INTERTIDAL COMMUNITIES OF NORTHERN SPENCER GULF, SOUTH AUSTRALIA

by R. C. Ainslie, D. A. Johnston & E. W. Offler*

Summary

Ainslie, R.C., Johnston, D.A. & Offler, E. W. (1989) Intertidal communities of northern Spencer Gulf, South Australia. *Trans. R. Soc. S. Aust.* **113**( ), 69–83, 31 May, 1989.

The fauna of the intertidal mudflats of northern Spencer Gulf was monitored between 1982 and 1986. Two main habitats were identified, the mid intertidal zone, and the seagrass fringing low intertidal zone. These habitats supported quantitatively differing faunas.

There was no evidence of the species impoverishment reported elsewhere for the epizoic fauna of this region. Comparison of the characteristics of the fauna with that of another negative estuary, the Port River in Gulf St Vincent, has provided the basis of a monitoring programme to assess potential environmental stress imposed by power station development in northern Spencer Gulf.

Key Words: Intertidal habitats, benthic fauna, seagrass, Spencer Gulf.

Introduction

Northern Spencer Gulf can be defined as that portion of Spencer Gulf, South Australia, north of the line from Ward Spit to Lowly Point, i.e. north of 33°S (Stefanson 1977). It is a unique, narrow body of water, projecting inland some 200km from the Southern Ocean coast (Fig. 1).

The waters of northern Spencer Gulf are characterised by high summer salinities, up to 48 (Nunes & Lennon 1986) and high summer temperatures with wide seasonal fluctuations, 11–25°C (Johnson 1981[1]). Due to high evaporation, and low fresh water inflow to the northern Gulf, there is a longitudinal salinity gradient of about four in 20km. The region has been described as a negative estuary.

A limited number of studies has been carried out on the marine communities of the "middle Gulf" (SEA 1981[2]; Ward & Young 1982, 83) and concurrently with this study, Kinhill (1987)[3] have examined intertidal communities at Ward Spit and Lowly Point. Shepherd (1983) provides the only published description of benthic communities of the narrow reaches of the northern Gulf. Shepherd found a marked reduction in species number in the epizoic communities on *Pinna bicolor* in northern Spencer Gulf compared to that of the same habitat in Gulf St Vincent, raising the possibility of a general species impoverishment in the hyper-saline waters of northern Spencer Gulf. He emphasised the need for further detailed study of other "component parts" of the biological system to determine its capacity to accept additional stresses of industrial wastes and discharges.

Since the mid 1950's Playford Power Station has been operating on the eastern shore of the northern Gulf, discharging warmed cooling water to the Gulf. The discharge from Playford Power Station, operating at it's maximum nominal capacity of 330MW, resulted in surface water temperatures about 6°C above ambient near the power station, with only occasional incursions of warmed water (about 3°C above ambient) to nearby intertidal zones (ETSA 1977[4]). In 1977 and 1985 the Electricity Trust of South Australia issued Environmental Impact Statements for three further power station units, with a total generating capacity of 750MW, to be built in this area. This development forms the Northern Power Station. Thermal discharges were predicted to more than double (ETSA 1977[4], 1985[5]).

The effects of warm water discharge from power stations on benthic fauna have been the subject of a number of reviews (Coutant & Talmage 1975; Talmage & Coutant 1980; Craven *et al* 1983; Langford 1983). Effects vary from site to site as a

[1] Johnson, J.E. (1981) Hydrological Data for Upper Spencer Gulf 1975–1978. Fisheries Res. Paper No. 3, 1–30, (Dept. Fisheries, Adelaide), unpubl.

[2] Social and Ecological Assessment (1981) Draft Environmental Impact Statement for port and terminal facilities at Stony Point, South Australia. Prepared for SANTOS, unpubl.

[3] Kinhill (1987) Upper Spencer Gulf Intertidal Survey. Final Report, May 1987, unpubl.

[4] Electricity Trust of South Australia (1977) Northern Power Station Environmental Impact Statement. July 1977, unpubl.

[5] Electricity Trust of South Australia (1985) Northern Power Station Environmental Impact Statement. August 1985. Prepared by Kinhill Stearns, unpubl.

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function of the climatic, hydrological and biological features (Crema & Pagliai 1980). Greatest effects are observed near the outfalls, at the hottest times of the year (Langford 1983) and include changes in the biological characteristics of the benthic communities within the zone of influence of the warm water plume (Robinson *et al* 1983; Robinson 1985; Thomas *et al* 1986). In particular, Bamber & Spencer (1984) and Thomas *et al* (1986) have described the decline in populations of particular bivalve mollusc species and the establishment of dense populations of opportunistic worm species as characteristic of thermal disturbance in soft substrates.

The present study began in 1982, three years prior to the commencement of operation of the new power station. Intermittent operation of the first 250MW unit commenced in the summer of 1985, with 500MW operating by summer 1986. The aim of the study was to investigate spatial and temporal patterns of the benthic communities in the negative estuary of northern Spencer Gulf. It was anticipated that detailed descriptions of these communities would identify whether or not there were any biological impacts from the existing power station development (and early operation of the new development), and establish baseline data for long term assessment of the effects of increased thermal discharge. This study concentrated on the intertidal and shallow sublittoral fringe, as the only other published South Australian study on the impacts of thermal discharge on the marine environment had described well defined patterns of change in the communities of this zone (Thomas *et al* 1986).

The influence on communities of sediment type, degree of emersion, and presence of seagrass are investigated in this study.

Station locations, elevations, and sediments.

Near Port Augusta the narrow channel basin of northern Spencer Gulf is bordered by shallow sublittoral seagrass meadows and extensive intertidal mudflats backed by stands of the grey mangrove, *Avicennia marina* var *resinifera* (Fig. 1).

Seven transects were established along the eastern shore of the gulf, both adjacent to and remote from, existing and proposed power station developments (Fig. 1). Three stations were established at different intertidal zones on each transect. Each station had an area of about 25m². On each transect, station 1 was located 30m seaward from the mangrove fringe, station 3 was located at the seagrass verge, (emergent at extreme low tide) and station 2 was located midway between 1 and 3. The locations and elevations of each station were confirmed relative to an established Port Augusta Power Station datum, using an EDM theodolite.

Sediment samples were collected from each station on all transects and analysed for grain size according to the Wentworth scale (Folk 1968) with minor modifications (Thomas *et al* 1986). Graphic means, Mz, (Folk 1968) were determined for the samples. The Bray-Curtis classification technique was used to determine homogeneity groups based on the percentage distribution of particular sediment size classes in each sample (Miedeke & Stephenson 1977; Thomas *et al* 1986).

Water and air temperature.

For the study period 1982–1986, a continuous record of Gulf water temperature was made at the cooling water intakes of Playford Power Station. A continuous three hourly record of ambient air temperature was made at the SA Weather Bureau's Port Augusta weather station No. 019066.

Fauna

Each station was sampled using a hand operated corer collecting a sediment sample of 1600 cm³, surface area 80 cm², to a depth of 20 cm. The samples were taken during daylight hours.

The pattern of species accumulation with repeated random coring within a station area was determined. By subsample 20, about 90% of the species recorded in 40 subsamples had been found, and those species which occurred after subsample 20 comprised an extremely small number of the total number of individuals sampled. The decision was made to proceed using 20 subsamples per station, exceeding the species-area requirements proposed by Cain & Castro (1959) and meeting the stringent proposals of Weinberg (1978). Each station was sampled twice yearly (winter and summer) from June 1982 to June 1986. Samples were treated as described in Thomas *et al* (1986). Faunal relationships (between stations, transects, tidal zones, and sampling times) were interpreted using Bray-Curtis classification after root-root transformation of the data, and dendrograms were constructed with group average sorting (Swartz 1978; Field *et al* 1982).

Species constancy, abundance rank scores, and average rank scores were assigned as in Hailstone (1976) for 160 species totalling 34,312 individuals.

Species associations were determined using Bray Curtis classification analysis on non-transformed data, considering the 40 top ranked species for the period 1982–1986.

Results

Station elevations and sediments

Tidal fluctuations relative to station zones result in different periods of emergence for stations 1, 2 and 3 on all transects. Considering February 1984,

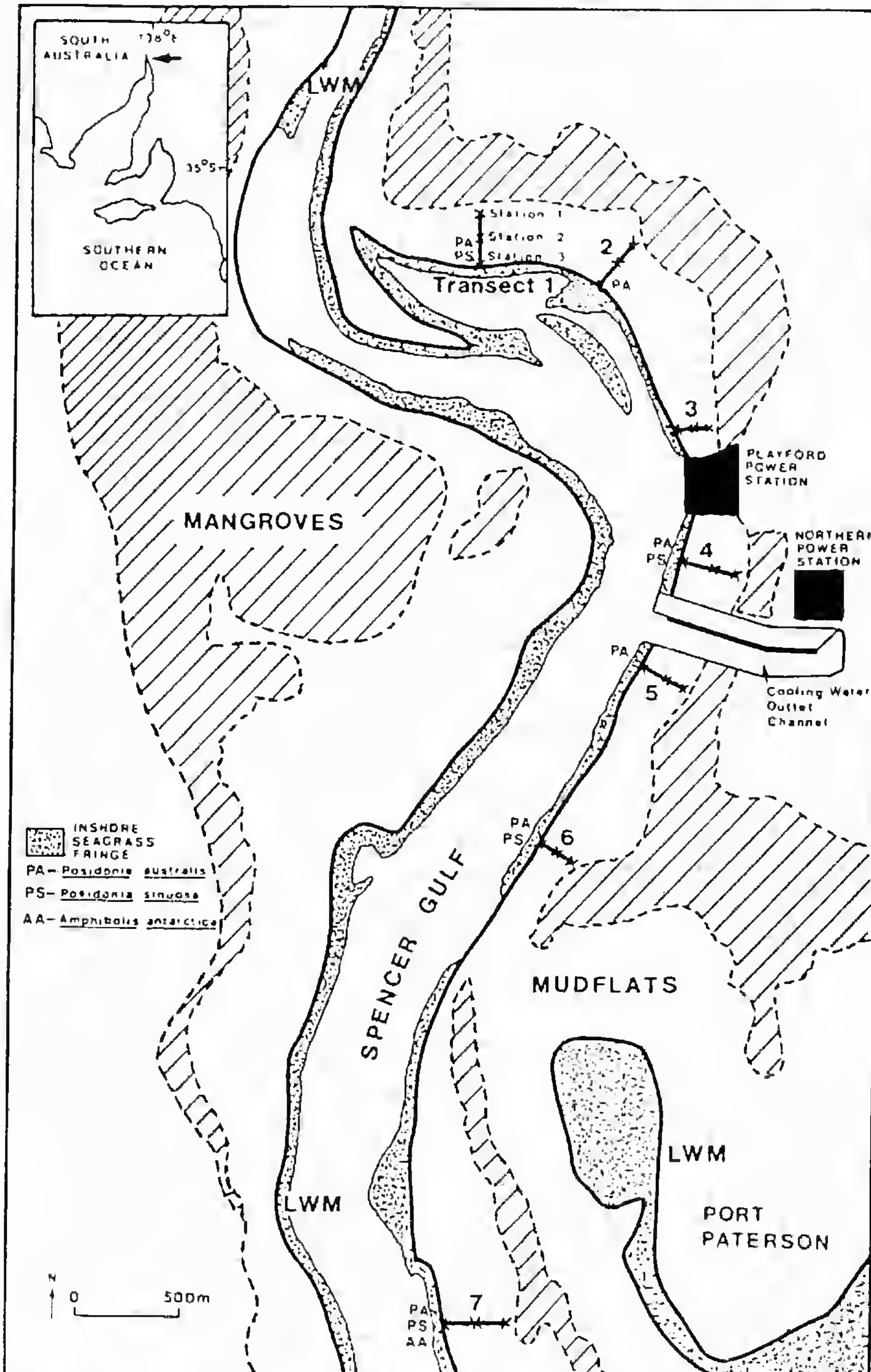

Fig. 1. Sampling station locations. Northern Spencer Gulf, South Australia. Inshore fringing seagrass species also denoted.

the station 1 zone is emergent for over 200 hours/month, station 2 for about 80 hours/month, and station 3 for about 5 hours/month, or less than 1% of the time. In winter even shorter periods of emergence occur at the low intertidal zone. Local meteorological conditions, such as wind velocity, also affect the degree of exposure on low spring tides. Thus stations 1 and 2 are clearly mid intertidal stations while station 3 is in the low intertidal zone.

The mid intertidal stations are devoid of seagrass cover. The seagrass species at stations 3 include both *Posidonia australis* and *Posidonia sinuosa*, without clear cut zonation in the shallow water. Some *Amphibolus antarctica* is present at transect 7.

The hierarchical classification of sediments from all stations gives two major groups of stations, groups (a) and (b) Fig. 2. The sediments of stations forming group (a) have Mz values which generally range from medium sand (1.5φ) to coarse sand (0.25φ). The exceptions are station 1.1 which is classified as fine sand (Mz = 2.5φ), and the subgroup formed by sediments of stations 6.1 and 6.2. These last two stations have Mz values between 0 and −.25φ (ie. at the lower end of the very coarse - sand scale).

The second major group of sediments (b) have Mz values ranging from very coarse sand (−.25φ) through to granules (−1.7φ), with stations 7.1 and 7.2 having the coarsest sediments recorded in the survey. Although sediments of station 7.3 have an Mz value of 1.25φ (medium sand), this station forms its own subgroup on the dendrogram because of the restricted distribution in grain size around the median, unlike all other samples which had more or less even ranges of grain sizes.

Air and water temperatures

Air and water temperatures 1982, 1984 and 1985 show that seasonal water temperatures follow air temperatures. Ambient average monthly water temperatures range from 11–12.5°C in winter to 24–25°C in summer (Fig. 3).

There is no indication of change in the overall ambient temperature from 1982–1985, as a result of intermittent cooling water discharge from the existing power station development.

Fauna

A total of 160 species were recorded; polychaetes were the most numerous with 52 species, including several new records for S. Aust. (Table 1). Molluscs with 50 species and crustaceans, 40 species, were next in abundance, with 18 species from various other taxa (Table 1).

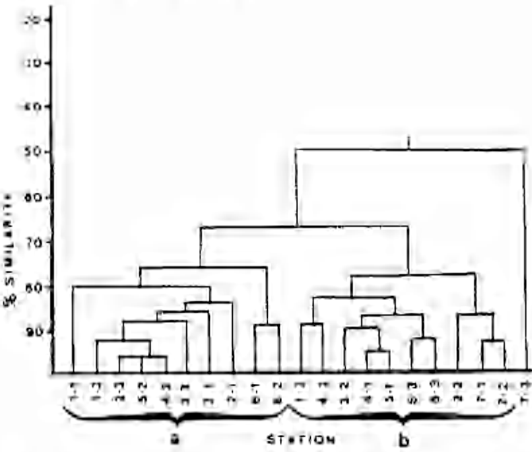

Fig. 2. Dendrogram of northern Spencer Gulf stations by sediment grades.

Fig. 4 presents the station faunal homogeneity dendrograms for the first two seasonal surveys (winter 1982, summer 1983), and for the last two surveys (summer and winter 1986). In all cases, at about the 25–30% level the homogeneity dendrograms consistently show two major collection clusters with high intra-group homogeneity (Fig. 4 (1–4), Groups A and B). Generally the faunas of stations 1 and 2 on all transects comprise Group A on each dendrogram, and station 3 faunas form Group B. In two of the dendrograms presented (winter 1982 and summer 1986) there are exceptions to this generalisation, but there is no seasonal or spatial pattern to the exceptions, and the major trend persists. There is no evidence of consistent subgrouping within the major observed associations (Group A and Group B, Fig. 4). This tendency for faunas of mid intertidal stations 1 and 2 to group more closely together than to those of station 3 has been consistent throughout the four year study period and is also reflected in the the tidal zone analysis, (Fig. 5) for each survey 1982–1986.

The species homogeneity dendrogram determined using the 40 most common species is presented in Fig. 6. Accepting the arbitrary cut-off level of 25% similarity, this dendrogram shows two major groups of species (A1 and B1, Fig. 6). Although all but two of the forty most common species occur over all stations, those which form Group A1 always contribute a greater proportion of the total number of individuals in the samples of stations 1 and 2 and those of Group B1 are always more abundant in the station 3 faunas.

Together these analyses (Figs. 4, 5 & 6) indicate that the two habitats represented by the mid intertidal region (stations 1 and 2) and the low interti-

TABLE 1. *Species recorded throughout the study. New records for South Australia are indicated by an asterisk.*

	Exclusively mid intertidal	Exclusively low intertidal
POLYCHAETES		
Olganereis edmondsi (Hartman)		
Neanthes vaalii Kinberg		
Neanthes cricognatha (Ehlers)		
Ceratonereis transversa Hutchings & Turvey		+
Ceratonereis mirabilis Kinberg		
Perinereis nuntia (Grube)		
Perinereis amblyodonta (Schmarda)	+	
Perinereis sp		
Nereis triangularis Hutchings & Turvey		
Nereis sp		+
Nematonereis unicornis (Grube)*		+
Marphysa sp*		
Arabellidae 1*		+
Arabellidae 2*		+
Lysidice sp		
Eunice sp		+
Schistomeringos sp		
Lumbrinereis sp		
Nephtys australiensis Fauchald		
Glycera americana Leidy		
Phylo sp*		+
Scoloplos cylindrifer Ehlers		
Leitoscoloplos normalis Day*		
Leitoscoloplos sp		
Naineris grubei australis Hartman		
Phyllodocidae 1*		+
Phyllodocidae 2*		+
Phyllodocidae 3*	+	
Cirriformia filigera (Grube)		
Cirratulidae sp		
Boccardia chilensis Blake & Kudenov		
Harmothoe sp 1^A		+
Harmothoe sp 2^A		+
Harmothoe sp 3^A		+
Lysilla apheles Hutchings*		
Liomia medusa (Savigny)*		
Eupolymnia nebulosa (Montague)		
Streblosoma sp*		
Terebellinae 1		
Terebellinae 2	+	
Terebellinae 3		+
Terebellinae 4		+
Polycirrinae*		+
Barantolla lepte Hutchings		
Notomastus sp		+
Paraonidae		
Pherusa sp		+
Armandia sp		
Galeolaria caespitosa (Savigny)		+
Scalibregma sp*		+
Maldanidae*		
Magelona sp*		
NEMERTEAN		
Nemertean spp	+	
SIPUNCULID		
Golfingia margaritacea adelaidensis Edmonds		

A – species seperated on basis of anterior elytrae.

	Exclusively mid intertidal	Exclusively low intertidal
BIVALVES		
Tellina deltoidalis Lamarck		
Laternula recta (Reeve)		
Katelysia peronii Lamarck		
Katelysia scalarina (Lamarck)		
Brachidontes erosus (Lamarck)		
Xenostrobus inconstans (Lamarck)		
Ostrea angasi Sowerby		
Pinna bicolor Gmelin		+
Malleus meridianus Cotton		+
Anomia trigonopsis Hutton		
Circe scripta Cotton		
Electroma georgiana (Quoy & Gaimard)		+
Trichomya hirsuta Lamarck		
Chlamys bifrons Lamarck		+
Musculus paulucciae Crosse		+
Corbula flindersi Cotton		+
Lucilinidae		+
GASTROPODS		
Salinator fragilis (Lamarck)		
Nassarius burchardi (Philippa)		
Nassarius pauperatus (Lamarck)		
Monodonta constricta Lamarck		
Bembicium melanostomum (Gmelin)		
Batillaria estuarina (Tate)	+	
Batillaria diemenensis (Quoy & Gaimard)		
Bedeva paivae (Crosse)		
Cominella erburnea (Reeve)		+
Cominella sp		
Austroliotia densilineata (Tate)		
Diala lauta A. Adams		+
Quibulla tenuissima Sowerby		
Lepsiella vinosa Lamarck		
Conus anemone Lamarck		+
Cantharidus irisodontes (Quoy & Gaimard)		
Clanculus plebejus (Philippi)		
Clanculus weedingi (Cotton)		+
Phasianella australis (Gmelin)	+	
Hydrobia sp		+
Microcolus sp	+	
Sophismalepas nigrita (Sowerby)		+
Pterynotus triformis (Reeve)		+
Nudibranchiata		
Opisthobranchia		+
Notomella sp		+
Elegidion occiduus Cotton		+
Asteracmea sp 1		
Asteracmea sp 2	+	
Stomatella auricula (Lamarck)		
CHITONS		
Ischnochiton variegatus Adams & Angus		+
Ischnochiton contractus Reeve		+
Heterozona sp		
CEPHALOPODS		
Hapalochlaena maculosa Quoy & Gaimard		

	Exclusively mid intertidal	Exclusively low intertidal
DECAPODS		
Penaeus latisulcatus (Kishinonye)		
Processa gracilis (Baker)		+
Leander serenus (Heller)		
Leander intermedius (Stimpson)		+
Paguristes frontalis (M. Edwards)		
Paguristes brevirostris (Baker)		+
Callianassa aequimana (Baker)		+
Callianassa ceramica (Fulton & Grant)		
Crangon socialis (Heller)		
Pilumnus fissifrons (Stimpson)		
Philyra laevis (Bell)		
Cryptocnemus vincentianus Hale		+
Polyonyx transversus (Haswell)		+
Gomeza bicornis (Gray)		+
Halicarcinus ovatus (Stimpson)		+
Litocheira bispinosa (Kinahan)		+
Portunus pelagicus (Linnaeus)		+
Helograpsus haswellianus (Whitelegge)		
Ceratoplax punctata (Baker)		+
AMPHIPODS		
Maera mastersii (Haswell)		+
Birubius panamunus Barnard & Drummond		
Elasmopus bampo Barnard		
Allorchestes compressa (Dana)		
Ceradocus serratus (Bate)		+
Cymadusa sp		
Gammaridae 1		
Gammaridae 2		+
Gammaridae 3		+
ISOPODS		
Cymodoce longicaudata (Baker)		+
Zuzara venosa (Stebbing)	+	
Exosphaeroma sp	+	
Cirolana woodjonesi (Hale)		+
Cymothoidae		+
Anthuridae 1		
Anthuridae 2		
TANAIDS		
Apsuedes australis (Haswell)		
Paratanais ignotus (Chilton)		
Tanaidae		
CIRRIPEDS		
Balanus amphitrite Darwin		
Elminius modestus Darwin		
CNIDARIANS		
Anthothoe albocincta (Stuckey)		
Cricophorus nutrix (Stuckey)		+
PISCES		
Nesogobius hinsbyi (McCulloch & Ogilby)		
Gymnapistes marmoratus (Cuvier & Valenciennes)		
Plotosidae		+

	Exclusively mid intertidal	Exclusively low intertidal
ECHINODERMS		
Leptosynapta dolabrifera (Stimpson)		
Taeniogyrus roebucki (Joshua)	+	
Amblypneustes sp		+
Trochodota sp	+	
Ophiuroidea 1		+
Ophiuroidea 2		
Dendrochirotida		
Echinoidea		
ASCIDIANS		
Ascidia sp		+
DIPTERA		
Dolichopodidae	+	

dal fringe (stations 3) can be considered to have quantitatively differing faunas.

Fig. 7 compares mean number of species/m², and mean numbers of individuals/m² for these two habitats over the period 1982–1986. Significantly more species/m² are found in the low intertidal stations. Reference to the species list for all surveys reveals that of the 160 species collected, 86 (54%) occur over the whole tidal range. This 55% includes 37 of the 40 most common species. Fifty-nine species, or 38% of the total, occur exclusively in the low intertidal zone, and only 8% occur exclusively in the mid intertidal zone occupied by stations 1 and 2 (Table 1). In contrast to species abundance, the communities of mid intertidal stations 1 and 2 consistently have significantly higher mean numbers of individuals (Fig. 7) than those of the seagrass fringing stations 3. Nine of the 10 most common species are more abundant at stations 1 and 2 (Table 2, Fig. 6); conversely, of the 61 species exclusive to the station 3 community, only two appear in the "top 40" list (Table 2). Nevertheless the less common, but exclusively station 3 species, contribute to the consistent separation on the station and tidal zone faunal homogeneity dendrograms (Figs. 4 and 5).

Fig. 8 shows the intersurvey time dendrograms comparing whole survey collections for each of the two communities for the period 1982–1986.

Discussion

Community-habitat relationships of the mid intertidal and low intertidal zones.

In many studies sediment characteristics have been shown to be a significant factor in determining benthic community patterns (Gray 1974; Saenger *et al* 1982; Jones *et al* 1986). In intertidal regions particularly, there is the potential for wave action to grade sediments, resulting in coarser particles on the upper shore line. Such a graded series of sediments is potentially reflected in the nature of the benthic communities (Gage 1974; Robinson 1985). On the low energy shore of northern Spencer Gulf there is no sediment gradation, with random groupings of station sediments irrespective of the zones in which the stations occur. There is a high overall similarity in the sediments, the two main groups discerned (medium to coarse sand, and coarse sand to granules) showing about 70% similarity on the homogeneity dendrogram (Fig. 2). In common with other studies of the South Australian Gulfs where a limited range of sediments is found (Kinhill 1987[3]; Thomas *et al* 1986) there is no evidence that this factor influences benthic community distributions in the northern Spencer Gulf.

The mid intertidal zone is characterised by species which, although more common in this zone, occur over the whole tidal range (Table 1). The most abundant species is the mussel, *Brachidontes erosus*, which forms dense mats in this zone. Such mussel mats are characteristic of many low energy sand and mud flat substrata in S. Aust. (Womersley & Thomas 1976; Thomas *et al* 1986). Other bivalves, although less abundant than the mussels, are also characteristic of the mid intertidal zone. These include *Tellina deltoidalis*, a species belonging to a genus known to have a behavioural response to light direction which contributes to its zone maintenance (Newell 1979), *Katelysia scalarina*, and *Laternula recta*. These bivalves contribute to the abundance of many other species as they provide the substratum for the settlement of the barnacles *Elminius modestus* and *Balanus amphi-*

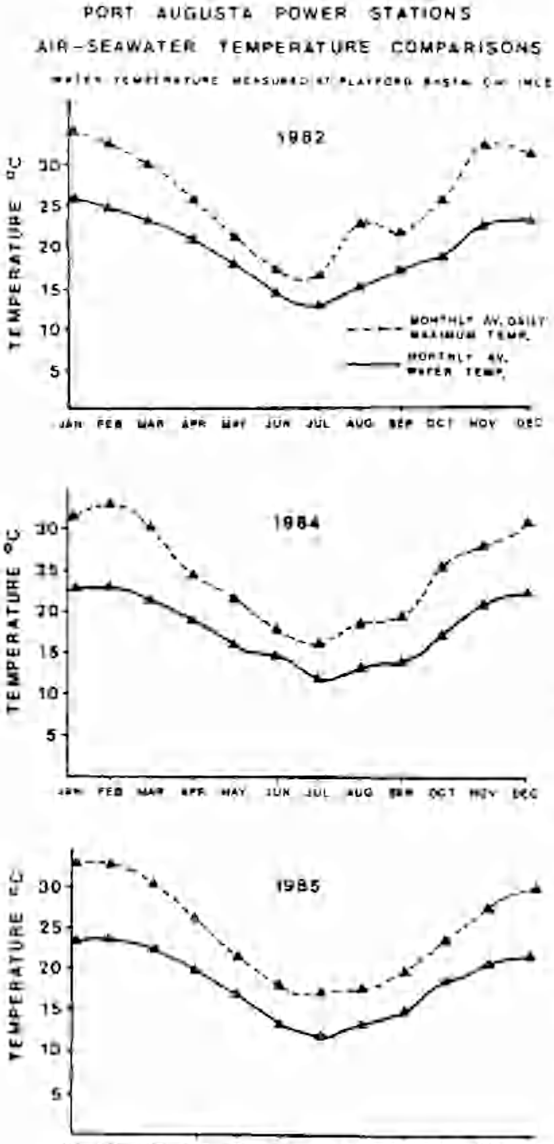

Fig. 3. Monthly averages of daily maximum air temperatures recorded at SA Weather Bureau Station No 019066, Playford Power Station, Pt Augusta (Fig 1). Monthly average ambient Gulf water temperature derived from continuous hourly records at the circulating water intakes, Playford Power Station.

trite, and the sea anemone *Anthothoe albocincta*. There also appears to be a close relationship between the large bivalve species and the omnivorous worm species *Nephtys australiensis, Neanthes vaalii, Olganereis edmondsi*, and *Nereis triangularis*. The last species seems generally to be associated with mussel beds (Hutchings & Murray 1984). Several species of scavenging and carnivorous snails (*Nassarius pauperatus, Bedeva paivae, Batillaria estuarina*, and *Batillaria diemenensis*) also occur in the community dominated by the mussel beds, as does the scavenging crab *Philyra laevis*, characteristic of the mid intertidal zone on low energy coastlines of S. Aust. (Womersley & Thomas 1976). The herbivorous top shell, *Monodonta constricta* is common among the dense mussel beds which provide a substrate for algal growth, particularly *Enteromorpha spp*.

In the extreme weather conditions of the northern Spencer Gulf it is clear that a number of ubiquitous intertidal species are restricted to the low intertidal zone. These include the polychaetes *Nematonereis unicornis, Ceratonereis transversa, Barantolla lepte, Cirriformia filigera* and *Leitoscoloplos normalis*, for which a range of habitats has been documented (Hutchings & Murray 1984) and the gastropods *Nassarius burchardi*, and *Austroliotia densilineata*, also found elsewhere over broad tidal ranges (Thomas *et al* 1986). Conversely, there are a number of species which are generally characteristic of the subtidal zone. These include such species as the hammer oyster *Malleus meridianus*, the scallop *Chlamys bifrons*, the blue swimmer crab *Portunus pelagicus*, and several other species primarily, or only, found in association with seagrass (*Electroma georgiana* (Ludbrook 1984), *Golfingia margaritacea adelaidensis* (Edmonds 1980) and *Amblypneustes* sp. (Shepherd & Sprigg 1976)). The major environmental factor which appears to separate the habitats described in this study is the "degree of exposure". This is a function not only of the length of the periods of emersion (in a region of high summer air temperatures) but also the protection from environmental extremes provided by the presence of seagrass in the low intertidal zone.

Comparisons with other areas.

Are the intertidal communities of northern Spencer Gulf impoverished as evidence may suggest for epizoic fauna on *Pinna bicolor*? There are inherent difficulties in comparing communities of various marine and estuarine areas. Generalisations from one area to another are often of limited value beyond the broad observation that marine dominated sites generally have more species than estuarine sites (Collett *et al* 1984). Accepting this limitation it can nevertheless be seen that the total number of species found in the present study (160) is within the range of species number recorded in several studies of eastern Australian "estuarine" regions (Rainer & Fitzhardinge 1981; Jones *et al* 1986), and is comparable to the number recorded in a recent study of the intertidal mudflat fauna of the Port River estuary, Gulf St Vincent (Thomas *et al* 1986). About one and a half times as

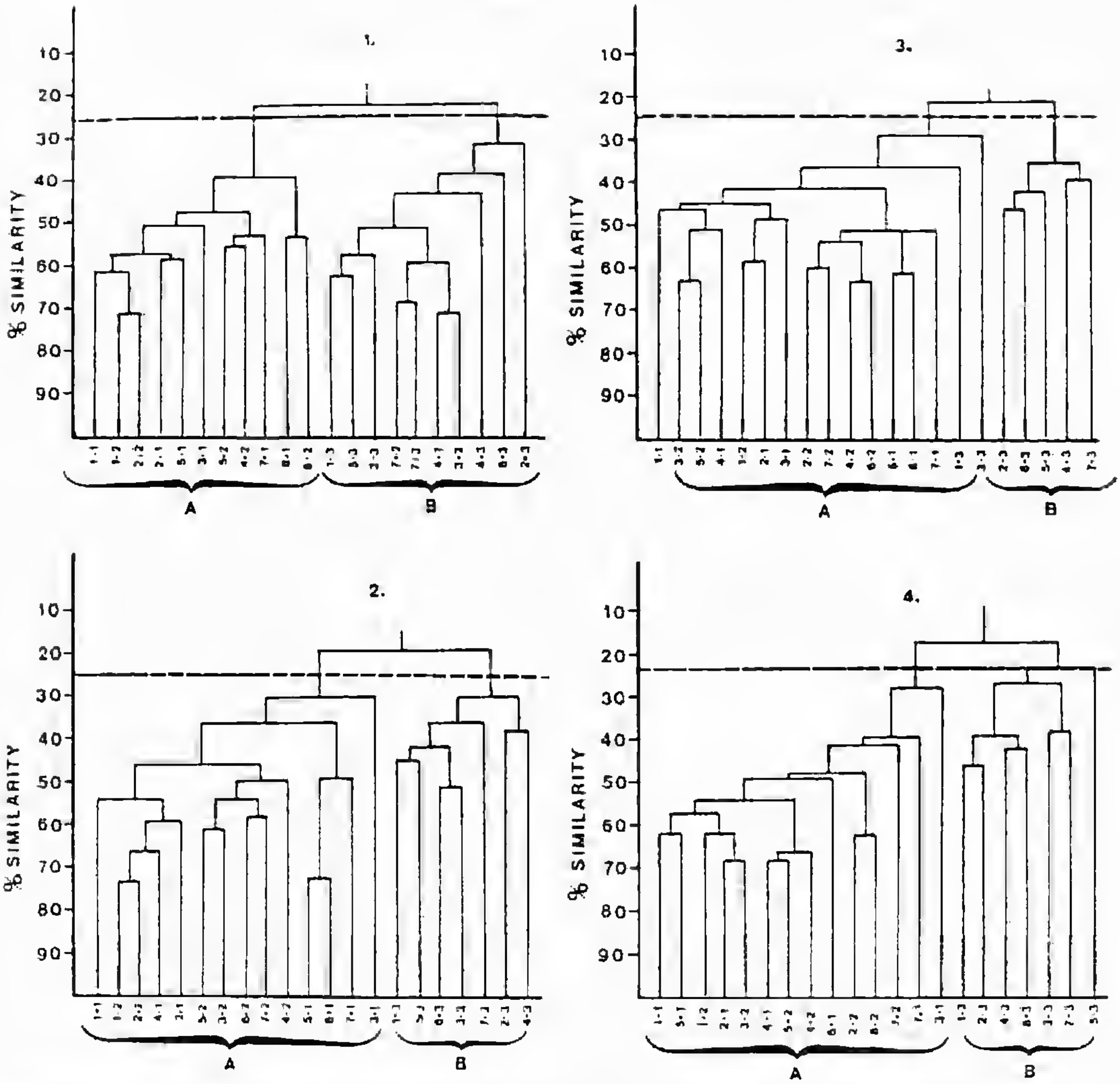

Fig. 4. Station faunal homogeneity dendrograms. (1) winter 1982, (2) summer 1983, (3) summer 1986, (4) winter 1986.

many species are recorded in the present study as were recorded by Kinhill (1987)[3] for intertidal mudflats about 50 km further south in Spencer Gulf where salinities are four to five lower (Nunes & Lennon 1986). Kinhill (1987)[3] did not sample at the seagrass fringe (D Evans pers. comm.). Disregarding the 38% of the total number of species which are exclusive to the seagrass fringe in the present study leaves a species number very similar to that found by Kinhill (1987)[3]. Therefore this study provides no evidence of species impoverishment in the intertidal zone, related to high salinity or other environmental factors characteristic of the area.

Natural variations in the intertidal communities of northern Spencer Gulf

For a baseline study to be of use in post development monitoring an understanding of natural variations in the species matrix is necessary. The faunal homogeneity dendrograms for both stations and tidal zones demonstrate the consistent relationship between the mid intertidal and low intertidal communities over several seasons. Between 1982 and 1986 the common core species characterising these two habitats remained constant (Table 2). Perhaps surprisingly no seasonal pattern emerged from the intersurvey comparisons. The over-riding pattern which showed for both habitats was the trend for sequential subgrouping of surveys, with survey faunas within each of the two habitats showing high similarity, grouping at the 60%–70% similarity level in each case. Sequential grouping of survey faunas does not appear to be unusual. Saenger *et al* (1980) interpreted such a pattern as demonstrating progressive recolonisation following environmental disturbance. Buchanan *et al* (1974, 1978), however, observed similar sequential subgrouping of survey faunas from undisturbed marine environments and interpreted this pattern as indicating a more or less continual change in the presence and abundance of occasional or rare species while the core species remain relatively constant. Given the overall similarity in survey faunas over time this seems the most likely explanation here. The slightly lower intersurvey similarities of the low intertidal communities, compared to those of the mid intertidal communities, is a consequence of the fact that the former are characterised by more rare or occasional species.

Monitoring for changes associated with environmental disturbance

Changes in estuarine faunas in response to organic or thermal disturbance have been well documented (Gray 1976; Parker 1980; Bamber & Spencer 1984; Thomas *et al* 1986). In particular, in the negative estuary of the Port River, Gulf St

TABLE 2. *Common species of the intertidal fauna of Northern Spencer Gulf, determined by reference to constancy, and abundance rank scores (Hailstone 1976).* Note that the top 40 species ranked in this table includes all 21 species° which would be selected on Field *et al*'s (1982) arbitrary cutoff for dominant species, namely species which contribute 4% or more to the total population of any one survey.

RANK	*CODE (Refer Fig 6)*	*SPECIES*	*% ABUNDANCE*	*% CONSTANCY*
°1	W1	*Olganereis edmondsi*	10.2	73.5
°1	W3	*Nephtys australiensis*	7.7	95.1
°3	B7	*Brachidontes erosus*	36.8	65.9
°4	B1	*Tellina deltoidalis*	3.0	73.0
°5	B15	*Nassarius pauperatus*	2.2	67.6
°6 *	C4	*Paguristes frontalis*	2.3	62.2
7	B13	*Batillaria diemenensis*	3.9	47.0
°8	B4	*Katelysia scalarina*	2.0	56.7
°9	C7	*Elminius modestus*	4.3	33.0
°10	W6	*Scoloplos cylindrifer*	1.7	49.2
°11	W2	*Neanthes vaalii*	1.8	45.9
12	B9	*Monodonta constricta*	0.95	34.0
°12	C2	*Callianassa ceramica*	0.8	53.5
°14	B3	*Salinator fragilis*	3.7	23.8
°14*	W7	*Cirriformia filigera*	0.95	34.0
°16	C32	*Balanus amphitrite*	4.6	20.5
°17*	W10	*Barantolla lepte*	0.9	28.1
°18*	C18	*Apsuedes australis*	0.9	23.8
19*	W30	Nemertean spp	0.35	34.6
20	W11	*Nereis triangularis*	0.55	24.3
20*	B5	*Nassarius burchardi*	0.5	28.1
°22*	W15	Maldanidae	0.5	26.5
23	W9	*Marphysa* sp	0.37	28.1
24	W19	Terebellinae 1	0.6	17.8
24	W22	*Lysilla apheles*	0.5	22.2
°26	C14	*Crangon socialis*	0.28	23.8
27	C9	*Philyra laevis*	0.26	23.8
28	B2	*Laternula recta*	0.21	23.8
29	B26	*Asteracmea* sp 1	0.3	20.5
30	B11	*Batillaria estuarina*	0.7	9.7
31	B12	*Bedeva paivae*	0.17	17.8
32	X5	*Anthothoe albocincta*	0.2	15.1
°33*	W33	*Eupolymnia nebulosa*	0.4	9.7
°33	W20	*Streblosoma* sp	0.24	13.0
35	B14	*Katelysia peronii*	0.14	15.7
36*	W38	*Golfingia m adelaidensis*	0.14	13.5
°37*	B35	*Electroma georgiana*	0.2	10.8
38*	B20	*Austroliotia densilineata*	0.5	7.6
38*	W34	*Schistomeringos* sp	0.12	15.1
40*	W12	*Leitoscoloplos normalis*	0.15	10.8

* Most common species in the low intertidal zone Group B1 Fig. 6.

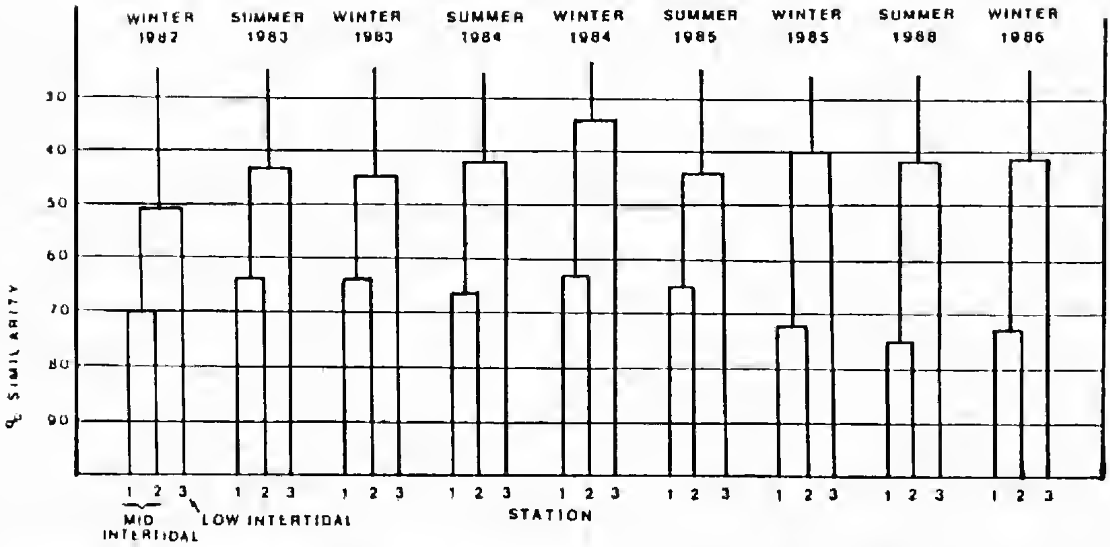

Fig. 5. Faunal homogeneity dendrograms with respect to tidal zones for all surveys, 1982–1986.

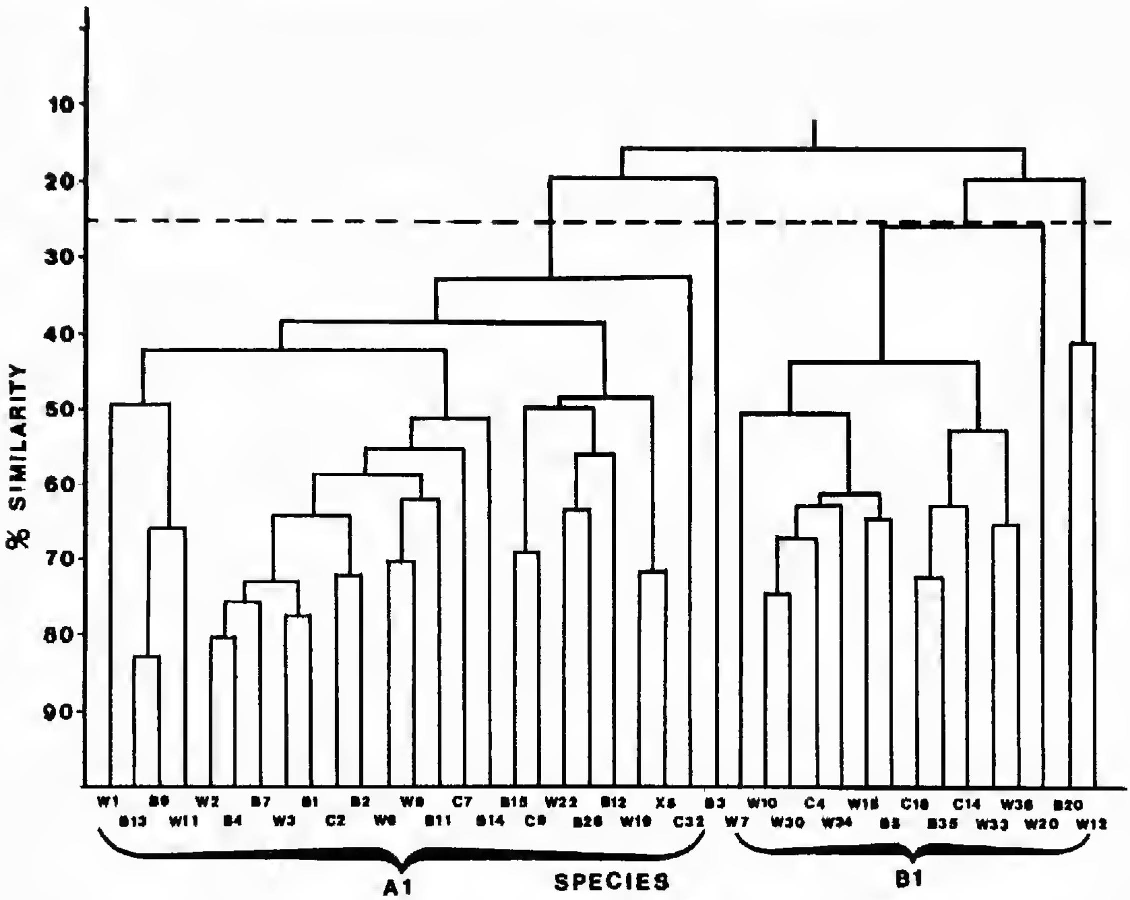

Fig. 6. Species homogeneity dendrogram determined on non transformed data for the 40 most common species for the period 1982–1986 as determined by average rank scores assigned as in Hailstone (1976).

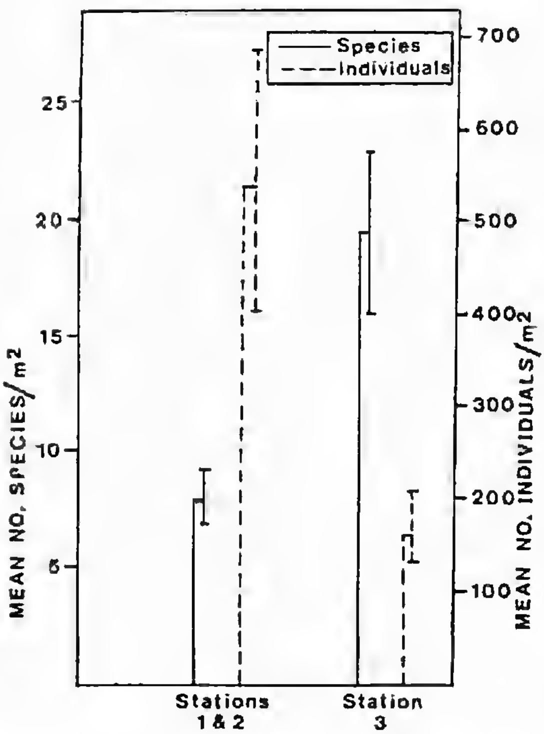

Fig. 7. Comparison of numbers of species/m² and numbers of individuals/m² for mid intertidal stations 1 and 2, and for low intertidal stations 3's.

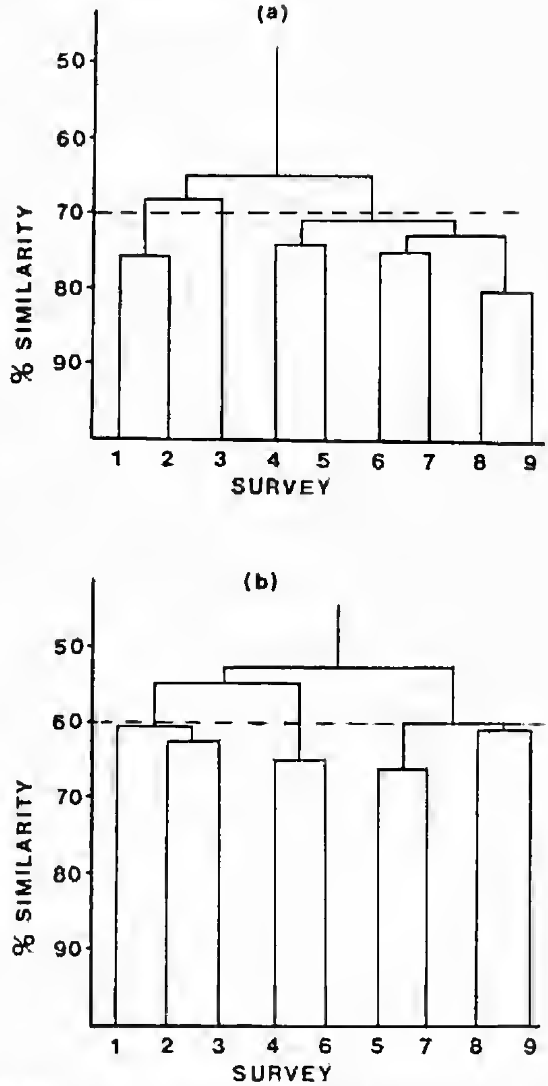

Fig. 8. Intersurvey faunal homogeneity dendrograms. (a) stations 1 and 2, (b) stations 3. Survey number 1 – winter 1982, 2 – summer 1983, 3 – winter 1983, 4 – summer 1984, 5 – winter 1984, 6 – summer 1985, 7 – winter 1985, 8 – summer 1986, 9 – winter 1986.

Vincent, Thomas *et al* (1986) describe responses of intertidal communities to progressive increase of thermal discharge from Torrens Island Power Station. These include suppression or elimination of populations of bivalve mollusc and worm species characteristic of undisturbed regions, and increases in populations of opportunistic worm species. Of the 120 species recorded from the Port River estuary about 50 species (40%) also contribute to the 160 species of the present study. These include several bivalve and worm species which had a negative response to thermal discharges, and which played a significant part in defining thermal perturbation in the Port River, namely the bivalves *Tellina deltoidalis, Katelysia scalarina* and *K. peronii,* and the worms *Nephtys australiensis, Neanthes vaalii* and *Scoloplos cylindrifer.* All of these species are common in the communities of the mudflats of northern Spencer Gulf, particularly in the mid intertidal zone (Table 2). The presence of these common indicator species provides the basis of a monitoring programme to detect potential thermal perturbation in northern Spencer Gulf. Any changes in abundance of these species in areas near thermal discharges will be reflected in recognisable changes to the stable faunal homogeneity relationships described in this study over the period 1982–1986. Such changes in faunal homogeneity dendrogram patterns have been clearly demonstrated by Thomas *et al* (1986) in studies of changes in the fauna of the Port River estuary with progressive increase in thermal discharge to that region. The cirratulid worm *Cirriformia filigera* is common in the low intertidal zone (Tables 1–2). Although the life history of this particular species is not well known, other members of this genus have been shown to have typical opportunistic characteristics, capable of rapid colonisation of disturbed regions

(George 1964 a,b; Thomas *et al* 1986). The archetypal opportunistic worm species *Capitella capitata* (Grassle & Grassle 1974; Gray 1976; Tsutsumi 1987) has not been recorded in the present study. It is, however, present in intertidal communities 50 km further south (Kinhill 1987[3]), and it is not unusual for opportunistic species in disturbed regions to be immigrants from other regions (Thomas *et al* 1986). As with changes in the indicator species discussed above, any changes in populations of opportunistic worm species near the thermal discharge can be expected to noticeably alter the patterns of the faunal homogeneity dendrograms, warning of potentially significant environmental perturbation. To 1986 no impact of the occasional incursions of warmed water from Thomas Playford Power Station to the intertidal zone, and the initial discharge from the Northern Power Station (from summer 1985) can be discerned from community relationships described in the present study.

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ROTIFERA FROM AUSTRALIAN INLAND WATERS. III. EUCHLANIDAE, MYTILINIDAE AND TRICHOTRIIDAE (ROTIFERA:MONOGONONTA)

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Summary

Diagnostic keys are given to the Australian representatives of the Rotifera: Monogononta in the families Euchlanidae *(Manfredium, Diplois, Dipleuchlanis, Tripleuchlanis, Euchlanis),* Mytilinidae *(Mytilina, Lophocharis)* and Trichotriidae *(Wolga, Macrochaetus, Trichotria).* All species known from Australian inland waters are described and figured, as are some widely distributed taxa not yet recorded from the continent. Distribution data and ecological information also are given.
KEY WORDS: Rotifera, Euchlanidae, Mytilinidae, Trichotriidae, Australia, taxonomic revision.