. The mangroves to the right of the seafront had been partially removed during the construction of a condominium in 1985-1986. The destruction had resulted in heavy



ure 1. Map of study sites at Cape Rachado, west coast Peninsular laysia.

ting over the coral reef, causing damage to the coral d marine algal communities. Site B stretches to a ximum of about 110 m out to sea and is about 350 m de. This area is popular for picnicking. The bay is rdered by a small stand of mangroves on the left and ocky shore on the right. Site C is the least exposed to man disturbance as the sea is rather deep. The maxi- um length is about 110 m and it is about 300 m wide. e bay here is surrounded by a rocky shore.

If the tide level is about 0.3 m or less, three-quarters the reef flats are exposed. At less than 0.1 m above art datum, the reef flats are completely exposed. The efs were exposed 27 times during the sampling period. extremely low tides, the reef flats are exposed for ore than three hours. Tides are at their lowest level ound August and between February and March.

An earlier study [9] in 1987 found that the nitrate els along the coast at Port Dickson ranged from 2.17 6.27 µg L^{-1}, ammonia levels between 3.92 to 6.49 L^{-1} and phosphate levels between 0.75 and 17.91 L^{-1}. Light penetration ranged between 2 m and 7 m as easured with a Secchi disk.

mpling procedure The study period was from May 87 to March 1988; sampling was carried out in May, gust and November 1987, and March 1988 during the lowest spring tide of the particular month. The beginning of the reef flats that is parallel to the shoreline was regarded as being the baseline for the measurements. Line transects were then laid at intervals of 40 m at Site A (seven) and Site B (four), and at intervals of 60 m at Site C (four). The line transects traversed the flats and were perpendicular to the baseline. Along each transect, poles were marked as stations at 10-m intervals; samplings were carried out in 0.09 m^2 quadrats. The algal material within each quadrat was collected and placed in plastic bags to be brought back to the laboratory and sorted according to species. The dry weight of the total biomass of each quadrat was determined. Dry weights were recorded only on those species that were abundant. Each species was assigned a proportion number, N, according to its percentage of the total wet biomass (Table 1). The proportion numbers were used in calculating the Diversity Index.

Table 1. Distribution of biomass.

Percentage of biomass (%)	N
0 - 10	1
11 - 20	2
21 - 30	3
31 - 40	4
41 - 50	5
51 - 60	6
61 - 70	7
71 - 80	8
81 - 90	9
91 - 100	10

Data processing The algal material was dried at 100°C for 72 hours in the *in situ* determination of biomass, but this method would exclude losses arising from detachment and grazing [24]. An Orion pH meter was used to measure the acidity. Dissolved oxygen levels were determined by the Winkler Method. Salinity (measured by a hand refractometer), temperature and the level of total suspended solids (TSS) were determined at each sampling time. The total suspended solids content was determined by filtering a fixed volume of sample onto a preweighed glass fibre filter, and dried to constant weight at 100°C. The acidity and salinity were determined at every quadrat and water samples from every

ere collected for TSS determination.
tal biomass (dry weight) was calculated in
s for each quadrat. Less quadrats were exam-
g high water levels (in November).
umber of species in a quadrat was counted
the Shannon-Weiner Diversity Index, H was
l from standard procedures [25]: H = - Σp_i log
s = number of species and pi = proportion of
n the quadrat. The Evenness Index, J, is H/log
rensen's Quotient of Similarity, S, of the three
given by S = [2C/(A+B)], where A = number
in Site A, B = number of species in Site B, and
er of species in the two sites being compared.
equencies (F) of each species in the transects
sites were calculated by dividing the number
ts in which a species was found by the total
f quadrats. The dominance of each species, in
he ratio of the abundance of the species to the
e of all species in the quadrat, was calculated
data of the March 1988 sample, which was
esentative.

RESULTS

composition and distribution

ie species were recorded in the three sites
2 and 3). The three sites displayed similar
tions, as suggested by the Sorensen's Quotient;
somewhat more similar to Site C (Table 4).
e seaweeds found in the three sites, the brown
aeophyta (*Sargassum*, *Turbinaria* and *Padina*)
st abundant. The red algae Rhodophyta (*Pte-*
caerulescens) were less abundant, but they had
st number of species. Table 5 gives the more
species at the four sampling times. *Lobophora*
a was the third most common species. With the
iyta family, *Udotea javensis*, *Struvea anastomosans* and *Cladophora vagabunda* were the most common species; however, *Turbinaria* sp. 1, *Valonia* sp., *Udotea flabellum*, *Herposiphonia*, *Gelidium* sp. 3, *Tolypiocladia glomerulata*, *Lyngbya majuscula*, *Caulerpa serrulata* and *Caulerpa taxifolia* were only found at Site A, and *Enteromorpha intestinalis*, *Cladophora* sp. 2, *Gelidium* sp. 2, *Galaxaura* sp., *Gelidiella bonetii* only at Site B, and *Hormophysa triquetra*, *Acetabularia* sp., *Laurencia* sp. 3 and *Hydroclathrus clathratus* only at Site C.

Number of species belonging to the different divisions in
ites.

No. es	Phaeophyta	Chlorophyta	Rhodophyta	Cyanophyta
	12	15	22	2
)	14	10	26	0
	18	8	19	0
	19	18	30	2

The number of species increased away from the shore (Fig. 2), decreasing somewhat at the edge of the reef. The lowest number of species per quadrat in Site A was unity (August and November) and the highest 16 (March). For Site B, this was again unity (all months except March) and 14 (March), whereas for Site C, this was 2 (August) and 12 (March). March appeared to have provided more suitable conditions for the growth of a diverse algal community than November, during which month rain storms were frequent.

Shannon-Weiner Diversity Index

The Diversity Indices suggest trends similar to those of species number, both values increasing seawards (Fig. 2). The indices for the three sites were lower nearer the shore, but increased from the middle of the flat (around quadrat 6 to 10) to near the reef edge. Site B had the highest diversity indices, the maximum being 1.29 (March) compared with 1.12 in Site A (March) and 1.05 in Site C (March).

Dominance

Dominance was calculated for the three sites from March 1988 (Table 6) and for each station/quadrat, from the baseline to the reef edge. At Site A, *Gracilaria salicornia* was co-dominant with *Acanthophora* sp. from quadrats 1 to 2 whereas *Caulerpa racemosa*, and *Caulerpa serrulata* were co-dominant at quadrats 2 and 3. The dominant species were *Ceratodictyon* sp. and Sargassum oligocystum in quadrats 5 to 7 but nearer the edge (from quadrats 8 to 13), *Sargassum oligocystum* was also co-dominant with *Sargassum baccularia*.

At Site B, *Sargassum oligocystum* was dominant from quadrats 1 to 11, with *Ceratodictyon* being co-dominant at quadrat 1 and *Turbinaria conoides* co-dominant from quadrats 9 to 11. *Sargassum siliquosum*, which was absent from the first few quadrats, was dominant in quadrats 9 and 10.

At Site C, *Sargassum oligocystum* and *Turbinaria*

ble 3. List of algae recorded in the sites.

HAEOPHYTA
rgassum oligocystum Montagne
rgassum baccularia (Mertens) C. Agardh
rgassum siliquosum J. Agardh
rgassum sp.1
rgassum sp.2
adina commersonii Bory de Saint-Vincent
adina tetrastromatica Hauck
rbinaria conoides (J.Agardh) Kutzing
rbinaria ornata (Turner) J. Agardh
rbinaria sp.1
erocladia caerulescens (Kutzing) Santelices
ictyota bartayresi Lamouroux
ictyota dichotoma (Hudson) Lamouroux
ictyota ceylanica Kutzing
ictyota cervicornis Kutzing
obophora variegata (Lamouroux) Womersley
ormophysa triquetra C.Agardh
ydroclathrus clathratus (Bory de Saint Vincent) Howe
ctocarpus

HLOROPHYTA
dotea javensis (Montagne) A. & E.S. Gepp
dotea flabellum (Ellis & Sonder) Howe
haetomorpha linum (Muller) Kutzing
ladophora fascicularis (Mertz) Kutzing
ladophora prolifera (Roth) Kutzing
ladophora sp.1
ladophora sp.2
nteromorpha intestinalis (Linnaeus) Nees
nteromorpha clathrata (Roth) Greville
alonia aegagropila C. Agardh
alonia sp.1
ruvea anastomosans (Harvey) Piccone & Grunow ex Piccone
ictyosphaeria
cetabularia
aulerpa racemosa (Forsskal) J. Agardh
aulerpa serrulata (Forsskal) J. Agardh
aulerpa verticillata J. Agardh
aulerpa taxifolia (Vahl) C. Agardh

HODOPHYTA
urencia sp.1 (cf. *concreta* Cribb)
urencia sp.2
urencia sp.3
racilaria salicornia (C. Agardh) Dawson
racilaria sp.1
pnea sp.1
pnea sp.2
pnea sp.3 (cf. *esperi* Bory de Saint-Vincent)
lysiphonia
eterosiphonia
ampia parvula (C. Agardh) Harvey
ramium
ratodictyon spongiosum Zanardini
phiroa fragillissima (Linnaeus) Lamouroux
phiroa foliacea Lamouroux
nia reubens (Linnaeus) Lamouroux
Leveillea jungermanniodes (Hering & Martens) Harvey
Centroceras
Herposiphonia
Gelidiella acerosa (Forsskal) Feldmann & Hamel
Gelidiella bornetii (Weber-van Bosse) Feldmann & Hamel
Gelidiella sp.1
Gelidium sp.1
Gelidium sp.2
Gelidium sp.3
Acanthophora spicifera (Vahl) Boergesen
Acanthophora orientalis J. Agardh
Galaxaura (cf. *filamentosa* Chou)
Tolypiocladia glomerulata (C. Agardh) Schmitz
Erythrotrichia

CYANOPHYTA
Lyngbya majuscula Harvey
Nostoc

Table 4. Sorensen's Quotient of Similarity (S)% for all sites (March 1988).

Site	A	B	C
A	100		
B	74	100	
C	68	79	100

conoides were co-dominant from quadrats 1 to 10, but at quadrat 11, *Sargassum siliquosum* was again abundant and co-dominant with *Sargassum baccularia*.

Faunal communities

At the three sites, the coral community was dominated by the hermatypic scleractinians. At least three species of alcyonaceans (soft corals) were found from the middle of the reef flats to the edge. Nearer the shore, species of *Porites* dominated whereas in the middle, *Goniastrea* and *Goniopora* dominated.

Large coral formations were observed at Site A, where the sediment load was highest near the shore; however, the polyps that were directly exposed to the sediments had been destroyed, although the polyps at the vertical planes of the corals were still alive. At Site B, *Porites enidari* Umbgrove that dominanted in the first few quadrats had been trampled on by people. At Site C, *Porites lutea* Milne Edwards developed branches and ramose forms, probably as an adaptation to the stress of sedimentation. Although the reef edge had a live coral cover of 60%, the reef flat had a live coral cover of only 27%.

ble 5. Average frequencies (%) of the most commonly occurring species for all sites at all sampling times.

ite	May 1987	August 1987	November 1987	March 1988
A	*Padina commersonii* (59%)	*Sargassum oligocystum* (58%)	*P. commersonii* (35%)	*P. commersonii* (50%)
	S. oligocystum (55%)	*P. commersonii* (56%)	*Pterocladia caerulescens* (28%)	*S. oligocystum* (48%)
	Lobophora variegata (45%)	*S. baccularia* (38%)	*L. variegata* (25%)	*S. baccularia* (48%)
	S.baccularia (37%)	*Turbinaria conoides* (36%)	*Udotea javensis* (25%)	*Pterocladia caerulescens* (41%)
B	*S. oligocystum* (75%)	*S. oligocystum* (82%)	*P. commersonii* (72%)	*S. oligocystum* (85%)
	T. conoides (67%)	*T. conoides* (68%)	*T. conoides* (62%)	*Champia parvula* (84%)
	L. variegata (48%)	*P. commersonii* (53%)	*S. oligocystum* (61%)	*T. conoides* (77%)
	P. commersonii (43%)	*S. baccularia* (52%)	*Gelidiella acerosa* (53%)	*Hypnea* sp.3 (77%)
C	*S. oligocystum* (91%)	*S. oligocystum* (93%)	*S. oligocystum* (87%)	*S. oligocystum* (87%)
	P. commersonii (84%)	*T.conoides* (83%)	*P. commersonii* (81%)	*T. conoides* (83%)
	T. conoides (56%)	*Amphiroa fragillisima* (63%)	*T. conoides* (61%)	*P. commersonii* (63%)
	Laurencia sp.2 (42%)	*Pterocladia caerulescens* (60%)	*G. acerosa* (50%)	*L. variegata* (62%)

orals (*Sarcophyton ehrenbergi* Von Maren-
bophytum crassum Von Marenzeller and *Lo-
n pauciflorum*) were common from the mid-
reef flat to the edge.

al species of coral fish were encountered, many
probably fed directly on the macroalgae as well
turf algae. Two species of sea cucumber,
ia sp. and *Stichopus* sp. were observed in the
s, being most abundant in the cleaner waters of

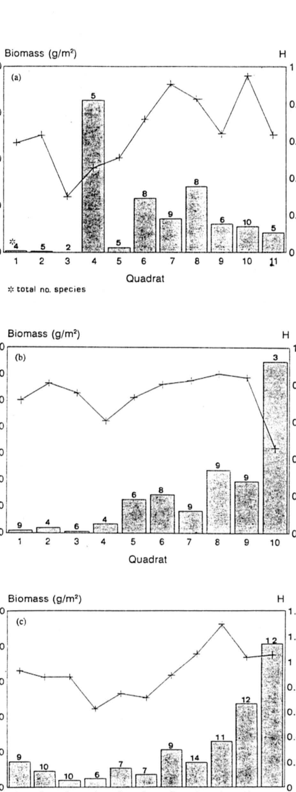
mental conditions and abundance

ists the average biomass (standing crop) of the
s at the various sampling times. The biomass
m of 103 g m^{-2}) is low.

st (1987) and March (1988) were the two peri-
oundant biomass production; the latter month
maximum yield for the three sites. July 1987

Table 6. Dominance of the marine algae at the three study sites.

	Site A	Site B	Site C
Dominant species	*Sargassum oligocystum* (18.2%)	*S. oligocystum* (21.6%)	*S. oligocystum* (28.3%)
Co-dominant species	*Sargassum baccularia* (9.3%) *Ceratodictyon* (8.0%)	*Turbinaria conoides* (13.8%)	*Turbinaria conoides* (24.7%)
Sub-dominant species	*Udotea javensis* (0.8%) *Laurencia* (0.8%)	*Gracilaria salicornia* (0.2%) *Udotea javensis* (0.9%)	*Acanthophora spicifera* (1.0%)



ure 2. Biomass (g/m²) and Shannon-Weiner Diversity Index) for

Transect A at Site A, March 1988;

Transect L at Site B, March 1988; and

Transect Q at Site C, March 1988.

Table 7. Average algal biomass (g m²) of all sites at all sampling times.

Date	Site A	Site B	Site C
May 1987	16.9 ± 9.7	39.1 ± 25.1	32.1 ± 2.3
August 1987	41.2 ± 13.5	83.8 ± 31.2	73.4 ± 5.4
November 1987	28.1 ± 17.8	43.4 ± 21.8	32.2 ± 11.4
March 1988	66.6 ± 44.3	103.5 ± 29.7	95.2 ± 32.7

Table 8. Range of the physical-chemical parameters measured in the study sites.

	Site A	Site B	Site C
pH	8.10 - 8.50	8.10-8.50	8.00 - 8.65
salinity ppm	29.0 - 34.0	29.0-33.0	30.0 - 33.0
*temperature C	30.5 - 31.5	30.5-31.0	30.5 - 31.0
*D.O. ppm	7.30 - 8.60	6.40-8.90	7.35 - 8.40
TSS ppm	17.2 - 1502.1	14.3-108.4	7.6 - 100.8

(* : taken at noon, time of sampling)

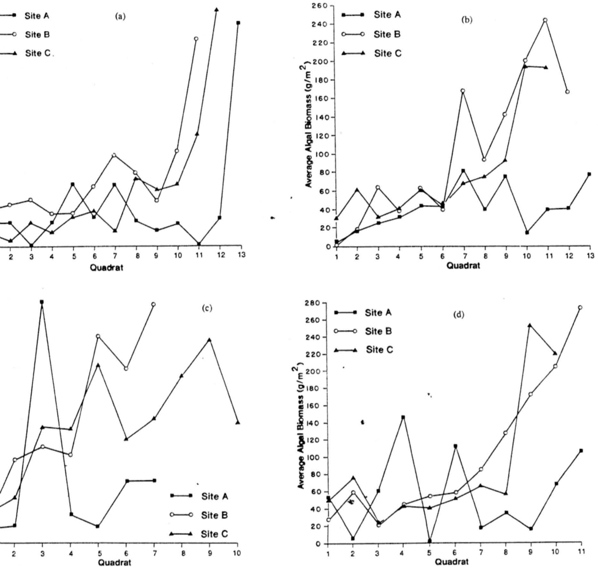
(mean maximum air temperature of 31.5°C) and February 1988 (mean maximum air temperature of 32.5°C) 1988 were hot and dry months. July 1987 and February 1988 had rainfalls of 130.5 mm and 157.4 mm; August 1987 and March 1988 had averages of 227.4 mm and 273.3 mm. A hot dry period preceding a wetter period appeared to have enhanced biomass production. Site B had the highest biomass. Biomass at the three sites increased away from the shoreline (Fig. 3).

The acidity, salinity, temperature, dissolved oxygen and TSS values taken during the sampling times (Table 8) showed no significant trends.

DISCUSSION

The coral reefs at Cape Rachado have a *Sargassum-Turbinaria* community whose flora is dominated by *Sargassum oligocystum*, *S. baccularia*, *Turbinaria conoides* and *Padina commersonii*. The literature also reports that *Sargassum* spp. were the dominant algae on reef flats at Pulau Bidong Laut [14] and Magnetic Island, Australia [26].

The level of TSS of the reefs points to the high level of pollution. The reefs were completely exposed for about 27 times a year. These two factors probably limited the species that could grow here. *Sargassum*, *Turbinaria* and *Padina*, being physically large and



Average algal biomass (g/m²) in quadrats from the land (quadrat 1) to the reef edge (a) May 1987, (b) August 1987, (c) November March 1988.

thrived because they could grow above the silt. es in quadrats nearer to shore included *phora* sp., *Enteromorpha* sp., *Lyngbya* sp., sp., *Valonia* sp., *Ceratodictyon* sp., *Udotea* *Udotea flabellum* and *Gracilaria salicornia*, presence of the first two in heavily silted s suggested their tolerance of high sediment he water. *Sargassum siliquosum*, *Sargassum* *ia* and *Amphiroa foliacea* were found mainly e reef edge. Species found throughout the reef *S. oligocystum*, *P. commersonii*, *T. conoides* *phora variegata*. *Lobophora variegata*, which encrusts over the dead coral surfaces, was dominant because of its tolerance to dessication and wave force [28]. *Acanthophora* and *Enteromorpha* were also found nearer the shore on the reef flat at Pulau Bidong Laut [14]. However, all algal species were distributed randomly on a rocky shore on Penang island [11]. The apparent zonation observed in the present study can be attributed to sediment load. *Gracilaria salicornia* was more abundant near the baseline possibly because of its ability to withstand the higher sediment load and longer exposure periods.

The most common of the 16 epiphytic algae belonged to the Rhodophyta (*Champia parvula* and *Polysiphonia*), followed by *Cladophora fascicularis*. The hosts were mainly *Sargassum* and *Turbinaria*. These epiphytes were found throughout the reef flat but were more common in the middle. High sediment loads and strong wave action at the reef edge probably contributed to the establishment of epiphytic communities. The epiphytes in the three sampling sites were most abundant in March [29]. Their pattern of growth paralleled that of their hosts, as observed previously [30]. Cape Rachado has a salinity that lies at the lower end of the range [31] of Shark Bay, Australia, which would explain its richness of species. *Leveillea jungermanniodes* and *Tolypiocladia glomerulata*, which are typically found at low salinity levels, were however relatively common. Many of the epiphytes, particularly *Polysiphonia* and *Champia*, were fertile during March, at which time biomass abundance peaked [29].

Algae did not grow in those quadrats dominated by the soft corals which secrete defense chemicals that inhibit the growth of other organisms. Their spicules [32] would also prevent other moving organisms from encroaching.

There were more species towards the edge of the reef as there was less sediment load but at the edge, the number decreased owing to strong wave action.

Gracilaria salicornia, *S. oligocystum* and *Ceratodictyon* sp. dominated the heavily sedimented areas whereas *S. siliquosum* and *S. baccularia* preferred the cleaner waters near the reef edge. Quadrats in the major part of the reef flats had several co-dominant species but near the edge, only one species was more dominant.

The seaweeds were physically smaller nearer the shore; *Sargassum baccularia*, *Turbinaria conoides* and *Padina* found here were damaged. These consisted largely of holdfasts and stipes with missing fronds; on the other hand, larger complete seaweeds were found near the edge. The difference in appearance was more marked at Site B owing to more frequent human disturbance.

Shorter exposure periods from the middle to the edge would decrease sediment load and improve biomass production. Wave action, detrimental to biomass production of *Gracilaria verrucosa* [36], could account for the decreased biomass at the reef edge. This trend was also noted in studies of algae on a rocky shore in Singapore [33], and on corals at Eilat, Red Sea [34,35]. In this study, trends in biomass production from one side of the reef area to the other were not evident.

The TSS contents were significantly different for th three sites, with Site A (51 species) having the highes sediment load and Site C (45 species) the lowest. Al though living organisms would be smothered by sediments that block out sunlight, the algae at Cape Racha do apparently tolerated the high sediment load, growing well even at a TSS of 100 ppm (Site B). A valu above 100 ppm was reflected in decreased biomas production (Site A). Biomass production at Site B exceeded that at Site C as frequent trampling by humans, which would stir up nutrients, stimulated th growth of the algae. The acidity and salinity did not vary significantly in the sites at the various sampling times Other reports [36,37] suggested that salinity did no contribute to the distribution and biomass production o *Gracilaria* species.

The algal biomass in the sites peaked around Augus and March; these months correspond to the hot and dr inter-monsoon periods. Such conditions favour biomass production [38]. In Guam, *Sargassum* (except *S* *cristaefolium*) attains maximum growth during th warmer months in the temperate areas and during th colder months in the tropical and sub-tropical areas However, in Puerto Penasco, Mexico, *Sargassum* ha higher growth rates from October to March (the coldes part of the year), peaking in spring. Since peak abundance [39] coincides with peak fertility [27], the *Sargassum* species in Puerto Penasco peak in spring so a to avoid reproducing during the seasonal extremes. I the tropics, most *Sargassum* species grow most abundantly in the cooler months (from November to March [27,40,41], whereas *S. siliquosum* and *S. paniculatur* grow well in the warmer months (from July to August In the Philippines, the growth was the least in the colde months. The species were fertile at the end of the rapid growth period, about one month after the plants ha reached maximum growth. Another study [42] ha claimed good correlations between maximum plan growth and high water-phosphate content, and betwee growth rate and daylight hours. Lower seawater temperatures have been suggested to initiate the onset o fertility; lower temperatures bring about a decline i standing crop but they contribute towards embryo growt and development [27]. Another study on algal succession patterns on the rocky shore on Penang island [13 showed that maximum biomass production was obtained in the hot dry inter-monsoon period (from January to April), but rainstorms caused scanty growth Strong wave action and high rainfall during the mon

sulted in low standing crop of *Gracilaria* in the
ines [36]. In the present study, heavy rains and
waves during the monsoons (especially in No-
) resulted in low biomass; the end of the mon-
was followed by a period of active growth.
ations of the microclimatic conditions showed a
ot and dry spell at the end of the monsoon period
ich time biomass peaked. Growth rates would
een highest during the warm period following the
Polysiphonia and *Champia* were most abundant
March. Biomass nearer to the shore was lower
at nearer the reef edge, possibly arising from the
of the longer duration of exposure at low tides,
gh the total biomass of the reef flat was not
d.

minor differences in temperature and light in-
es between monsoons and inter-monsoon periods
ly gave rise to the observed patterns of growth
production of all algae. For the epiphytic species,
aximum points of biomass and of fertility were
ed that could be attributed to abrupt changes in
croclimate.

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HE EFFECT OF SILTATION ON ALGAL OMASS PRODUCTION AT A FRINGING CORAL REEF FLAT, PORT DICKSON, PENINSULAR MALAYSIA.

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ODUCTION

narine environment in Malaysia is threatened rious pollutants arising from both land-based es and from the heavy traffic in its waters. The pollutants include silt in the form of terrestial al sediment, oil, pesticides and detergents g *et al.*, 1987). Silt comes from both inland opment schemes and construction along the line. Damage to coral reefs at Pulau Tioman e east coast has been reported as being at- ed to sedimentation and the use of explosives hing (De Silva *et at.*, 1984). On the west coast, er land development activities result in higher nent loads being brought by the rivers into the ts of Melaka. Sheltered by Sumatra, the sedi- ation problem is enhanced. Much of the corals nd Pulau Besar, Melaka are dead or dying, red by a layer of silt (Phang *et al.*, 1987). ck of light and excessive sediment deposition are factors which limit but not prohibit coral development (Roy & Smith, 1971). Many coral ies have cleaning mechanisms to remove the ments. Species of *Favia, Fungia* and *Porites* been shown to survive in water containing 800 of suspended mud (Marshall & Orr, 1931). High ment loads were observed to control species per, diversity and cover of both coral and roalgal communities on a fringing reef flat at netic Island, Australia (Morrissey, 1980). The tioned parameters increased seawards across eef flat as emersion, sedimentation and water ement decreased.

HOD

e Rachado at Port Dickson, has fringing coral s extending almost all around it. The study site fringing reef flat in the bay on the east of the e. It extends to a maximum of 140m to the reef e. To the right was a stand of mangroves domi- d by species of *Rhizophora*. Construction of a dominium complex at the beach just behind the groves started in 1985 and was completed in . The land which slopes down to the sea was red and a major portion of the mangroves were red for 'aesthetic' reasons. This resulted in an essive amount of silt being washed into the l reef.

Sargassum spp. are the dominant algae on the heavily sedimented reefs at Cape Rachado.

Biomass estimations of the marine algae growing on the coral reef flats around Cape Rachado were carried out in March 1986, and from May 1987 to March 1988. Only results from this particular site and for three sampling periods are discussed. The sampling periods were March 1986, August 1987 and March 1988. They correspond to the early part of the construction, the end and about 7 months after completion of the complex respectively.

Line transects were laid perpendicular to a baseline which ran parallel to the shore at the start of the reef fiat. Seven transects at intervals of 40m were used each time. 0.3 m^2 quadrats were placed at 10 m intervals along the transects and all algal material within the quadrats were collected as far as possible, and brought back to the laboratory for sorting. This was done according to species, but only the total dry weight of each quadrat was determined. This was done by drying the algae at 100°C for 72 hours. Many species were too small for individual dry weights to be assessed. However, each species was assigned a proportion number according to its percentage of the total wet biomass in the quadrat as follows:

centage al biomass	Proportion Number
— 10	1
— 20	2
— 30	3
— 40	4
— 50	5
— 60	6
— 70	7
— 80	8
— 90	9
— 100	10

mbers were used for calculating the Shan-
ver Diversity Index (Shannon & Weaver,

S AND DISCUSSION

gives the average pH, salinity and total
ed solids (TSS) content and the average
mass (g/m²) for the different sampling
ere were no significant differences in pH
y. In March 1986, after construction had
ced, the TSS ranged from 17 to 150 mg/l.
he highest TSS determined was 1530 mg/l
drat 60 m from the baseline. In 1988, the
reased, ranging from 40 to 107 mg/l. Ave-
mass of the algae was observed to be in-
proportional to the TSS content, being
(80 g/m²) in 1986 and lowest (32 g/m²) in
ncreased again in 1988 (67 g/m²) following
ease in TSS content.

2 shows the total number of species per
S), the Shannon Weaver Diversity Index (H)
Eveness Index (J) for selected transects
e three sampling periods. The Shannon
Index did not change significantly for the
sampling periods. This may be because
the species inhabiting this reef are tolerant
sediment loads and were able to survive
n in decreased abundance. The index also
d the same trend as the total number of
per quadrat, both increasing towards the
ge but decreasing slightly at the edge.
sediment loads and longer exposure pe-
ear shore and stronger wave action at the
re possible reasons for this trend. The
highest number of species per quadrat encountered in 1986 was 13, in 1987 was 10, and in 1988 was 16.

The dominant species on this reef belong to *Sargassum, Turbinaria* and *Padina*. Having a much dissected thallus and being flexible in the water probably help to prevent these plants being smothered by the sediments. *Udotea javensis, Dictyota* spp., *Gracilaria salicornia* and *Pterocladia* were also frequently observed in the reef flat.

There were no significant difference in the most frequently occurring species between the sampling periods. *Sargassum binderi, Padina commersoni* and *Turbinaria conoides* were most frequently occurring at all times. *Avrainvillea* sp., *Leveillea junggermanniodes* and *Microdictyon* sp. which were observed in March 1986 were not observed again. *Tolypiocladia glomerulata* and *Caulerpa racemosa* which was present in March 1986 but disappeared in 1987 was collected again in 1988.

CONCLUSION

Observations show that increased TSS in the water due to the nearby construction, resulted in decreased algal biomass production at the coral reef flat. Many of the corals belonging to species of *Porites* and *Goniostrea* nearer shore were dead and covered by a layer of sediment. However algal biomass production appeared to recover quite soon after the end of construction. Species diversity did not change significantly throughout the sampling periods, showing that although abundance decreased, most of the original species could have remained throughout the construction period. Species like *Avrainvillea* and *Microdictyon* which are perhaps more vulnerable to heavy sediments loads were however not observed again. This reef flat lies in a protected area which would naturally have a higher sediment load than other reef and coastal areas. Species growing here are quite tolerant of high sediment loads and were able to survive the sudden increase, although with the 'loss' of a few species. Species growing on reefs in 'cleaner' waters may not be able to do the same, and irreversible damage may occur to our coral reefs if our coastline and our many islands are not protected from unnecessary development.

Table 1

The four parameters at the three sampling times

Parameter	March 1986	August 1987	March 1988
pH	8.25	8.25	8.26
Salinity mg/l	31	30	32
TSS mg/l	17 — 150	78 — 1503	40 — 107
Algal Biomass g/m²	80	32	67

Table 2

Total number of species per quadrat (S), Shannon Weaver Diversity Index (H) and the Eveness Index (J) for the three sampling periods.

Quadrat	March 1986			August 1987			March 1988		
	S	H	J	S	H	J	S	H	J
0 seline)	1	—	—	1	—	—	4	0.589	0.978
1	4	0.565	0.939	6	0.634	0.815	5	0.630	0.901
2	8	0.828	0.917	6	0.614	0.789	2	0.301	0.999
3	6	0.728	0.936	10	0.954	0.954	5	0.454	0.650
4	10	0.941	0.941	7	0.756	0.895	5	0.509	0.728
5	7	0.797	0.662	9	0.886	0.928	8	0.716	0.793
6	7	0.687	0.812	5	0.638	0.913	9	0.905	0.948
7	5	0.549	0.493	5	0.627	0.897	8	0.825	0.914
8	7	0.491	0.630	7	0.784	0.704	6	0.640	0.822
9				6	0.637	0.819	10	0.951	0.951
10							5	0.633	0.906

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COMPOSTING OF AGRICULTURAL WASTES: A RURAL TECHNOLOGY

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cently, there has been a widespread interest in utilization of agricultural wastes. This is in- asingly evident in countries where agriculture an important part of the economy. These areas en face problems with the disposal of post- rvest material such as crop residues and agri- tural by-products. These organic wastes which essentially "resources out-of-place" are poten- l sources of pollution. Efficient utilization of the ste is often made difficult by the presence of no-cellulosic material which may not be amena- e to biodegradation.

n this context composting, which has been prac- ed since time immemorial has been singled out as a useful method, for the treatment of organic waste particularly in rural areas. The process involves the natural breakdown of the higher plant polymers by a succession of aerobic thermophilic microorganisms. Inherent in the waste, they ultimately convert it to a nutrient rich and stable humus suitable for crop production. With the increasing cost of chemical fertilizers particularly in developing countries where there may be a ready supply of labour, the process of composting appears to have good potential. Organic fertilizer derived from agro-industrial waste are known to last longer in the soil, thus releasing nutrients slowly in a sustained manner.

Appendix 2(a)

In-situ Physicochemical Measurements

Site A

Sampling Point (distance from baseline)	Temperature (°C)	DO (mg L^{-1})	pH	Salinity (ppt)
A1 (0 m)	30.5	7.2	7.32	29
A2 (20 m)	31.0	7.2	7.48	30
A3 (30 m)	32.0	7.0	7.84	32
Mean	31.20 ± 0.76	7.10 ± 0.12	7.50 ± 0.27	30.30 ± 1.53

Site B

Sampling Point (distance from baseline)	Temperature (°C)	DO (mg L^{-1})	pH	Salinity (ppt)
B1 (0 m)	32.5	9.5	7.98	31
B2 (20 m)	32.5	9.8	8.19	31
B3 (40 m)	31.5	10.0	8.20	32
B4 (60 m)	31.5	10.5	8.36	32
B5 (80 m)	31.5	10.2	8.37	32
Mean	31.90 ± 0.49	10.00 ± 0.34	8.20 ± 0.14	31.60 ± 0.49

Site C

Sampling Point (distance from baseline)	Temperature (°C)	DO (mg L^{-1})	pH	Salinity (ppt)
C1 (0 m)	25	8	7.7	31
C2 (20 m)	31	7.2	7.8	31
C3 (40 m)	32	6.9	7.9	30
C4 (60 m)	32	7.0	7.9	30
C5 (80 m)	31	7.3	7.6	29
Mean	30.20 ± 2.64	7.28 ± 0.39	7.78 ± 0.12	30.20 ± 0.77

Appendix 2(b)

Nutrients (NH_3-N & O-PO_4)

Ammoniacal Nitrogen (NH_3-N)

Sampling Point (distance from baseline)	Concentration ($\mu g\ L^{-1}$) at site A	Concentration ($\mu g\ L^{-1}$) at site B	Concentration ($\mu g\ L^{-1}$) at site C
A1/ B1/ C1 (0 m)	10.6	1.44	1.59
A2/ B2/ C2 (20 m)	6.25	2.41	3.55
A3/ B3/ C3 (40 m)	5.84	2.79	5.40
A4/ B4/ C4 (60 m)	missing data	2.02	3.72
A5/ B5/ C5 (80 m)	missing data	0.63	6.23
Mean	7.56 ± 2.60	1.86 ± 0.85	4.10 ± 1.80

Dissolved Orthophosphate (O-PO_4)

Sampling Point (distance from baseline)	Concentration ($\mu g\ L^{-1}$) at site A	Concentration ($\mu g\ L^{-1}$) at site B	Concentration ($\mu g\ L^{-1}$) at site C
A1/ B1/ C1 (0 m)	1.15	0.19	0.04
A2/ B2/ C2 (20 m)	1.85	0.15	0.22
A3/ B3/ C3 (40 m)	1.78	0.10	1.15
A4/ B4/ C4 (60 m)	missing data	0.11	non-detectable
A5/ B5/ C5 (80 m)	missing data	0.08	non-detectable
Mean	1.59 ± 0.40	0.13 ± 0.04	0.28 ± 0.50

Appendix 2(c)

Total Suspended Solids (TSS)

Site A

Sampling Point (distance from baseline)	Replicate	W_1 (g)	W_2 (g)	W_2-W_1 (g)	TSS (mg L^{-1})	Mean TSS (mg L^{-1})
A1 (0 m)	I	0.0936	0.0833	0.0103	103.0	108.0 ± 5.0
	II	0.0923	0.0815	0.0108	108.0	
	III	0.0923	0.0810	0.0113	113.0	
A2 (20 m)	I	0.0935	0.1042	0.0107	107.0	108.3 ± 6.11
	II	0.0932	0.1035	0.0103	103.0	
	III	0.0925	0.1040	0.0115	115.0	
A3 (40 m)	I	0.0928	0.1045	0.0117	117.0	117.1 ± 3.10
	II	0.0917	0.1032	0.0115	115.0	
	III	0.0921	0.1046	0.0121	121.0	
Mean TSS at site A (mg L^{-1})						111.3 ± 5.49

Site B

Sampling Point (distance from baseline)	Replicate	W_1 (g)	W_2 (g)	W_2-W_1 (g)	TSS (mg L^{-1})	Mean TSS (mg L^{-1})
B1 (0 m)	I	0.0924	0.1269	0.0345	34.5	34.5 ± 9.50
	II	0.0925	0.0969	0.0044	44.0	
	III	0.0941	0.0966	0.0025	25.0	
B2 (20 m)	I	0.0929	0.0965	0.0036	36.0	38.0 ± 5.29
	II	0.0929	0.0973	0.0044	44.0	
	III	0.0927	0.0961	0.0034	34.0	
B3 (40 m)	I	0.0929	0.0939	0.0010	10.0	11.3 ± 3.21
	II	0.0919	0.0934	0.0015	15.0	
	III	0.0928	0.0937	0.0009	9.0	
B4 (60 m)	I	0.0927	0.0932	0.0005	5.0	8.3 ± 4.16
	II	0.0931	0.0944	0.0013	13.0	
	III	0.0927	0.0934	0.0007	7.0	
B5 (80 m)	I	0.0930	0.0939	0.0009	9.0	9.0 ± 0.00
	II	0.0917	0.0926	0.0009	9.0	
	III	0.0932	0.0941	0.0009	9.0	
Mean TSS at site B (mg L^{-1})						20.2 ± 14.7

Appendix 2(c) [Continued]

Total Suspended Solids (TSS)

Site C

Sampling Point (distance from baseline)	Replicate	W_1 (g)	W_2 (g)	W_2-W_1 (g)	TSS (mg L^{-1})	Mean TSS (mg L^{-1})
C1 (0 m)	I	0.0957	0.0975	0.0018	18.0	16.0 ± 2.0
	II	0.0942	0.0958	0.0016	16.0	
	III	0.0947	0.0961	0.0014	14.0	
C2 (20 m)	I	0.0944	0.0954	0.0010	10.0	11.3 ± 3.21
	II	0.0952	0.0961	0.0009	9.0	
	III	0.0941	0.0956	0.0015	15.0	
C3 (40 m)	I	0.0942	0.0945	0.0013	13.0	10.7 ± 2.52
	II	0.0946	0.0954	0.0008	8.0	
	III	0.0947	0.0958	0.0011	11.0	
C4 (60 m)	I	0.0945	0.0947	0.0002	2.0	7.7 ± 5.13
	II	0.0961	0.0970	0.0009	9.0	
	III	0.0965	0.0977	0.0012	12.0	
C5 (80 m)	I	0.0960	0.0967	0.0007	7.0	6.7 ± 1.53
	II	0.0972	0.0977	0.0005	5.0	
	III	0.0969	0.0977	0.0008	8.0	
Mean TSS at site C (mg L^{-1})						10.5 ± 3.65

Appendix 3

Mean Air Temperature

Month	Temperature					Relative Humidity
	Mean			Extreme		
	Max	Min	Mly	Max	Min	Mly
Jan	32.7	24.2	27.6	35.2	22.8	81.0
Feb	35.1	25.0	29.0	37.3	24.0	74.7
Mar	35.5	25.3	29.3	37.2	22.8	75.4
Apr	35.9	25.9	30.0	37.3	25.2	75.3
May	34.4	25.4	29.1	38.0	23.0	81.7
Jun	32.6	24.7	28.1	34.7	23.0	83.5
Jul	32.5	24.2	27.9	35.7	22.3	82.2
Aug	31.6	23.8	27.1	33.5	22.2	85.7
Sep	31.8	24.0	27.5	33.3	22.8	83.0
Oct	32.7	24.5	28.1	35.6	22.8	79.8
Nov	32.0	24.1	27.4	34.0	23.0	83.0

Source: Malaysian Meteorological Service

Appendix 4

Seaweed Composition Checklist for Cape Rachado

Division	Order	Family	Species	Site A	Site B	Site C
Cyanophyta	Oscillatoriales	Oscillatoriaceae	*Lyngbya majuscula* Harvey	x		
			Lyngbya sp. 1	x		
			Oscillatoria sp. 1	x		x
			Oscillatoria sp. 2			x
			Oscillatoria sp. 3	x	x	x
			Oscillatoria sp. 4	x	x	x
Total				5	2	4
Chlorophyta	Ulvales	Ulvaceae	*Enteromorpha clathrata* (Roth) Greville	x	x	x
			E. intestinalis (Linnaeus) Nees	x	x	x
			Enteromorpha sp. 1			x
		Boodleaceae	*Struvea anostomosans* (Harvey) Piccone & Grunow ex Piccone	x		x
			Boodlea composita (Harvey) Brand	x		x
		Valoniaceae	*Dictyosphaeria cavernosa* (Forsskaal) Boerg ex Endlicher		x	x
			Valonia aegagrophila C. Agardh	x		x
		Cladophoraceae	*Chaetomorpha linum* (O. F. Muller) Kutzing	x	x	x
			Chaetomorpha cf. *antennina* (Bory de Saint Vincent) Kutzing			x
			Chaetomorpha sp. 1	x		x
			Cladophora fascicularis (Mert.) Kutzing	x	x	x
			Cladophora cf. *rupestris* (Linnaeus) Kutzing			x
			Cladophora cf. *stimpsonii* Harvey	x		x
			Cladophora sp. 1			x
			Cladophora sp. 2			x
			Cladophora sp. 3			x
			Cladophora sp. 4			x
			Cladophoropsis sp.	x		
			Rhizoclonium sp.	x		x
	Caulerpales	Caulerpaceae	*Caulerpa racemosa* (Forsskaal) J. Agardh	x	x	x
			C. peltata Lamouroux		x	
			C. verticillata J. Agardh	x		
		Udoteaceae	*Udotea javensis* (Montagne) A & E. S. Gepp	x	x	x
			Avrainvillea erecta (Berkeley) A & E. S. Gepp	x		
		Polyphysaceae	*Acetabularia* sp. 1	x		x
			Acetabularia sp. 2			x
	Bryopsidales	Bryopsidaceae	*Bryopsis pennata* Lamouroux	x		x
Total				17	8	23

Appendix 4 [Continued]

Seaweed Composition Checklist for Cape Rachado

Division	Order	Family	Species	Site A	Site B	Site C
Rhodophyta	Nemalionales	Achrochaetiaceae	*Achrochaetium* sp.		x	x
		Gelidiaceae	*Gelidiella acerosa* (Forsskaal) Feldmann & Hamel		x	x
			Gelidiella cf. *pannosa* (Bornet) Feldmann & Hamel	x		
			Pterocladia caerulescens (Kutzing) Santelices	x	x	x
	Cryptonemiales	Corallinaceae	*Amphiroa fragilissima* (Linnaeus) Lamouroux	x	x	x
			Amphiroa cf. *anceps* (Lamarck) Decaisne			x
			Jania rubens (Linnaeus) Lamouroux		x	x
	Gigartinales	Hypneaceae	*Hypnea pannosa* J. Agardh	x	x	x
			H. cf. *esperi* Bory de Saint Vincent	x		x
			H. cf. *charoides* Lamouroux	x		x
		Champiaceae	*Champia parvula* C. Agardh	x	x	x
		Gracilariaceae	*Gracilaria salicornia* (C. Agardh) Dawson	x		
			Gelidiopsis sp.	x		x
			Ceratodictyon spongiosum Zanardini	x		
	Ceramiales	Ceramiaceae	*Ceramium tenuissimum* (Roth) J. E. Areschoug	x	x	x
			C. gracillimum (Kutzing) Zanardini	x	x	x
			Centroceras sp.	x		
			Anotrichium tenue (C. Agardh) Nageli		x	x
			Griffithsia sp.	x		x
			Callithamnion sp.	x		x
		Rhodomelaceae	*Acanthophora spicifera* (Vahl.) Bergesen		x	x
			Chondria sp. 1			x
			Chondria sp. 2			x
			Laurencia parvipapillata Tseng		x	x
			Laurencia cf. *corymbosa* J. Agardh	x	x	x
			Laurencia sp. 1	x		x
			Laurencia sp. 2			x
			Leveillea junggermannioides (Martens et Herling) Harvey	x	x	x
			Polysiphonia cf. *nigrescens* (Hudson) Greville	x	x	x
			Polysiphonia cf. *violaceae* (Greville)			x
			Polysiphonia sp. 1			x
			Polysiphonia sp. 2	x	x	x
			Tolypiocladia glomerulata (C. Agardh) Schmitz	x		x
			Herposiphonia sp.	x	x	x
	Hildenbrandiales	Hildenbrandiaceae	*Hildenbrandia* sp.	x		x
Total				23	17	31

Appendix 4 [Continued]

Seaweed Composition Checklist for Cape Rachado

Division	Order	Family	Species	Site A	Site B	Site C
Phaeophyta	Ectocarpales	Ectocarpaceae	*Ectocarpus* sp.		x	x
	Dictyotales	Dictyotaceae	*Padina commersonii* Domantay	x	x	x
			P. tetrastromatica Hauck		x	x
			Lobophora variegata (Lamouroux) Womerseley	x	x	x
			Dictyota dentata Lamouroux	x		
			D. dichotoma (Hudson) Lamouroux	x		x
			Dictyopteris delicatula Lamouroux	x		
	Fucales	Sargassaceae	*Sargassum baccularia* (Mert.) C. Agardh	x	x	x
			S. binderi Sonder	x	x	x
			S. siliquosum Agardh			x
			Sargassum sp. 1			x
			Turbinaria conoides (J. Agardh) Kutzing	x	x	x
	Sphacelariales	Sphacelariaceae	*Sphacelaria* sp.	x	x	x
Total				9	8	11
Total number of species at each site				54	35	69
Total number of species at Cape Rachado						81

Appendix 5

Species Richness, Shannon Index (H') and Evenness Index (J) for Cape Rachado, 1998.

Site A										Mean Species Richness for each quadrat (S.D.)	Mean H' for each quadrat (S.D.)	Mean J for each quadrat (S.D.)
Quadrat	Transect A			Transect B			Transect C					
	Species Richness	H'	J	Species Richness	H'	J	Species Richness	H'	J			
0	6	0.53	0.68	2	0.13	0.44	11	0.80	0.77	6 (5)	0.49 (0.34)	0.63 (0.17)
1	9	0.70	0.73	8	0.69	0.76	3	0.28	0.58	7 (3)	0.56 (0.24)	0.69 (0.10)
2	3	0.25	0.52	3	0.31	0.66	1	0.00	0.00	2 (1)	0.19 (0.16)	0.39 (0.35)
3	6	0.51	0.65	1	0.00	0.00	13	0.89	0.80	7 (6)	0.47 (0.45)	0.48 (0.42)
4	6	0.61	0.79	14	0.99	0.86	20	1.15	0.88	13 (7)	0.91 (0.27)	0.84 (0.05)
5	6	0.51	0.65	15	0.91	0.78	18	1.11	0.89	13 (6)	0.85 (0.31)	0.77 (0.12)
6	14	0.95	0.83	23	1.24	0.91	16	1.05	0.87	18 (5)	1.08 (0.15)	0.87 (0.04)
7	15	0.96	0.82	11	0.80	0.77	17	1.08	0.88	14 (3)	0.95 (0.14)	0.82 (0.05)
Transect mean (S.D.)	8 (4)	0.63 (0.24)	0.71 (0.11)	10 (8)	0.63 (0.44)	0.65 (0.3)	12 (7)	0.79 (0.43)	0.71 (0.3)			
Total Species Richness	36			42			30					
Overall mean at site A (S.D.)										10 (6)	0.69 (0.37)	0.69 (0.24)

Appendix 5 [Continued]

Species Richness, Shannon Index (*H′*) and Evenness Index (*J*) for Cape Rachado, 1998.

Site B										Mean Species Richness for each quadrat (S.D.)	Mean *H′* for each quadrat (S.D.)	Mean *J* for each quadrat (S.D.)
Quadrat	Transect A			Transect B			Transect C					
	Species Richness	*H′*	*J*	Species Richness	*H′*	*J*	Species Richness	*H′*	*J*			
0	9	0.90	0.94	1	0.0	0.0	12	0.91	0.84	7 (6)	0.6 (0.52)	0.59 (0.52)
1	8	0.72	0.80	5	0.63	0.91	12	0.96	0.89	8 (4)	0.77 (0.17)	0.87 (0.06)
2	9	0.82	0.86	15	1.04	0.88	13	0.95	0.85	12 (3)	0.94 (0.11)	0.87 (0.01)
3	9	0.82	0.86	8	0.78	0.87	14	1.01	0.88	10 (3)	0.87 (0.12)	0.87 (0.01)
4	8	0.69	0.76	7	0.77	0.91	1	0.00	0.00	5 (4)	0.49 (0.42)	0.56 (0.49)
5	6	0.60	0.78	11	0.90	0.87	18	1.22	0.97	12 (6)	0.91 (0.31)	0.87 (0.10)
6	13	1.00	0.90	12	1.03	0.95	18	1.13	0.90	14 (3)	1.05 (0.06)	0.92 (0.03)
7				11	0.88	0.84				11	0.88	0.84
Transect mean (S.D)	9 (2)	0.79 (0.13)	0.84 (0.07)	9 (5)	0.75 (0.36)	0.78 (0.34)	13 (6)	0.88 (0.40)	0.76 (0.34)			
Total Species Richness	22			22			29					
Overall mean at site B (S.D.)										10 (5)	0.81 (0.30)	0.79 (0.26)

Appendix 5 [Continued]

Species Richness, Shannon Index (H') and Evenness Index (J) for Cape Rachado, 1998.

Quadrat	Site C									Mean Species Richness for each quadrat (S.D.)	Mean H' for each quadrat (S.D.)	Mean J for each quadrat (S.D.)
	Transect A			Transect B			Transect C					
	Species Richness	H'	J	Species Richness	H'	J	Species Richness	H'	J			
0	8	0.67	0.74	13	0.98	0.88	17	1.03	0.84	13 (5)	0.89 (0.20)	0.82 (0.07)
1	8	0.80	0.88	12	0.87	0.81	12	0.85	0.78	11 (2)	0.84 (0.04)	0.82 (0.05)
2	13	0.98	0.88	12	0.91	0.84	20	1.20	0.92	15 (4)	1.03 (0.15)	0.88 (0.04)
3	15	0.99	0.84	14	0.95	0.83	18	1.06	0.85	16 (2)	1.00 (0.06)	0.84 (0.01)
4	13	1.05	0.94	14	1.11	0.97	20	1.25	0.96	16 (4)	1.14 (0.10)	0.96 (0.01)
5	13	0.99	0.89	21	1.17	0.88	20	1.21	0.93	18 (4)	1.12 (0.12)	0.90 (0.03)
6	12	0.91	0.84	16	1.10	0.91	17	1.12	0.91	15 (3)	1.04 (0.12)	0.89 (0.04)
7	18	1.16	0.93	17	1.10	0.90	14	0.93	0.81	16 (2)	1.06 (0.12)	0.88 (0.06)
8	18	1.08	0.86	15	1.10	0.93	22	1.19	0.89	18 (4)	1.12 (0.06)	0.89 (0.04)
9	16	1.11	0.92	23	1.29	0.95	20	1.12	0.86	20 (4)	1.17 (0.10)	0.91 (0.05)
10	17	1.13	0.92	16	1.13	0.94	19	1.16	0.90	17 (2)	1.14 (0.02)	0.92 (0.02)
11	17	1.15	0.93	22	1.25	0.93	0	0.00	0.00	13 (12)	0.80 (0.69)	0.62 90.54)
12	16	1.09	0.90	15	1.07	0.91	24	1.28	0.93	18 (5)	1.15 (0.12)	0.91 (0.01)
13	18	1.11	0.89	20	1.26	0.96	25	1.35	0.97	21 (4)	1.24 (0.12)	0.94 (0.05)
14	18	1.19	0.95	32	1.49	0.99				25 (10)	1.34 (0.21)	0.97 (0.03)
15	29	1.39	0.95							29	1.39	0.95
Transect mean (S.D.)	16 (5)	1.05 (0.17)	0.89 (0.05)	17 (5)	1.12 (0.16)	0.91 (0.05)	18 (6)	1.05 (0.33)	0.82 (0.24)			
Total Species Richness	49			53			50					
Overall mean at site C (S.D.)										17 (5)	1.10 (0.16)	0.90 (0.05)

Appendix 6

Categorisation of the seaweeds of Cape Rachado according to Littler's functional morphologic groups.

Division	Family	Species	Group
Chlorophyta	Ulvaceae	*Enteromorpha clathrata* (Roth) Greville	SG
		E. intestinalis (Linnaeus) Nees	SG
		Enteromorpha sp. 1	SG
	Boodleaceae	*Struvea anostomosans* (Harvey) Piccone & Grunow ex Piccone	SG
		Boodlea composita (Harvey) Brand	SG
	Valoniaceae	*Dictyosphaeria cavernosa* (Forsskaal) Boerg ex Endlicher	SG
		Valonia aegagrophila C. Agardh	SG
	Cladophoraceae	*Chaetomorpha linum* (O. F. Muller) Kutzing	F
		Chaetomorpha cf. *antennina* (Bory de Saint Vincent) Kutzing	F
		Chaetomorpha sp. 1	F
		Cladophora fascicularis (Mert.) Kutzing	F
		Cladophora cf. *rupestris* (Linnaeus) Kutzing	F
		Cladophora cf. *stimpsonii* Harvey	F
		Cladophora sp. 1	F
		Cladophora sp. 2	F
		Cladophora sp. 3	F
		Cladophora sp. 4	F
		Cladophoropsis sp.	F
		Rhizoclonium sp.	F
	Caulerpaceae	*Caulerpa racemosa* (Forsskaal) J. Agardh	CB
		C. peltata Lamouroux	CB
		C. verticillata J. Agardh	CB
	Udoteaceae	*Udotea javensis* (Montagne) A & E. S. Gepp	CB
		Avrainvillea erecta (Berkeley) A & E. S. Gepp	TL
	Polyphysaceae	*Acetabularia* sp. 1	F
		Acetabularia sp. 2	F
	Bryopsidaceae	*Bryopsis pennata* Lamouroux	SG
Rhodophyta	Achrochaetiaceae	*Achrochaetium* sp.	F
	Gelidiaceae	*Gelidiella acerosa* (Forsskaal) Feldmann & Hamel	CB
		Gelidiella cf. *pannosa* (Bornet) Feldmann & Hamel	CB
		Pterocladia caerulescens (Kutzing) Santelices	CB
	Corallinaceae	*Amphiroa fragilissima* (Linnaeus) Lamouroux	JC
		Amphiroa cf. *anceps* (Lamarck) Decaisne	JC
		Jania rubens (Linnaeus) Lamouroux	JC
	Hypneaceae	*Hypnea pannosa* J. Agardh	CB
		H. cf. *esperi* Bory de Saint Vincent	CB
		H. cf. *charoides* Lamouroux	CB
	Champiaceae	*Champia parvula* C. Agardh	CB
	Gracilariaceae	*Gracilaria salicornia* (C. Agardh) Dawson	CB
		Gelidiopsis sp.	CB
		Ceratodictyon spongiosum Zanardini	CB
	Ceramiaceae	*Ceramium tenuissimum* (Roth) J. E. Areschoug	F
		C. gracillimum (Kutzing) Zanardini	F
		Centroceras sp.	F
		Anotrichium tenue (C. Agardh) Nageli	F
		Griffithsia sp.	F
		Callithamnion sp.	F
	Rhodomelaceae	*Acanthophora spicifera* (Vahl.) Bergesen	CB
		Chondria sp. 1	CB
		Chondria sp. 2	CB
		Laurencia parvipapillata Tseng	CB
		Laurencia cf. *corymbosa* J. Agardh	CB
		Laurencia sp. 1	CB
		Laurencia sp. 2	CB
		Leveillea junggermannioides (Martens et Herling) Harvey	CB
		Polysiphonia cf. *nigrescen* (Hudson) Greville	F
		Polysiphonia cf. *violaceae* (Greville)	F
		Polysiphonia sp. 1	F
		Polysiphonia sp. 2	F
		Tolypiocladia glomerulata (C. Agardh) Schmitz	F
		Herposiphonia sp.	F
	Hildenbrandiaceae	*Hildenbrandia* sp.	C

Appendix 6 [Continued]

Categorisation of the seaweeds of Cape Rachado according to Littler's functional morphologic groups.

Division	Family	Species	Site A
Phaeophyta	Ectocarpaceae	*Ectocarpus* sp.	F
	Dictyotaceae	*Padina commersonii* Domantay	TL
		P. tetrastromatica Hauck	TL
		Lobophora variegata (Lamouroux) Womerseley	TL
		Dictyota dentata Lamouroux	TL
		D. dichotoma (Hudson) Lamouroux	TL
		Dictyopteris delicatula Lamouroux	TL
	Sargassaceae	*Sargassum baccularia* (Mert.) C. Agardh	TL
		S. binderi Sonder	TL
		S. siliquosum Agardh	TL
		Sargassum sp. 1	TL
		Turbinaria conoides (J. Agardh) Kutzing	TL
	Sphacelariaceae	*Sphacelaria* sp.	F

Abbreviations:

SG	Sheet group
F	Filamentous group
CB	Coarsely branched group
TL	Thick-leathery group
JC	Jointed calcareous group
C	Crustose group

Appendix 7

Seaweed Dry Weight Biomass for Cape Rachado in 1998.

Site A				
Quadrat	Transect A ($g\ m^{-2}$)	Transect B ($g\ m^{-2}$)	Transect C ($g\ m^{-2}$)	Mean for each quadrat (S.D.)
0	3.24	3.15	2.73	3.04 (0.3)
1	11.21	2.21	0.22	4.55 (5.9)
2	35.73	5.82	0.16	13.9 (19.1)
3	60.52	44.66	1.99	35.72 (30.3)
4	2.05	5.67	100.22	35.98 (55.7)
5	7.50	12.21	96.14	38.62 (49.9)
6	22.96	61.79	103.28	62.68 (40.2)
7	63.48	12.09	102.19	59.25 (45.2)
Transect mean (S.D.)	25.84 (24.93)	18.45 (22.25)	50.87 (53.06)	
Mean seaweed dry weight biomass at site A, Cape Rachado				31.72 (37.38)

Site B				
Quadrat	Transect A ($g\ m^{-2}$)	Transect B ($g\ m^{-2}$)	Transect C ($g\ m^{-2}$)	Mean for each quadrat (S.D.)
0	19.05	3.58	19.45	14.03 (9.05)
1	69.42	31.21	22.64	41.09 (24.91)
2	20.70	15.29	35.38	23.79 (10.39)
3	38.19	55.97	46.88	47.01 (8.89)
4	74.80	86.21	4.74	55.25 (44.11)
5	22.19	47.97	93.00	54.39 (35.84)
6	137.14	116.05	95.11	116.1 (21.01)
7		189.71		189.71
Transect mean (S.D.)	54.5 (43.15)	68.25 (61.28)	45.31 (35.79)	
Mean seaweed dry weight biomass at site B, Cape Rachado				56.58 (47.38)

Appendix 7 [Continued]

Seaweed Dry Weight Biomass for Cape Rachado in 1998.

Site C				
Quadrat	Transect A ($g\ m^{-2}$)	Transect B ($g\ m^{-2}$)	Transect C ($g\ m^{-2}$)	Mean for each quadrat (S.D.)
0	0.58	25.75	32.39	19.58 (16.78)
1	2.42	27.95	35.81	22.06 (17.45)
2	40.05	12.69	29.99	27.58 (13.84)
3	39.44	30.26	59.78	43.16 (15.11)
4	8.70	5.10	33.69	15.83 (15.57)
5	12.66	93.79	86.85	64.43 (44.97)
6	25.82	34.31	182.78	80.97 (88.27)
7	41.47	31.13	41.05	37.88 (5.85)
8	24.67	30.56	41.77	32.33 (8.69)
9	93.76	106.54	46.06	82.12 (31.88)
10	62.31	36.73	190.88	96.64 (82.61)
11	79.22	36.43	0.00	38.55 (39.65)
12	32.08	96.05	110.21	79.45 (41.63)
13	56.64	62.59	137.61	85.61 (45.13)
14	192.06	84.64		138.35 (75.96)
15	157.44			157.44
Transect mean (S.D.)	54.33 (54.17)	47.63 (32.43)	73.49 (59.71)	
Mean seaweed dry weight biomass at site C, Cape Rachado				58.06 (50.06)

Appendix 8 (a)

Frequency, Dominance and the Importance Value Index (IVI) for seaweed species at site A, Cape Rachado, in 1998.

Site A

Seaweed species	Number of quadrat in which species was recorded [a]	Frequency value (*f*) [b] = [a]/24 quadrats	Frequency (%) [c] = [b]*100	Relative frequency (*Rf*) [d] = [b]/total [b]*100	Total *N* value [e]	Dominance (%) [f] = [e]/total [e]*100	Dominance value (*d*) [*g*] = [e]/area sampled [area sampled = 2.16 m^2]	Relative dominance (*Rd*) [h] = [g]/total [g]*100	IVI [i] = [[d] + [h]]/2
Cyanophyta							5.09	2.48	1.67
Lyngbya majuscula	2	0.08	8.33	0.85	11	2.59	1.39	0.68	0.98
Lyngbya sp. 1	3	0.13	12.50	1.28	3	0.71	1.39	0.68	0.98
Oscillatoria sp. 1	3	0.13	12.50	1.28	3	0.71	0.00	0.00	0.43
Oscillatoria sp. 2	2	0.08	8.33	0.85		0.00	0.93	0.45	0.65
Oscillatoria sp. 3	2	0.08	8.33	0.85	2	0.47	1.39	0.68	0.98
Oscillatoria sp. 4	3	0.13	12.50	1.28	3	0.71			
Chlorophyta							5.09	2.48	3.58
Enteromorpha clathrata	11	0.46	45.83	4.68	11	2.59	0.46	0.23	0.33
E. intestinalis	1	0.04	4.17	0.43	1	0.24	0.00	0.00	0.00
Enteromorpha sp. 1		0.00	0.00	0.00		0.00	0.93	0.45	0.65
Struvea anostomosans	2	0.08	8.33	0.85	2	0.47	3.24	1.58	2.07
Boodlea composita	6	0.25	25.00	2.55	7	1.65	0.00	0.00	0.00
Dictyosphaeria cavernosa		0.00	0.00	0.00		0.00	0.93	0.45	0.65
Valonia aegagrophila	2	0.08	8.33	0.85	2	0.47	0.46	0.23	0.33
Chaetomorpha linum	1	0.04	4.17	0.43	1	0.24	0.00	0.00	0.00
Chaetomorpha cf. *antennina*		0.00	0.00	0.00		0.00	0.46	0.23	0.33
Chaetomorpha sp. 1	1	0.04	4.17	0.43	1	0.24	6.02	2.93	4.23
Cladophora fascicularis	13	0.54	54.17	5.53	13	3.07	0.00	0.00	0.00
Cladophora cf. *rupestris*		0.00	0.00	0.00		0.00	1.85	0.90	1.30
Cladophora cf. *stimpsonii*	4	0.17	16.67	1.70	4	0.94	0.00	0.00	0.00
Cladophora sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophora sp. 2		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophora sp. 3		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophora sp. 4		0.00	0.00	0.00		0.00	0.46	0.23	0.33
Cladophoropsis sp.	1	0.04	4.17	0.43	1	0.24	0.46	0.23	0.33
Rhizoclonium sp.	1	0.04	4.17	0.43	1	0.24	2.31	1.13	1.42
Caulerpa racemosa	4	0.17	16.67	1.70	5	1.18	0.00	0.00	0.00
C. peltata Lamouroux		0.00	0.00	0.00		0.00	0.93	0.45	0.65
C. verticillata	2	0.08	8.33	0.85	2	0.47	11.57	5.64	5.80
Udotea javensis	14	0.58	58.33	5.96	25	5.90	9.26	4.51	2.68
Avrainvillea erecta	2	0.08	8.33	0.85	20	4.72	0.00	0.00	0.00
Acetabularia sp. 1		0.00	0.00	0.00		0.00			

Appendix 8 (a) [Continued]

Frequency, Dominance and the Importance Value Index (IVI) for seaweed species at site A, Cape Rachado, in 1998.

Site A

Seaweed species	Number of quadrat in which species was recorded [a]	Frequency value (*f*) [b] = [a]/24 quadrats	Frequency (%) [c] = [b]*100	Relative frequency (*Rf*) [d] = [b]/total [b]*100	Total *N* value [e]	Dominance (%) [f] = [e]/total [e]*100	Dominance value (*d*) [*g*] = [e]/area sampled [area sampled = 2.16 m^2]	Relative dominance (*Rd*) [h] = [g]/total [g]*100	IVI [i] = [[d] + [h]]/2
Acetabularia sp. 2	1	0.04	4.17	0.43	1	0.24	0.46	0.23	0.33
Bryopsis pennata	2	0.08	8.33	0.85	5	1.18	2.31	1.13	0.99
<u>Rhodophyta</u>									
Achrochaetium sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Gelidiella acerosa		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Gelidiella cf. *pannosa*	1	0.04	4.17	0.43	1	0.24	0.46	0.23	0.33
Pterocladia caerulescens	3	0.13	12.50	1.28	12	2.83	5.56	2.71	1.99
Amphiroa fragilissima	5	0.21	20.83	2.13	7	1.65	3.24	1.58	1.85
Amphiroa cf. *anceps*		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Jania rubens		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Hypnea pannosa	7	0.29	29.17	2.98	16	3.77	7.41	3.61	3.30
H. cf. *esperi*	6	0.25	25.00	2.55	7	1.65	3.24	1.58	2.07
H. cf. *charoides*	1	0.04	4.17	0.43	9	2.12	4.17	2.03	1.23
Champia parvula	4	0.17	16.67	1.70	4	0.94	1.85	0.90	1.30
Gracilaria salicornia	5	0.21	20.83	2.13	49	11.56	22.69	11.06	6.59
Gelidiopsis sp.	1	0.04	4.17	0.43	1	0.24	0.46	0.23	0.33
Ceratodictyon spongiosum	4	0.17	16.67	1.70	25	5.90	11.57	5.64	3.67
Ceramium tenuissimum	11	0.46	45.83	4.68	11	2.59	5.09	2.48	3.58
C. gracillimum	9	0.38	37.50	3.83	9	2.12	4.17	2.03	2.93
Centroceras sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Anotrichium tenue		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Griffithsia sp.	3	0.13	12.50	1.28	3	0.71	1.39	0.68	0.98
Callithamnion sp.	5	0.21	20.83	2.13	5	1.18	2.31	1.13	1.63
Acanthophora spicifera		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Chondria sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Chondria sp. 2		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Laurencia parvipapillata		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Laurencia cf. *corymbosa*	1	0.04	4.17	0.43	1	0.24	0.46	0.23	0.33
Laurencia sp. 1	2	0.08	8.33	0.85	2	0.47	0.93	0.45	0.65
Laurencia sp. 2		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Leveillea junggermannioides	1	0.04	4.17	0.43	1	0.24	0.46	0.23	0.33
Polysiphonia cf. *nigrescens*	6	0.25	25.00	2.55	6	1.42	2.78	1.35	1.95
Polysiphonia cf. *violaceae*	3	0.13	12.50	1.28	3	0.71	1.39	0.68	0.98

Appendix 8 (a) [Continued]

Frequency, Dominance and the Importance Value Index (IVI) for seaweed species at site A, Cape Rachado, in 1998.

Site A

Seaweed species	Number of quadrat in which species was recorded [a]	Frequency value (*f*) [b] = [a]/24 quadrats	Frequency (%) [c] = [b]*100	Relative frequency (*Rf*) [d] = [b]/total [b]*100	Total *N* value [e]	Dominance (%) [f] = [e]/total [e]*100	Dominance value (*d*) [*g*] = [e]/area sampled [area sampled = 2.16 m2]	Relative dominance (*Rd*) [h] = [g]/total [g]*100	IVI [i] = [[d] + [h]]/2
Polysiphonia sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Polysiphonia sp. 2	4	0.17	16.67	1.70	4	0.94	1.85	0.90	1.30
Tolypiocladia glomerulata	4	0.17	16.67	1.70	4	0.94	1.85	0.90	1.30
Herposiphonia sp.	6	0.25	25.00	2.55	6	1.42	2.78	1.35	1.95
Hildenbrandia sp.	13	0.54	54.17	5.53	20	4.72	9.26	4.51	5.02
<u>Phaeophyta</u>									
Ectocarpus sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Padina commersonii	10	0.42	41.67	4.26	28	6.60	12.96	6.32	5.29
P. tetrastromatica		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Lobophora variegata	7	0.29	29.17	2.98	7	1.65	3.24	1.58	2.28
Dictyota dentata	2	0.08	8.33	0.85	2	0.47	0.93	0.45	0.65
D. dichotoma	2	0.08	8.33	0.85	2	0.47	0.93	0.45	0.65
Dictyopteris delicatula	5	0.21	20.83	2.13	5	1.18	2.31	1.13	1.63
Sargassum baccularia	8	0.33	33.33	3.40	48	11.32	22.22	10.84	7.12
S. binderi	4	0.17	16.67	1.70	12	2.83	5.56	2.71	2.21
S. siliquosum		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Sargassum sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Turbinaria conoides	6	0.25	25.00	2.55	6	1.42	2.78	1.35	1.95
Sphacelaria sp.	3	0.13	12.50	1.28	3	0.71	1.39	0.68	0.98
Total	24 quadrats	9.79	979.17	100.00	443	104.48	205.09	100.00	100.00

Appendix 8 (b)

Frequency, Dominance and the Importance Value Index (IVI) for seaweed species at site B, Cape Rachado, in 1998.

Site B

Seaweed species	Number of quadrat in which species was recorded [a]	Frequency value (*f*) [b] = [a]/22 quadrats	Frequency (%) [c] = [b]*100	Relative frequency (*Rf*) [d] = [b]/total [b]*100	Total *N* value [e]	Dominance (%) [f] = [e]/total [e]*100	Dominance value (*d*) [*g*] = [e]/area sampled [area sampled = 1.98 m^2]	Relative dominance (*Rd*) [h] = [g]/total [g]*100	IVI [i] = [[d] + [h]]/2
<u>Cyanophyta</u>									
Lyngbya majuscula		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Lyngbya sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Oscillatoria sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Oscillatoria sp. 2		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Oscillatoria sp. 3		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Oscillatoria sp. 4		0.00	0.00	0.00		0.00	0.00	0.00	0.00
<u>Chlorophyta</u>									
Enteromorpha clathrata	4	0.18	18.18	1.81	4	1.01	2.02	1.01	1.41
E. intestinalis	4	0.18	18.18	1.81	4	1.01	2.02	1.01	1.41
Enteromorpha sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Struvea anostomosans		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Boodlea composita	1	0.05	4.55	0.45	1	0.25	0.51	0.25	0.35
Dictyosphaeria cavernosa	1	0.05	4.55	0.45	1	0.25	0.51	0.25	0.35
Valonia aegagrophila		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Chaetomorpha linum	3	0.14	13.64	1.36	7	1.76	3.54	1.76	1.56
Chaetomorpha cf. *antennina*		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Chaetomorpha sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophora fascicularis	12	0.55	54.55	5.43	12	3.02	6.06	3.02	4.22
Cladophora cf. *rupestris*		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophora cf. *stimpsonii*		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophora sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophora sp. 2		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophora sp. 3		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophora sp. 4		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophoropsis sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Rhizoclonium sp.		0.00	0.00	0.00		0.00	0.00	0.00	13.04
Caulerpa racemosa	16	0.73	72.73	7.24	75	18.84	37.88	18.84	0.35
C. peltata Lamouroux	1	0.05	4.55	0.45	1	0.25	0.51	0.25	0.00
C. verticillata		0.00	0.00	0.00		0.00	0.00	0.00	1.06
Udotea javensis	3	0.14	13.64	1.36	3	0.75	1.52	0.75	0.00
Avrainvillea erecta		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Acetabularia sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	

Appendix 8 (b) [Continued]

Frequency, Dominance and the Importance Value Index (IVI) for seaweed species at site B, Cape Rachado, in 1998.

Site B

Seaweed species	Number of quadrat in which species was recorded [a]	Frequency value (*f*) [b] = [a]/22 quadrats	Frequency (%) [c] = [b]*100	Relative frequency (*Rf*) [d] = [b]/total [b]*100	Total *N* value [e]	Dominance (%) [f] = [e]/total [e]*100	Dominance value (*d*) [g] = [e]/area sampled [area sampled = 1.98 m2]	Relative dominance (*Rd*) [h] = [g]/total [g]*100	IVI [i] = [[d] + [h]]/2
Acetabularia sp. 2		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Bryopsis pennata		0.00	0.00	0.00		0.00	0.00	0.00	0.00
<u>Rhodophyta</u>									
Achrochaetium sp.	1	0.05	4.55	0.45	1	0.25	0.51	0.25	0.35
Gelidiella acerosa	9	0.41	40.91	4.07	10	2.51	5.05	2.51	3.29
Gelidiella cf. *pannosa*		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Pterocladia caerulescens	11	0.50	50.00	4.98	14	3.52	7.07	3.52	4.25
Amphiroa fragilissima	6	0.27	27.27	2.71	6	1.51	3.03	1.51	2.11
Amphiroa cf. *anceps*		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Jania rubens	3	0.14	13.64	1.36	3	0.75	1.52	0.75	1.06
Hypnea pannosa	17	0.77	77.27	7.69	17	4.27	8.59	4.27	5.98
H. cf. *esperi*	1	0.05	4.55	0.45	1	0.25	0.51	0.25	0.35
H. cf. *charoides*		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Champia parvula	16	0.73	72.73	7.24	16	4.02	8.08	4.02	5.63
Gracilaria salicornia		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Gelidiopsis sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Ceratodictyon spongiosum		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Ceramium tenuissimum	1	0.05	4.55	0.45	1	0.25	0.51	0.25	0.35
C. gracillimum	10	0.45	45.45	4.52	10	2.51	5.05	2.51	3.52
Centroceras sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Anotrichium tenue	1	0.05	4.55	0.45	1	0.25	0.51	0.25	0.35
Griffithsia sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Callithamnion sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Acanthophora spicifera	2	0.09	9.09	0.90	2	0.50	1.01	0.50	0.70
Chondria sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Chondria sp. 2		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Laurencia parvipapillata	3	0.14	13.64	1.36	3	0.75	1.52	0.75	1.06
Laurencia cf. *corymbosa*	7	0.32	31.82	3.17	7	1.76	3.54	1.76	2.46
Laurencia sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Laurencia sp. 2		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Leveillea junggermannioides	6	0.27	27.27	2.71	6	1.51	3.03	1.51	2.11
Polysiphonia cf. *nigrescens*	6	0.27	27.27	2.71	6	1.51	3.03	1.51	2.11
Polysiphonia cf. *violaceae*		0.00	0.00	0.00		0.00	0.00	0.00	0.00

Appendix 8 (b) [Continued]

Frequency, Dominance and the Importance Value Index (IVI) for seaweed species at site B, Cape Rachado, in 1998.

Site B

Seaweed species	Number of quadrat in which species was recorded [a]	Frequency value (*f*) [b] = [a]/22 quadrats	Frequency (%) [c] = [b]*100	Relative frequency (*Rf*) [d] = [b]/total [b]*100	Total *N* value [e]	Dominance (%) [f] = [e]/total [e]*100	Dominance value (*d*) [*g*] = [e]/area sampled [area sampled = 1.98 m2]	Relative dominance (*Rd*) [h] = [g]/total [g]*100	IVI [i] = [[d] + [h]]/2
Polysiphonia sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Polysiphonia sp. 2	7	0.32	31.82	3.17	7	1.76	3.54	1.76	2.46
Tolypiocladia glomerulata		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Herposiphonia sp.	6	0.27	27.27	2.71	6	1.51	3.03	1.51	2.11
Hildenbrandia sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Phaeophyta									
Ectocarpus sp.	2	0.09	9.09	0.90	2	0.50	1.01	0.50	0.70
Padina commersonii	16	0.73	72.73	7.24	16	4.02	8.08	4.02	5.63
P. tetrastromatica	2	0.09	9.09	0.90	2	0.50	1.01	0.50	0.70
Lobophora variegata	3	0.14	13.64	1.36	3	0.75	1.52	0.75	1.06
Dictyota dentata		0.00	0.00	0.00		0.00	0.00	0.00	0.00
D. dichotoma		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Dictyopteris delicatula		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Sargassum baccularia	18	0.82	81.82	8.14	76	19.10	38.38	19.10	13.62
S. binderi	9	0.41	40.91	4.07	35	8.79	17.68	8.79	6.43
S. siliquosum		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Sargassum sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Turbinaria conoides	13	0.59	59.09	5.88	39	9.80	19.70	9.80	7.84
Sphacelaria sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Total	22 quadrats	10.05	1004.55	100.00	398	100.00	201.01	100.00	100.00

Appendix 8 (c)

Frequency, Dominance and the Importance Value Index (IVI) for seaweed species at site C, Cape Rachado, in 1998.

Site C

Seaweed species	Number of quadrat in which species was recorded [a]	Frequency value (*f*) [b] = [a]/45 quadrats	Frequency (%) [c] = [b]*100	Relative frequency (*Rf*) [d] = [b]/total [b]*100	Total *N* value [e]	Dominance (%) [f] = [e]/total [e]*100	Dominance value (*d*) [*g*] = [e]/area sampled [area sampled = 4.05 m^2]	Relative dominance (*Rd*) [h] = [g]/total [g]*100	IVI [i] = [[d] + [h]]/2
Cyanophyta									
Lyngbya majuscula	3	0.07	6.67	0.40	3	0.28	0.74	0.28	0.34
Lyngbya sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Oscillatoria sp. 1	3	0.07	6.67	0.40	3	0.28	0.74	0.28	0.34
Oscillatoria sp. 2	2	0.04	4.44	0.26	2	0.19	0.49	0.19	0.23
Oscillatoria sp. 3	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Oscillatoria sp. 4	2	0.04	4.44	0.26	2	0.19	0.49	0.19	0.23
Chlorophyta									
Enteromorpha clathrata	26	0.58	57.78	3.43	26	2.42	6.42	2.42	2.93
E. intestinalis	12	0.27	26.67	1.58	12	1.12	2.96	1.12	1.35
Enteromorpha sp. 1	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Struvea anostomosans	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Boodlea composita	6	0.13	13.33	0.79	6	0.56	1.48	0.56	0.68
Dictyosphaeria cavernosa	4	0.09	8.89	0.53	3	0.28	0.74	0.28	0.40
Valonia aegagrophila	2	0.04	4.44	0.26	2	0.19	0.49	0.19	0.23
Chaetomorpha linum	23	0.51	51.11	3.03	23	2.14	5.68	2.14	2.59
Chaetomorpha cf. *antennina*	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Chaetomorpha sp. 1	2	0.04	4.44	0.26	2	0.19	0.49	0.19	0.23
Cladophora fascicularis	36	0.80	80.00	4.75	36	3.36	8.89	3.36	4.05
Cladophora cf. *rupestris*	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Cladophora cf. *stimpsonii*	2	0.04	4.44	0.26	2	0.19	0.49	0.19	0.23
Cladophora sp. 1		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Cladophora sp. 2	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Cladophora sp. 3	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Cladophora sp. 4	2	0.04	4.44	0.26	2	0.19	0.49	0.19	0.23
Cladophoropsis sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Rhizoclonium sp.	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Caulerpa racemosa	2	0.04	4.44	0.26	9	0.84	2.22	0.84	0.55
C. peltata Lamouroux		0.00	0.00	0.00		0.00	0.00	0.00	0.00
C. verticillata		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Udotea javensis	18	0.40	40.00	2.37	18	1.68	4.44	1.68	2.03
Avrainvillea erecta		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Acetabularia sp. 1	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11

Appendix 8 (c) [Continued]

Frequency, Dominance and the Importance Value Index (IVI) for seaweed species at site C, Cape Rachado, in 1998.

Site C

Seaweed species	Number of quadrat in which species was recorded [a]	Frequency value (*f*) [b] = [a]/45 quadrats	Frequency (%) [c] = [b]*100	Relative frequency (*Rf*) [d] = [b]/total [b]*100	Total *N* value [e]	Dominance (%) [f] = [e]/total [e]*100	Dominance value (*d*) [g] = [e]/area sampled [area sampled = 4.05 m2]	Relative dominance (*Rd*) [h] = [g]/total [g]*100	IVI [i] = [[d] + [h]]/2
Acetabularia sp. 2	4	0.09	8.89	0.53	4	0.37	0.99	0.37	0.45
Bryopsis pennata	6	0.13	13.33	0.79	6	0.56	1.48	0.56	0.68
<u>Rhodophyta</u>									
Achrochaetium sp.	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Gelidiella acerosa	28	0.62	62.22	3.69	31	2.89	7.65	2.89	3.29
Gelidiella cf. *pannosa*		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Pterocladia caerulescens	34	0.76	75.56	4.49	34	3.17	8.40	3.17	3.83
Amphiroa fragilissima	30	0.67	66.67	3.96	30	2.80	7.41	2.80	3.38
Amphiroa cf. *anceps*	3	0.07	6.67	0.40	3	0.28	0.74	0.28	0.34
Jania rubens	5	0.11	11.11	0.66	6	0.56	1.48	0.56	0.61
Hypnea pannosa	38	0.84	84.44	5.01	38	3.54	9.38	3.54	4.28
H. cf. *esperi*	2	0.04	4.44	0.26	2	0.19	0.49	0.19	0.23
H. cf. *charoides*	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Champia parvula	38	0.84	84.44	5.01	38	3.54	9.38	3.54	4.28
Gracilaria salicornia		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Gelidiopsis sp.	3	0.07	6.67	0.40	3	0.28	0.74	0.28	0.34
Ceratodictyon spongiosum		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Ceramium tenuissimum	13	0.29	28.89	1.72	13	1.21	3.21	1.21	1.46
C. gracillimum	27	0.60	60.00	3.56	27	2.52	6.67	2.52	3.04
Centroceras sp.		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Anotrichium tenue	21	0.47	46.67	2.77	21	1.96	5.19	1.96	2.36
Griffithsia sp.	3	0.07	6.67	0.40	3	0.28	0.74	0.28	0.34
Callithamnion sp.	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Acanthophora spicifera	20	0.44	44.44	2.64	21	1.96	5.19	1.96	2.30
Chondria sp. 1	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Chondria sp. 2	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Laurencia parvipapillata	4	0.09	8.89	0.53	5	0.47	1.23	0.47	0.50
Laurencia cf. *corymbosa*	16	0.36	35.56	2.11	16	1.49	3.95	1.49	1.80
Laurencia sp. 1	4	0.09	8.89	0.53	4	0.37	0.99	0.37	0.45
Laurencia sp. 2	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Leveillea junggermannioides	7	0.16	15.56	0.92	7	0.65	1.73	0.65	0.79
Polysiphonia cf. *nigrescens*	19	0.42	42.22	2.51	19	1.77	4.69	1.77	2.14
Polysiphonia cf. *violaceae*	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11

Appendix 8 (c) [Continued]

Frequency, Dominance and the Importance Value Index (IVI) for seaweed species at site C, Cape Rachado, in 1998.

Site C

Seaweed species	Number of quadrat in which species was recorded [a]	Frequency value (*f*) [b] = [a]/45 quadrats	Frequency (%) [c] = [b]*100	Relative frequency (*Rf*) [d] = [b]/total [b]*100	Total *N* value [e]	Dominance (%) [f] = [e]/total [e]*100	Dominance value (*d*) [*g*] = [e]/area sampled [area sampled = 4.05 m]	Relative dominance (*Rd*) [h] = [g]/total [g]*100	IVI [i] = [[d] + [h]]/2
Polysiphonia sp. 1	3	0.07	6.67	0.40	3	0.28	0.74	0.28	0.34
Polysiphonia sp. 2	29	0.64	64.44	3.83	29	2.70	7.16	2.70	3.26
Tolypiocladia glomerulata	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Herposiphonia sp.	14	0.31	31.11	1.85	14	1.30	3.46	1.30	1.58
Hildenbrandia sp.	4	0.09	8.89	0.53	5	0.47	1.23	0.47	0.50
<u>Phaeophyta</u>									
Ectocarpus sp.	2	0.04	4.44	0.26	2	0.19	0.49	0.19	0.23
Padina commersonii	36	0.80	80.00	4.75	50	4.66	12.35	4.66	4.70
P. tetrastromatica	23	0.51	51.11	3.03	41	3.82	10.12	3.82	3.43
Lobophora variegata	27	0.60	60.00	3.56	27	2.52	6.67	2.52	3.04
Dictyota dentata	17	0.38	37.78	2.24	18	1.68	4.44	1.68	1.96
D. dichotoma		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Dictyopteris delicatula		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Sargassum baccularia	42	0.93	93.33	5.54	225	20.97	55.56	20.97	13.26
S. binderi	13	0.29	28.89	1.72	37	3.45	9.14	3.45	2.58
S. siliquosum	1	0.02	2.22	0.13	3	0.28	0.74	0.28	0.21
Sargassum sp. 1	1	0.02	2.22	0.13	1	0.09	0.25	0.09	0.11
Turbinaria conoides	38	0.84	84.44	5.01	98	9.13	24.20	9.13	7.07
Sphacelaria sp.	21	0.47	46.67	2.77	21	1.96	5.19	1.96	2.36
Total	45 quadrats	16.84	1684.44	100.00	1073	100.00	264.94	100.00	100.00

Appendix 9

Seaweed Composition Checklist for Cape Rachado, as recorded in the surveys of 1987/88 and 1998

Division	Species	1987/88			1998		
		Site A	Site B	Site C	Site A	Site B	Site C
Cyanophyta	*Lyngbya majuscula* Harvey	x			x		
	Lyngbya sp. 1				x		
	Oscillatoria sp. 1				x		x
	Oscillatoria sp. 2						x
	Oscillatoria sp. 3				x	x	x
	Oscillatoria sp. 4				x	x	x
	Nostoc	x					
Total		2	0	0	5	2	4
Chlorophyta	*Enteromorpha clathrata* (Roth) Greville	x	x		x	x	x
	E. intestinalis (Linnaeus) Nees	x	x		x	x	x
	Enteromorpha sp. 1						x
	Struvea anostomosans (Harvey) Piccone & Grunow ex Piccone	x	x	x	x		x
	Boodlea composita (Harvey) Brand				x		x
	Dictyosphera cavernosa (Forsskaal) Boerg ex Endlicher	x	x	x		x	x
	Valonia aegagrophila C. Agardh	x	x	x	x		x
	Valonia sp. 1	x					
	Chaetomorpha linum (O. F. Muller) Kutzing	x	x		x	x	x
	Chaetomorpha cf. *antennina* (Bory de Saint Vincent) Kutzing						x
	Chaetomorpha sp. 1				x		x
	Cladophora fascicularis (Mert.) Kutzing	x	x	x	x	x	x
	Cladophora cf. *rupestris* (Linnaeus) Kutzing						x
	Cladophora cf. *stimpsonii* Harvey				x		x
	Cladophora sp. 1(1987/88)	x		x			
	Cladophora sp. 2 (1987/88)		x				
	Cladophora sp. 1(1998)						x
	Cladophora sp. 2 (1998)						x
	Cladophora sp. 3 (1998)						x
	Cladophora sp. 4 (1998)						x
	Cladophoropsis sp.				x		
	Rhizoclonium sp.				x		x
	Caulerpa racemosa (Forsskaal) J. Agardh		x		x	x	x
	C. peltata Lamouroux					x	
	C. verticillata J. Agardh	x			x		
	C. serrulata (Forsskaal) J. Agardh	x					
	C. taxifolia (Vahl) C. Agardh	x		x			
	Udotea javensis (Montagne) A & E. S. Gepp	x	x	x	x	x	x
	Udotea flabellum (Ellis & Sonder) Howe	x					
	Avrainvillea erecta (Berkeley) A & E. S. Gepp				x		
	Acetabularia sp. 1(1987/88)			x			
	Acetabularia sp. 1(1998)				x		x
	Acetabularia sp. 2 (1998)						x
	Bryopsis pennata Lamouroux				x		x
Total		15	10	8	17	8	23

Appendix 9 [Continued]

Seaweed Composition Checklist for Cape Rachado,A20 as recorded in the surveys of 1987/88 and 1998

Division	Species	1987/88			1998		
		Site A	Site B	Site C	Site A	Site B	Site C
Rhodophyta	*Achrochaetium* sp.					x	x
	Gelidiella acerosa (Forsskaal) Feldmann & Hamel	x	x	x		x	x
	Gelidiella cf. *pannosa* (Bornet) Feldmann & Hamel				x		
	Gelidiella bornetti (Weber van Bosse) Feldmann & Hamel		x				
	Gelidiella sp. 1			x			
	Gelidium sp. 1		x	x			
	Gelidium sp. 2	x	x	x			
	Gelidium sp. 3	x	x				
	Pterocladia caerulescens (Kutzing) Santelices	x	x	x	x	x	x
	Amphiroa fragilissima (Linnaeus) Lamouroux	x	x	x	x	x	x
	Amphiroa cf. *anceps* (Lamarck) Decaisne						x
	Amphiroa foliaceae (Linnaeus) Lamouroux		x				
	Jania rubens (Linnaeus) Lamouroux		x			x	x
	Hypnea pannosa J. Agardh				x	x	x
	H. cf. *esperi Bory de Saint Vincent*	x	x	x	x		x
	H. cf. *charoides* Lamouroux				x		x
	Hypnea sp. 1 (1987/88)	x	x	x			
	Hypnea sp. 2 (1987/88)	x	x				
	Champia parvula C. Agardh	x	x	x	x	x	x
	Gracilaria salicornia (C. Agardh) Dawson	x	x	x	x		
	Gracilaria sp. 1 (1987/88)	x	x	x			
	Gelidiopsis sp.				x		x
	Ceratodictyon spongiosum Zanardini	x	x	x	x		
	Ceramium tenuissimum (Roth) J. E. Areschoug				x	x	x
	C. gracillimum (Kutzing) Zanardini				x	x	x
	Ceramium sp. (1987/88)	x	x	x			
	Centroceras sp.	x	x		x		
	Anotrichium tenue (C. Agardh) Nageli					x	x
	Griffithsia sp.				x		x
	Callithamnion sp.				x		x
	Acanthophora spicifera (Vahl.) Bergesen	x	x	x		x	x
	Acanthophora orientalis J. Agardh	x		x			
	Chondria sp. 1						x
	Chondria sp. 2						x
	Laurencia parvipapillata Tseng					x	x
	Laurencia cf. *corymbosa* J. Agardh				x	x	x
	Laurencia cf. *concreta* Cribb		x	x			
	Laurencia sp. 1(1998)				x		x
	Laurencia sp. 2 (1998)						x
	Laurencia sp. 2 (1987/88)	x	x	x			
	Laurencia sp. 3 (1987/88)		x				
	Leveillea junggermannioides (Martens et Herling) Harvey	x	x		x	x	x
	Polysiphonia cf. *nigrescens* (Hudson) Greville				x	x	x
	Polysiphonia cf. *violaceae* (Greville)						x
	Polysiphonia sp. 1 (1987/88)	x	x	x			
	Polysiphonia sp. 1 (1998)						x
	Polysiphonia sp. 2 (1998)				x	x	x
	Tolypiocladia glomerulata (C. Agardh) Schmitz	x			x		x
	Galaxaura cf. *filamentosa* Chou			x			
	Herposiphonia sp.	x	x		x	x	x
	Heterosiphonia sp.	x					
	Erythrotrichia sp.		x				
	Hildenbrandia sp.				x		x
Total		22	26	19	23	17	31

Appendix 9 [Continued]

Seaweed Composition Checklist for Cape Rachado, as recorded in the surveys of 1987/88 and 1998

Division	Species	1987/88			1998		
		Site A	Site B	Site C	Site A	Site B	Site C
Phaeophyta	*Ectocarpus* sp.		x	x		x	x
	Padina commersonii Domantay	x	x	x	x	x	x
	P. tetrastromatica Hauck	x	x	x		x	x
	Lobophora variegata (Lamouroux) Womerseley	x	x	x	x	x	x
	Dictyota dentata Lamouroux				x		
	D. dichotoma (Hudson) Lamouroux		x	x	x		x
	D. bartayresi Lamouroux	x	x	x			
	D. ceylanica Kutzing	x	x	x			
	D. cervicornis Kutzing	x	x	x			
	Dictyopteris delicatula Lamouroux				x		
	Sargassum baccularia (Mert.) C. Agardh	x	x	x	x	x	x
	S. oligocystum Montagne	x	x	x	x	x	x
	S. siliquosum Agardh		x	x			x
	Sargassum sp. 1(1987/88)			x			
	Sargassum sp. 2 (1987/88)	x	x	x			
	Sargassum sp. 1(1998)						x
	Turbinaria conoides (J. Agardh) Kutzing	x	x	x	x	x	x
	Turbinaria ornata (Turner) J. Agardh	x	x	x			
	Turbinaria sp. 1	x		x			
	Hormophysa triquetra C. Agardh			x			
	Hydroclathrus clathratus (Bory de Saint Vincent) Howe			x			
	Sphacelaria sp.				x	x	x
Total		12	14	18	9	8	11
Total number of species at each site		51	50	45	54	35	69
Total number of species at Cape Rachado				69			81

Appendix 10

Results of the Newman-Keuls post-hoc test for two-way ANOVA, performed on the water quality and biotic parameters of 1987/88 and 1998

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_PH (2wayanov.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2				
SITE	OCCASION		{1} .9316571	{2} .9700856	{3} .9663006	{4} .9668885	{5} .9653460
A	98	{1}		.000010*	.000020*	.000026*	.000017*
A	875	{2}	.000010*		.425656	.404471	.315719
A	878	{3}	.000020*	.425656		.813411	.701561
A	883	{4}	.000026*	.404471	.813411		.809557
A	8711	{5}	.000017*	.315719	.701561	.809557	
B	98	{6}	.000022*	.311595	.915242	.901801	.961245
B	875	{7}	.000032*	.990921	.287017	.203327	.231658
B	878	{8}	.000017*	.785244	.175635	.228412	.085548
B	883	{9}	.000008*	.383474	.911239	.916736	.978122
B	8711	{10}	.000012*	.863047	.438804	.464338	.300238
C	98	{11}	.000011*	.000032*	.000017*	.000020*	.000008*
C	875	{12}	.000023*	.294978	.009496*	.017266*	.002694*
C	878	{13}	.000026*	.027223*	.000139*	.000342*	.000036*
C	883	{14}	.000015*	.932930	.417963	.472663	.264866
C	8711	{15}	.000020*	.319480	.014738*	.024854*	.004606*

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_PH (2wayanov.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2				
SITE	OCCASION		{6} .9646790	{7} .9700572	{8} .9724181	{9} .9652777	{10} .9705153
A	98	{1}	.000022*	.000032*	.000017*	.000008*	.000012*
A	875	{2}	.311595	.990921	.785244	.383474	.863047
A	878	{3}	.915242	.287017	.175635	.911239	.438804
A	883	{4}	.901801	.203327	.228412	.916736	.464338
A	8711	{5}	.961245	.231658	.085548	.978122	.300238
B	98	{6}		.257118	.059194	.810091	.270115
B	875	{7}	.257118		.878108	.307152	.981537
B	878	{8}	.059194	.878108		.096866	.725186
B	883	{9}	.810091	.307152	.096866		.350860
B	8711	{10}	.270115	.981537	.725186	.350860	
C	98	{11}	.000009*	.000026*	.000015*	.000022*	.000010*
C	875	{12}	.001281*	.354585	.484069	.002912*	.310461
C	878	{13}	.000027*	.033682*	.119378	.000040*	.034479*
C	883	{14}	.219529	.983214	.560901	.301673	.855288
C	8711	{15}	.002367*	.397571	.337348	.005098*	.311444

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_PH (2wayanov.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2				
SITE	OCCASION		{11} .9434561	{12} .9752795	{13} .9779330	{14} .9709697	{15} .9748079
A	98	{1}	.000011*	.000023*	.000026*	.000015*	.000020*
A	875	{2}	.000032*	.294978	.027223*	.932930	.319480
A	878	{3}	.000017*	.009496*	.000139*	.417963	.014738*
A	883	{4}	.000020*	.017266*	.000342*	.472663	.024854*
A	8711	{5}	.000008*	.002694*	.000036*	.264866	.004606*
B	98	{6}	.000009*	.001281*	.000027*	.219529	.002367*
B	875	{7}	.000026*	.354585	.033682*	.983214	.397571
B	878	{8}	.000015*	.484069	.119378	.560901	.337348
B	883	{9}	.000022*	.002912*	.000040*	.301673	.005098*
B	8711	{10}	.000010*	.310461	.034479*	.855288	.311444
C	98	{11}		.000020*	.000023*	.000012*	.000017*
C	875	{12}	.000020*		.286731	.307882	.849862
C	878	{13}	.000023*	.286731		.041405*	.421045
C	883	{14}	.000012*	.307882	.041405*		.271788
C	8711	{15}	.000017*	.849862	.421045	.271788	

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_SALT (2wayanov.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{1} 1.495666	{2} 1.503771	{3} 1.494444	{4} 1.521542	{5} 1.529303
A	98	{1}		.039163*	.713146	.000010*	.000015*
A	875	{2}	.039163*		.025831*	.000027*	.000010*
A	878	{3}	.713146	.025831*		.000012*	.000017*
A	883	{4}	.000010*	.000027*	.000012*		.051168
A	8711	{5}	.000015*	.000010*	.000017*	.051168	
B	98	{6}	.000028*	.037859*	.000032*	.031565*	.000028*
B	875	{7}	.022472*	.678286	.011203*	.000031*	.000032*
B	878	{8}	.419554	.000640*	.527430	.000020*	.000026*
B	883	{9}	.000483*	.236744	.000154*	.001832*	.000026*
B	8711	{10}	.000032*	.000022*	.000010*	.967220	.081776
C	98	{11}	.874943	.027941*	.900743	.000015*	.000020*
C	875	{12}	.019564*	.917415	.018886*	.000033*	.000012*
C	878	{13}	.795403	.010273*	.846457	.000017*	.000023*
C	883	{14}	.000026*	.046513*	.000027*	.030359*	.000025*
C	8711	{15}	.000012*	.000032*	.000015*	.063208	.633468

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_SALT (2wayanov.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{6} 1.513168	{7} 1.505150	{8} 1.489938	{9} 1.509159	{10} 1.521406
A	98	{1}	.000028*	.022472*	.419554	.000483*	.000032*
A	875	{2}	.037859*	.678286	.000640*	.236744	.000022*
A	878	{3}	.000032*	.011203*	.527430	.000154*	.000010*
A	883	{4}	.031565*	.000031*	.000020*	.001832*	.967220
A	8711	{5}	.000028*	.000032*	.000026*	.000026*	.081776
B	98	{6}		.074760	.000015*	.449506	.013217*
B	875	{7}	.074760		.000152*	.227774	.000026*
B	878	{8}	.000015*	.000152*		.000010*	.000017*
B	883	{9}	.449506	.227774	.000010*		.001327*
B	8711	{10}	.013217*	.000026*	.000017*	.001327*	
C	98	{11}	.000010*	.010649*	.434926	.000128*	.000012*
C	875	{12}	.039638*	.862312	.000714*	.310772	.000027*
C	878	{13}	.000012*	.003096*	.420537	.000048*	.000015*
C	883	{14}	.817410	.074382	.000012*	.329452	.018526*
C	8711	{15}	.000077*	.000026*	.000023*	.000020*	.138988

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_SALT (2wayanov.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{11} 1.494029	{12} 1.503426	{13} 1.492615	{14} 1.512401	{15} 1.527718
A	98	{1}	.874943	.019564*	.795403	.000026*	.000012*
A	875	{2}	.027941*	.917415	.010273*	.046513*	.000032*
A	878	{3}	.900743	.018886*	.846457	.000027*	.000015*
A	883	{4}	.000015*	.000033*	.000017*	.030359*	.063208
A	8711	{5}	.000020*	.000012*	.000023*	.000025*	.633468
B	98	{6}	.000010*	.039638*	.000012*	.817410	.000077*
B	875	{7}	.010649*	.862312	.003096*	.074382	.000026*
B	878	{8}	.434926	.000714*	.420537	.000012*	.000023*
B	883	{9}	.000128*	.310772	.000048*	.329452	.000020*
B	8711	{10}	.000012*	.000027*	.000015*	.018526*	.138988
C	98	{11}		.024288*	.670613	.000033*	.000017*
C	875	{12}	.024288*		.010086*	.053970	.000010*
C	878	{13}	.670613	.010086*		.000010*	.000020*
C	883	{14}	.000033*	.053970	.000010*		.000055*
C	8711	{15}	.000017*	.000010*	.000020*	.000055*	

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_TSS (2wayanov.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{1} 2.044294	{2} 1.971501	{3} 2.600069	{4} 1.866103	{5} 2.008487
A	98	{1}		.996945	.029846*	.979116	.984395
A	875	{2}	.996945		.063063	.872384	.983359
A	878	{3}	.029846*	.063063		.026886*	.053576
A	883	{4}	.979116	.872384	.026886*		.961307
A	8711	{5}	.984395	.983359	.053576	.961307	
B	98	{6}	.017555*	.022515*	.000138*	.049669*	.020569*
B	875	{7}	.506487	.369499	.001143*	.261860	.469756
B	878	{8}	.978318	.706742	.030208*	.904994	.945275
B	883	{9}	.037587*	.037790*	.000129*	.060859	.039989*
B	8711	{10}	.925996	.994462	.042480*	.974581	.939868
C	98	{11}	.001215*	.001799*	.000151*	.005048*	.001535*
C	875	{12}	.191009	.159001	.000282*	.176725	.187006
C	878	{13}	.317169	.753310	.111680	.588068	.642349
C	883	{14}	.041274*	.046545*	.000136*	.085781	.045803*
C	8711	{15}	.996125	.903725	.065042	.925211	.957826

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_TSS (2wayanov.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{6} 1.239936	{7} 1.626253	{8} 1.891488	{9} 1.322424	{10} 2.024535
A	98	{1}	.017555*	.506487	.978318	.037587*	.925996
A	875	{2}	.022515*	.369499	.706742	.037790*	.994462
A	878	{3}	.000138*	.001143*	.030208*	.000129*	.042480*
A	883	{4}	.049669*	.261860	.904994	.060859	.974581
A	8711	{5}	.020569*	.469756	.945275	.039989*	.939868
B	98	{6}		.369400	.048180*	.919719	.019656*
B	875	{7}	.369400		.427099	.329685	.499841
B	878	{8}	.048180*	.427099		.069013	.969695
B	883	{9}	.919719	.329685	.069013		.040181*
B	8711	{10}	.019656*	.499841	.969695	.040181*	
C	98	{11}	.355788	.080809	.004520*	.553339	.001395*
C	875	{12}	.658918	.503094	.228730	.449264	.194933
C	878	{13}	.000965*	.091890	.597721	.002365*	.516201
C	883	{14}	.716866	.467182	.089026	.979944	.044931*
C	8711	{15}	.019828*	.410611	.871616	.036356*	.990927

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_TSS (2wayanov.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{11} 1.042910	{12} 1.483652	{13} 2.257867	{14} 1.317057	{15} 1.997227
A	98	{1}	.001215*	.191009	.317169	.041274*	.996125
A	875	{2}	.001799*	.159001	.753310	.046545*	.903725
A	878	{3}	.000151*	.000282*	.111680	.000136*	.065042
A	883	{4}	.005048*	.176725	.588068	.085781	.925211
A	8711	{5}	.001535*	.187006	.642349	.045803*	.957826
B	98	{6}	.355788	.658918	.000965*	.716866	.019828*
B	875	{7}	.080809	.503094	.091890	.467182	.410611
B	878	{8}	.004520*	.228730	.597721	.089026	.871616
B	883	{9}	.553339	.449264	.002365*	.979944	.036356*
B	8711	{10}	.001395*	.194933	.516201	.044931*	.990927
C	98	{11}		.242186	.000166*	.403466	.001514*
C	875	{12}	.242186		.019080*	.712070	.165313
C	878	{13}	.000166*	.019080*		.002564*	.732433
C	883	{14}	.403466	.712070	.002564*		.042979*
C	8711	{15}	.001514*	.165313	.732433	.042979*	

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_SP (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{1}	{2}	{3}	{4}	{5}
			.9479923	.6346822	.4135936	.6385682	.6033112
A	98	{1}		.001278*	.000017*	.001282*	.000243*
A	875	{2}	.001278*		.009136*	.958758	.676298
A	878	{3}	.000017*	.009136*		.014622*	.011581*
A	8711	{4}	.001282*	.958758	.014622*		.885735
A	8803	{5}	.000243*	.676298	.011581*	.885735	
B	98	{6}	.600577	.000151*	.000020*	.000157*	.000036*
B	875	{7}	.043462*	.519209	.000536*	.298349	.431879
B	878	{8}	.281075	.237334	.000039*	.199543	.120434
B	8711	{9}	.270032	.248412	.000037*	.193613	.138017
B	8803	{10}	.691121	.000053*	.000023*	.000054*	.000024*
C	98	{11}	.001789*	.000020*	.000026*	.000017*	.000023*
C	875	{12}	.310999	.179662	.000012*	.158202	.080200
C	878	{13}	.038849*	.667463	.000657*	.524089	.527758
C	8711	{14}	.467579	.055668	.000012*	.050887	.018678*
C	8803	{15}	.738042	.003996*	.000015*	.003859*	.000902*

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_SP (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{6}	{7}	{8}	{9}	{10}
			.9873315	.7167085	.8000242	.7877082	1.009542
A	98	{1}	.600577	.043462*	.281075	.270032	.691121
A	875	{2}	.000151*	.519209	.237334	.248412	.000053*
A	878	{3}	.000020*	.000536*	.000039*	.000037*	.000023*
A	8711	{4}	.000157*	.298349	.199543	.193613	.000054*
A	8803	{5}	.000036*	.431879	.120434	.138017	.000024*
B	98	{6}		.009598*	.126076	.109461	.767545
B	875	{7}	.009598*		.684065	.611789	.003863*
B	878	{8}	.126076	.684065		.869810	.077913
B	8711	{9}	.109461	.611789	.869810		.062673
B	8803	{10}	.767545	.003863*	.077913	.062673	
C	98	{11}	.005850*	.000015*	.000033*	.000010*	.005358*
C	875	{12}	.162295	.657205	.806358	.911902	.111735
C	878	{13}	.008954*	.965004	.535886	.367562	.003725*
C	8711	{14}	.323880	.400629	.707090	.773674	.268284
C	8803	{15}	.666797	.087688	.358919	.374194	.656153

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_SP (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{11}	{12}	{13}	{14}	{15}
			1.218847	.8184438	.7200054	.8596377	.9228621
A	98	{1}	.001789*	.310999	.038849*	.467579	.738042
A	875	{2}	.000020*	.179662	.667463	.055668	.003996*
A	878	{3}	.000026*	.000012*	.000657*	.000012*	.000015*
A	8711	{4}	.000017*	.158202	.524089	.050887	.003859*
A	8803	{5}	.000023*	.080200	.527758	.018678*	.000902*
B	98	{6}	.005850*	.162295	.008954*	.323880	.666797
B	875	{7}	.000015*	.657205	.965004	.400629	.087688
B	878	{8}	.000033*	.806358	.535886	.707090	.358919
B	8711	{9}	.000010*	.911902	.367562	.773674	.374194

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_SP (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{11} 1.218847	{12} .8184438	{13} .7200054	{14} .8596377	{15} .9228621
B	8803	{10}	.005358*	.111735	.003725*	.268284	.656153
C	98	{11}		.000027*	.000012*	.000044*	.000788*
C	875	{12}	.000027*		.556414	.583518	.346269
C	878	{13}	.000012*	.556414		.340077	.075218
C	8711	{14}	.000044*	.583518	.340077		.400096
C	8803	{15}	.000788*	.346269	.075218	.400096	

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_BIO (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{1} 1.140461	{2} .8026197	{3} .7819315	{4} .8628028	{5} .9222190
A	98	{1}		.228548	.234010	.318499	.370844
A	875	{2}	.228548		.898640	.710954	.741795
A	878	{3}	.234010	.898640		.872276	.823500
A	8711	{4}	.318499	.710954	.872276		.714475
A	8803	{5}	.370844	.741795	.823500	.714475	
B	98	{6}	.068618	.000059*	.000044*	.000242*	.000994*
B	875	{7}	.888397	.211325	.234327	.258962	.228774
B	878	{8}	.028531*	.000026*	.000026*	.000053*	.000204*
B	8711	{9}	.506524	.012258*	.009791*	.032007*	.069001
B	8803	{10}	.003276*	.000023*	.000026*	.000021*	.000025*
C	98	{11}	.070189	.000076*	.000055*	.000340*	.001232*
C	875	{12}	.253702	.016103*	.014261*	.035323*	.062202
C	878	{13}	.050936	.000063*	.000047*	.000273*	.000956*
C	8711	{14}	.392824	.012649*	.010544*	.030957*	.062013
C	8803	{15}	.043150*	.000032*	.000029*	.000099*	.000439*

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_BIO (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{6} 1.600946	{7} 1.117669	{8} 1.673607	{9} 1.365956	{10} 1.780151
A	98	{1}	.068618	.888397	.028531*	.506524	.003276*
A	875	{2}	.000059*	.211325	.000026*	.012258*	.000023*
A	878	{3}	.000044*	.234327	.000026*	.009791*	.000026*
A	8711	{4}	.000242*	.258962	.000053*	.032007*	.000021*
A	8803	{5}	.000994*	.228774	.000204*	.069001	.000025*
B	98	{6}		.058632	.895547	.469926	.687378
B	875	{7}	.058632		.021848*	.543566	.002245*
B	878	{8}	.895547	.021848*		.405492	.511782
B	8711	{9}	.469926	.543566	.405492		.141587
B	8803	{10}	.687378	.002245*	.511782	.141587	
C	98	{11}	.912790	.063039	.944688	.374343	.743836
C	875	{12}	.535643	.405478	.387970	.966907	.115902
C	878	{13}	.992807	.048379*	.980480	.182685	.828277
C	8711	{14}	.541924	.471484	.428195	.932757	.143421
C	8803	{15}	.806428	.034738*	.839648	.438818	.666545

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_BIO (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{11} 1.583159	{12} 1.325823	{13} 1.582358	{14} 1.352252	{15} 1.640743
A	98	{1}	.070189	.253702	.050936	.392824	.043150*
A	875	{2}	.000076*	.016103*	.000063*	.012649*	.000032*
A	878	{3}	.000055*	.014261*	.000047*	.010544*	.000029*
A	8711	{4}	.000340*	.035323*	.000273*	.030957*	.000099*
A	8803	{5}	.001232*	.062202	.000956*	.062013	.000439*
B	98	{6}	.912790	.535643	.992807	.541924	.806428
B	875	{7}	.063039	.405478	.048379*	.471484	.034738*
B	878	{8}	.944688	.387970	.980480	.428195	.839648
B	8711	{9}	.374343	.966907	.182685	.932757	.438818

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_BIO (hjbanova.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2				
SITE	OCCASION		{11} 1.583159	{12} 1.325823	{13} 1.582358	{14} 1.352252	{15} 1.640743
B	8803	{10}	.743836	.115902	.828277	.143421	.666545
C	98	{11}		.507284	.996070	.485580	.933045
C	875	{12}	.507284		.390250	.870736	.454135
C	878	{13}	.996070	.390250		.332106	.984099
C	8711	{14}	.485580	.870736	.332106		.481064
C	8803	{15}	.933045	.454135	.984099	.481064	

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_H (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{1} .2153919	{2} .2206327	{3} .1872593	{4} .1796189	{5} .2190918
A	98	{1}		.991158	.511165	.409845	.976528
A	875	{2}	.991158		.569836	.387875	.931105
A	878	{3}	.511165	.569836		.903665	.557407
A	8711	{4}	.409845	.387875	.903665		.395696
A	8803	{5}	.976528	.931105	.557407	.395696	
B	98	{6}	.465025	.362372	.019994*	.005657*	.424508
B	875	{7}	.564282	.581882	.942066	.721819	.579406
B	878	{8}	.890789	.986550	.521107	.385997	.943963
B	8711	{9}	.940733	.989061	.426241	.449879	.983100
B	8803	{10}	.088062	.083173	.000650*	.000132*	.092243
C	98	{11}	.000010*	.000020*	.000020*	.000026*	.000026*
C	875	{12}	.965679	.997225	.416106	.363039	.994477
C	878	{13}	.877212	.944035	.406654	.589453	.931494
C	8711	{14}	.926602	.603486	.288093	.149972	.816918
C	8803	{15}	.428210	.261284	.020873*	.006234*	.350200

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_H (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{6} .2496576	{7} .1859640	{8} .2178391	{9} .2094587	{10} .2657962
A	98	{1}	.465025	.564282	.890789	.940733	.088062
A	875	{2}	.362372	.581882	.986550	.989061	.083173
A	878	{3}	.019994*	.942066	.521107	.426241	.000650*
A	8711	{4}	.005657*	.721819	.385997	.449879	.000132*
A	8803	{5}	.424508	.579406	.943963	.983100	.092243
B	98	{6}		.018258*	.475174	.369488	.365164
B	875	{7}	.018258*		.555779	.551153	.000552*
B	878	{8}	.475174	.555779		.965602	.100434
B	8711	{9}	.369488	.551153	.965602		.050362
B	8803	{10}	.365164	.000552*	.100434	.050362	
C	98	{11}	.000221*	.000023*	.000032*	.000015*	.002123*
C	875	{12}	.505252	.492001	.982236	.771901	.095663
C	878	{13}	.185228	.638726	.902144	.677507	.015365*
C	8711	{14}	.508304	.287685	.906165	.913635	.182402
C	8803	{15}	.948575	.019441*	.420941	.356948	.595824

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_H (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{11} .3205605	{12} .2146250	{13} .2020474	{14} .2298890	{15} .2485081
A	98	{1}	.000010*	.965679	.877212	.926602	.428210
A	875	{2}	.000020*	.997225	.944035	.603486	.261284
A	878	{3}	.000020*	.416106	.406654	.288093	.020873*
A	8711	{4}	.000026*	.363039	.589453	.149972	.006234*
A	8803	{5}	.000026*	.994477	.931494	.816918	.350200
B	98	{6}	.000221*	.505252	.185228	.508304	.948575
B	875	{7}	.000023*	.492001	.638726	.287685	.019441*
B	878	{8}	.000032*	.982236	.902144	.906165	.420941
B	8711	{9}	.000015*	.771901	.677507	.913635	.356948

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_H (hjbanova.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2				
SITE	OCCASION		{11} .3205605	{12} .2146250	{13} .2020474	{14} .2298890	{15} .2485081
B	8803	{10}	.002123*	.095663	.015365*	.182402	.595824
C	98	{11}		.000012*	.000017*	.000020*	.000312*
C	875	{12}	.000012*		.760079	.956614	.479355
C	878	{13}	.000017*	.760079		.772934	.183412
C	8711	{14}	.000020*	.956614	.772934		.296126
C	8803	{15}	.000312*	.479355	.183412	.296126	

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_J (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{1} .2218657	{2} .2486083	{3} .2237438	{4} .2310587	{5} .2698632
A	98	{1}		.385443	.900545	.813679	.037758*
A	875	{2}	.385443		.347967	.472421	.618269
A	878	{3}	.900545	.347967		.626400	.044644*
A	8711	{4}	.813679	.472421	.626400		.131274
A	8803	{5}	.037758*	.618269	.044644*	.131274	
B	98	{6}	.313098	.952501	.247702	.267719	.680943
B	875	{7}	.358600	.948356	.362706	.576808	.511365
B	878	{8}	.052172	.788462	.064101	.189373	.999940
B	8711	{9}	.323493	.800115	.312971	.486036	.651345
B	8803	{10}	.027773*	.705857	.035727*	.123354	.994053
C	98	{11}	.014420*	.641355	.019671*	.080370	.995176
C	875	{12}	.013813*	.658388	.019110*	.080293	.997568
C	878	{13}	.087182	.718458	.096390	.228230	.717314
C	8711	{14}	.031455*	.760664	.040931*	.141167	.998954
C	8803	{15}	.044320*	.712635	.053593	.158825	.992719

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_J (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{6} .2477131	{7} .2532689	{8} .2700205	{9} .2524133	{10} .2737254
A	98	{1}	.313098	.358600	.052172	.323493	.027773*
A	875	{2}	.952501	.948356	.788462	.800115	.705857
A	878	{3}	.247702	.362706	.064101	.312971	.035727*
A	8711	{4}	.267719	.576808	.189373	.486036	.123354
A	8803	{5}	.680943	.511365	.999940	.651345	.994053
B	98	{6}		.982753	.816023	.947498	.727324
B	875	{7}	.982753		.798826	.954601	.750216
B	878	{8}	.816023	.798826		.850429	.805273
B	8711	{9}	.947498	.954601	.850429		.792151
B	8803	{10}	.727324	.750216	.805273	.792151	
C	98	{11}	.649265	.732169	.955510	.754851	.961014
C	875	{12}	.661326	.761115	.980498	.776429	.989166
C	878	{13}	.800313	.457928	.982371	.703507	.972102
C	8711	{14}	.774419	.819414	.965523	.846386	.995392
C	8803	{15}	.755034	.681215	.998934	.768350	.966706

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_J (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{11} .2777613	{12} .2784616	{13} .2644227	{14} .2738122	{15} .2700005
A	98	{1}	.014420*	.013813*	.087182	.031455*	.044320*
A	875	{2}	.641355	.658388	.718458	.760664	.712635
A	878	{3}	.019671*	.019110*	.096390	.040931*	.053593
A	8711	{4}	.080370	.080293	.228230	.141167	.158825
A	8803	{5}	.995176	.997568	.717314	.998954	.992719
B	98	{6}	.649265	.661326	.800313	.774419	.755034
B	875	{7}	.732169	.761115	.457928	.819414	.681215
B	878	{8}	.955510	.980498	.982371	.965523	.998934
B	8711	{9}	.754851	.776429	.703507	.846386	.768350

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_J (hjbanova.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{11} .2777613	{12} .2784616	{13} .2644227	{14} .2738122	{15} .2700005
B	8803	{10}	.961014	.989166	.972102	.995392	.966706
C	98	{11}		.962836	.974506	.792715	.985750
C	875	{12}	.962836		.982768	.948598	.993342
C	878	{13}	.974506	.982768		.989231	.926869
C	8711	{14}	.792715	.948598	.989231		.994279
C	8803	{15}	.985750	.993342	.926869	.994279	

Appendix 11

Results of the Newman-Keuls post-hoc test for one-way ANOVA, performed on the pooled data of 1987/88 versus the data of 1998

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_PH (2wayanv2.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

			{1}	{2}	{3}	{4}	{5}
SITE	OCCASION		.9316571	.9669102	.9646790	.9695172	.9434561
A	98	{1}		.000008*	.000022*	.000017*	.000036*
A	87/88	{2}	.000008*		.428526	.354929	.000022*
B	98	{3}	.000022*	.428526		.198837	.000009*
B	87/88	{4}	.000017*	.354929	.198837		.000008*
C	98	{5}	.000036*	.000022*	.000009*	.000008*	
C	87/88	{6}	.000020*	.013240*	.001729*	.057820	.000017*

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_PH (2wayanv2.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

			{6}
SITE	OCCASION		.9748633
A	98	{1}	.000020*
A	87/88	{2}	.013240*
B	98	{3}	.001729*
B	87/88	{4}	.057820
C	98	{5}	.000017*
C	87/88	{6}	

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_SALT (2wayanv2.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{1} 1.495666	{2} 1.514023	{3} 1.513168	{4} 1.505912	{5} 1.494029
A	98	{1}		.075086	.067213	.150719	.818456
A	87/88	{2}	.075086		.904651	.666211	.056784
B	98	{3}	.067213	.904651		.565594	.056277
B	87/88	{4}	.150719	.666211	.565594		.218142
C	98	{5}	.818456	.056784	.056277	.218142	
C	87/88	{6}	.153703	.748571	.544950	.680022	.159946

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_SALT (2wayanv2.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{6} 1.508852
A	98	{1}	.153703
A	87/88	{2}	.748571
B	98	{3}	.544950
B	87/88	{4}	.680022
C	98	{5}	.159946
C	87/88	{6}	

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_TSS (2wayanv2.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{1} 2.044294	{2} 2.111540	{3} 1.239936	{4} 1.695618	{5} 1.042910	{6} 1.731023
A	98	{1}		.763501	.003414*	.267281	.000400*	.164088
A	87/88	{2}	.763501		.002178*	.251555	.000264*	.209348
B	98	{3}	.003414*	.002178*		.044837*	.379216	.077849
B	87/88	{4}	.267281	.251555	.044837*		.012947*	.874118
C	98	{5}	.000400*	.000264*	.379216	.012947*		.015446*
C	87/88	{6}	.164088	.209348	.077849	.874118	.015446*	

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_SP (hjbanov2.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2				
SITE	OCCASION		{1} .9479923	{2} .5474777	{3} .9873315	{4} .8332209	{5} 1.218847
A	98	{1}		.000008*	.520737	.060982	.000049*
A	87/88	{2}	.000008*		.000017*	.000030*	.000020*
B	98	{3}	.520737	.000017*		.031856*	.000164*
B	87/88	{4}	.060982	.000030*	.031856*		.000008*
C	98	{5}	.000049*	.000020*	.000164*	.000008*	
C	87/88	{6}	.123514	.000013*	.046352*	.934993	.000017*

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_SP (hjbanov2.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2
SITE	OCCASION		{6} .8282241
A	98	{1}	.123514
A	87/88	{2}	.000013*
B	98	{3}	.046352*
B	87/88	{4}	.934993
C	98	{5}	.000017*
C	87/88	{6}	

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_BIO (hjbanov2.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2				
SITE	OCCASION		{1} 1.140461	{2} .8364168	{3} 1.600946	{4} 1.496081	{5} 1.583159
A	98	{1}		.020055*	.003938*	.017949*	.003965*
A	87/88	{2}	.020055*		.000020*	.000010*	.000017*
B	98	{3}	.003938*	.000020*		.701751	.891795
B	87/88	{4}	.017949*	.000010*	.701751		.505414
C	98	{5}	.003965*	.000017*	.891795	.505414	
C	87/88	{6}	.010682*	.000024*	.767305	.867684	.682734

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_BIO (hjbanov2.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2
SITE	OCCASION		{6} 1.474297
A	98	{1}	.010682*
A	87/88	{2}	.000024*
B	98	{3}	.767305
B	87/88	{4}	.867684
C	98	{5}	.682734
C	87/88	{6}	

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_H (hjbanov2.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{1} .2153919	{2} .2032851	{3} .2496576	{4} .2217164	{5} .3205605
A	98	{1}		.387004	.068305	.651335	.000017*
A	87/88	{2}	.387004		.008205*	.385652	.000020*
B	98	{3}	.068305	.008205*		.113047	.000009*
B	87/88	{4}	.651335	.385652	.113047		.000008*
C	98	{5}	.000017*	.000020*	.000009*	.000008*	
C	87/88	{6}	.839419	.481285	.059466	.911031	.000022*

STAT.
GENERAL
MANOVA

Newman-Keuls test; LOG_H (hjbanov2.sta)
Probabilities for Post Hoc Tests
INTERACTION: 1 x 2

SITE	OCCASION		{6} .2232803
A	98	{1}	.839419
A	87/88	{2}	.481285
B	98	{3}	.059466
B	87/88	{4}	.911031
C	98	{5}	.000022*
C	87/88	{6}	

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_J (hjbanov2.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2				
SITE	OCCASION		{1} .2218657	{2} .2444446	{3} .2477131	{4} .2634402	{5} .2777613
A	98	{1}		.047712*	.060594	.001535*	.000033*
A	87/88	{2}	.047712*		.774418	.218477	.028725*
B	98	{3}	.060594	.774418		.167865	.041877*
B	87/88	{4}	.001535*	.218477	.167865		.420359
C	98	{5}	.000033*	.028725*	.041877*	.420359	
C	87/88	{6}	.000125*	.075246	.085213	.456944	.608707

STAT. GENERAL MANOVA			Newman-Keuls test; LOG_J (hjbanov2.sta) Probabilities for Post Hoc Tests INTERACTION: 1 x 2
SITE	OCCASION		{6} .2719235
A	98	{1}	.000125*
A	87/88	{2}	.075246
B	98	{3}	.085213
B	87/88	{4}	.456944
C	98	{5}	.608707
C	87/88	{6}	