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THE PHYSICAL ENVIRONMENT, MARINE HABITATS, AND CHARACTERISTICS OF THE MARINE FAUNA

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The Physical Environment

The geography, physiography, climate and oceanography of the region have been summarised by Deegan (1992). These are discussed below in relation to how they affect habitats and fauna.

The sea surface temperature range of 20–33°C places the Montebellos within Ekman's (1976) tropical zone, delineated from the subtropical zone by the 20°C minimum isotherm. In terms of biogeographical provinces, determined principally by water temperature, the Montebellos fall within the Dampierian or Northern Australian Tropical Province (Wilson and Allen, 1987).

The quantity and quality of suspended particulate matter is an important environmental parameter for marine organisms. The waters of the Montebellos are little influenced by terrigenous sediments from the mainland or the islands themselves because there is insignificant freshwater runoff in the area. Most turbidity is the result of wave action due to the shallowness of the area and the high tidal range; turbidity conditions of the Montebellos are typical of the mid-shelf and are unlike those of the atolls on the outer shelf edge, such as the Rowley Shoals; which are typically oceanic. The semi-diurnal tidal regime, with a moderately high range at springs (3.5 m), also contributes to turbidity at the Montebellos.

An important physical environmental factor influencing the marine fauna in shallow water at the Montebellos is the frequency of occurrence of tropical cyclones. Examination of cyclone tracks provided by the Bureau of Meteorology showed that in the 16 years between 1977/78 and 1991/92 a total of 9 cyclones passed within approximately 1° of the islands, an average of 0.6 per year. The marine biota, particularly of shallow and intertidal areas, is therefore subject to frequent natural perturbation. Communities are consequently likely to be either resilient or transient. An example of the latter is the tabular *Acropora* on the western barrier reef flat, the distribution and percentage cover of which appears to be particularly dynamic, possibly as a result of cyclones. Probable recent cyclone damage evident in shallow areas of the lagoons during the survey, may have resulted from cyclones "Ian" (Feb/March 1992), "Ilona" (December 1988) and/or "Orson" (April 1989).

In broad morphological terms, the Montebello Islands and associated reefs resemble the shape of an arrowhead, comprising a central "chain" of islands with unusually irregular or convoluted coastlines lying on a north-south axis. These islands are in close proximity to one another and are separated by narrow channels, which generally run east-west. The northernmost island in this chain (Northwest Island) forms the apex and from it an almost unbroken barrier reef runs to the south-west and a large elongate island (Trimouille Island) and series of smaller islands runs to the south-east (Figure 1).

Marine Habitats

The geomorphology provides an unusually high diversity of habitat types, including protected lagoons, embayments, mangroves, channels, rocky and sandy shores and coral reefs. The total shoreline of infratidal land within the Montebellos is approximately 210 km in length and is significantly longer if the margins of intertidal areas, particularly the western barrier reef, are included. An extensive, shallow intertidal zone is therefore contained within a relatively small total area, making it more vulnerable to cyclones or oil spillages than the intertidal zone on a straighter coastline, such as is typical along much of the Pilbara coast.

The following major benthic physical environmental units and dominant or conspicuous biotas occur at the Montebellos:

Exposed benthic habitat. The exposed benthic habitat near the Montebellos is a region of relatively high wave and current energy. The survey concentrated on the area to the west of the islands. In the shallows near the reef the bottom is composed of extensive areas of exposed limestone pavement and reef, interspersed with smaller patches where a thin veneer of sand overlies the pavement. The water is relatively clear, particularly compared with the lagoon and channels. The pavement is covered by dense macroalgal growth, especially of *Sargassum*, with scattered colonies of hard and soft corals, sponges and the ascidian *Polycarpa clavata*. All of these taxa are adapted to being able to adhere to the bottom during periods of high swell and wave action. Diversity is reduced

in this region. An extensive area of coral bombies and high relief limestone outcrops with high coral cover occur towards the south-east of the group.

Barrier reef. The barrier reef occurs along the western edge of the Montebellos, some 3 km from the islands in the north, increasing to 8 km in the south. The barrier reef extends approximately 12 km from north to south and is characterised by very high wave energy. The outer reef slope is not steep and, where examined, was not dissected by spur and groove formations, but became progressively more broken with depth. The reef crest is indistinct; in some places it has boulder accumulations, but there is no rubble crest. A typical reef flat, largely composed of consolidated coral slabs interspersed with sand, drops off steeply in parts where patch reefs occur. Several large breaks in the reef form deep channels. Tabular *Acropora* spp. reach their highest percentage cover on the edges of some of these channels and isolated patches of 100% cover were recorded. Despite the high abundance of coral, diversity of corals is low. The central region is somewhat deeper than elsewhere. In this section of the reef dense *Sargassum* covers hard substratum with small *Acropora* colonies scattered throughout.

Lagoon. This is divided into two sections: (i) a shallow western lagoon, bounded by the western barrier reef on the west and by the central island chain on the east and (ii) a deeper eastern lagoon bounded by Trimouille Island and the series of islets on the east and the central island chain on the west. Both the western and eastern lagoons are shallowest and most protected in the north and become progressively deeper and more exposed to the south. The lagoons, particularly in the north, are characterised by relatively high turbidity and low wave and current energy, resulting in extensive areas of sand substratum.

Extensive monospecific stands of the brown macroalga *Turbinaria* and large isolated colonies of the coral *Porites cylindrica* characterise the northern lagoon. Sandy substrates support sparse seagrass cover (no dense monospecific stands were encountered) comprised of six species: *Cymodocea angustata, Halophila ovalis, H. spinulosa, H. ovata, Thalassia hemprickii* and *Syringodium isoetifolium.* Dominant algae on sand are sparse, spreading *Caulerpa* spp and, in more exposed areas on rubble and rock, dense stands of *Sargassum* spp. Small colonies of hard corals and sponges are scattered throughout the lagoon. The stalked ascidian *Polycarpa clavata* is ubiquitous and conspicuous. The sandy substrates are inhabited by numerous species of bivalve molluscs and are rich in echinoderms.

Channels. Channels are one of the key habitats in the centre of the island chain, and connect the eastern and western lagoons. Stephenson Channel is an exception in that it is a blind channel leading into the interior of Hermite Island. The channels are characterised by high turbidity and very high current energy, resulting in coarse sand and rubble substrates in the intertidal zone with extensive exposures of limestone pavement when scouring occurs. Scattered hard coral colonies are found on all rocky-sided channels and in some, fringing coral reefs occur. Subtidally the substrate becomes a mud bottom.

Intertidal shorelines. Shorelines are rocky or sandy, depending on their degree of exposure to wave and/or current energy. Rocky shores predominate at the Montebellos with typically a 2–4 m high intertidal cliff present. The cliff may he heavily undercut. As is usual for rocky shores, diversity is lowest in the upper intertidal and increases down the shore. The rock oyster *Saccostrea cucullata* is particularly abundant and forms a conspicuous zone in many areas. There may be a rich diversity of invertebrates utilising the habitat created by the presence of the oysters. In the lower intertidal the cliff gives way abruptly to a flat platform. The platform surface is typically limestone, but may be overlain by a layer of fine silt. Isolated rocks which have fallen off the cliff are present in many areas.

Sandy beaches are not as common as rocky shores. The Montebello Islands are a major nesting area for the green turtle, with over 100 individuals having been sighted in a single afternoon on Trimouille Island where one of the atomic tests was conducted (Wells, pers. obs.). Hawksbill turtles also breed on the islands (CALM, 1994). Apart from turtles, the marine fauna of the intertidal sand beaches is impoverished. The ghost crab *Ocypode ceratophthalma* is common on many of the sandy beaches.

Intertidal environments in the protected bays are subject mainly to tidal energy and are characterised by fine, soft sandy substrates of low organic content. Some bays contain simple mangrove communities, either consisting of narrow fringes of *Avicennia marina* or *A. marina* in association with *Bruguiera exaristata, Ceriops tagal* and/or *Rhizophora stylosa* (see below). Turbidity may be higher where mangroves are present. The bays are important nursery areas in which juvenile fishes are particularly abundant.

The fauna on the intertidal sandy substrates is diverse and abundant. It is dominated by molluscs, crustaceans and polychaete worms (not surveyed). Echinoderms may also be a major component of the fauna in these areas.

Mangroves. Mangroves are trees and shrubs which live in the mid to upper intertidal zones of protected tropical and subtropical bays and estuaries. In Western Australia mangroves are most diverse (16 species) and occupy the greatest areas in the Kimberley region. Diversity decreases with increasing latitude along the Western Australian

coast. Only 8 species of mangroves occur in the Pilbara region, and of these only four are found in the Montebellos: *Avicennia marina, Rhizophora stylosa, Bruguiera exaristata* and *Ceriops tagal.* The dominant species is *A. marina* (Semeniuk *et al.*, 1978; Johnstone, 1990).The mangrove habitat in the Montebello Islands is small in areal extent. The major concentration of mangroves occurs as four patches on the west side of Hermite Island.

The dominant invertebrate species in the Montebello mangroves are similar to those found in other Pilbara mangroves. The dominant molluscs were the potamidid gastropods *Terebralia palustris, T. semistriata, Cerithidea cingulata,* and *C. reidi. Telescopium telescopium,* which is abundant in Pilbara mangroves, was not recorded, nor was the mangrove nerite *Nerita balteata.* Only one individual of the ark shell *Anadara* was found, although some fossilised shells were found on dry salt pans. *Littoraria* were abundant, and diverse, with four species being recorded. The most abundant bivalve was the oyster *Saccostrea cucullata.*

Invertebrates in the Montebello mangroves were not examined quantitatively. However, Wells (1983; 1984) undertook such a study in the Bay of Rest in Exmouth Gulf, and the observed patterns were similar to those found in the Montebellos. Diversity, density and biomass of total invertebrates was greatest in the seaward mudflat of the Bay of Rest. Diversity and density decreased in *Avicennia marina,* but biomass increased due to the abundance of the large potamidid snail *Terebralia semistriata* (recorded as *T. sulcata*). All three parameters decreased significantly in the *Rhizophora* zone. Invertebrates were essentially absent on the saltflat landward of the mangroves. The major apparent difference in the Montebello mangroves is the absence of the landward saltflat. Instead, the landward margin of the mangroves tends to be a low intertidal cliff.

Johnstone (1990) surveyed the mangrove birds of Western Australia. Twenty-two species were considered to be confined to mangroves for at least part of their range in the State. Eight species occur in the Pilbara, but only four in the Montebellos: Bar-shouldered Dove (*Geopelia humeralis*), Mangrove Kingfisher (*Halycon chloris*), Yellow White-eye (*Zosterops lutea*), White-breasted Woodswallow (*Artamus leucorhynchus*).

Characteristics of the Marine Fauna

Detailed accounts of the selected fauna groups studied are contained in the subsequent sections. High species diversity, and in many cases large numbers of individuals were recorded, in all groups surveyed. Comparative species diversity of the Montebello Islands and other coral reef areas surveyed is summarised in Table 2.

Table 2 indicates that the marine fauna of the Montebello Islands is very diverse. Diversity of fish (457 species) is higher on the offshore atolls (Rowley Shoals, Scott Reef and Ashmore Reef) than has been recorded inshore, but the Montebellos has the greatest diversity of fishes for any of the inshore areas studied. Mollusc diversity in the Montebellos (633 species) is higher than any of the sites examined except the Muiron Islands and eastern shoreline of Exmouth Gulf, which was slightly more diverse (655 species). Diversity of echinoderms (170 species) was slightly less than at Ashmore Reef (175 species) and the Houtman Abrolhos Islands (172 species), but much higher than at the other localities studied. Known diversity of echinoderms in the Abrolhos has been increased by the fact that a number of surveys have been made over the years. Diversity of corals at the Montebellos (150 species)

Table 2 Comparative species diversity of major taxa in coral reef areas surveyed in Western Australia and adjacent areas.

	Fish	Molluscs	Crustaceans	Echinoderms	Corals	References
Montebellos	457	633	85	170	150	This report
Christmas Island	575	430	204	87	92	Berry and Wells, 2000
Cocos (Keeling) Islands	533	610		88	99	Woodroffe, 1994
Ashmore Reef	545	433	142	175	250	Berry, 1993; Russell and Hanley, 1993; Allen, 1996
Hibernia Reef	347	294	161	34	52	Russell and Hanley, 1993
Cartier Reef	410	381		61	101	Berry, 1993; Russell and Hanley, 1993
Scott Reef and Seringapatam Reefs	558	267	56	98	207	Berry, 1986; Done *et al.*, 1994; Hutchins *et al.*, 1995
Rowley Shoals	490	264		82	204	Berry, 1986; Done *et al.*, 1994; Hutchins, *et al.*, 1995
Muiron Island	393	655	52 (barnacles and some crabs)	92		Hutchins *et al.*, 1996
Bernier and Dorre Islands	300	425	23 (barnacles)		106	Hutchins *et al.*, 1995
Houtman Abrolhos	389	492		172	184	Wells, 1997

is substantially less than on the offshore atolls (204–250 species), but much higher than inshore localities except the Abrolhos (184 species).

The Montebellos are geographically situated in an area near the Leeuwin Current Source area (Cresswell, 1991; Pearce, 1991). Therefore, they may serve as an important recruitment source for tropical species along the west coast of Western Australia.

As indicated in the introduction, surveys of the clear waters of the open ocean atolls (Rowley Shoals, Scott Reef, Ashmore Reef, etc) provided a large number of species recorded for the first time in Western Australia. These species have not been found in the more turbid waters of the continental coastline. The Montebello Islands are located on the outer continental shelf, well offshore of the mainland coastline, but well inshore of the Rowley Shoals. One hypothesis made before the trip was that the fauna of the Montebello Islands would also be intermediate between that of the offshore oceanic atolls and the mainland coastline. In fact, the marine fauna of the Montebellos is closer to that of the mainland coastline. This is well demonstrated by the presence of large conch shells (*Syrinx aruanus*) and several species of volutes (three species of *Amoria* and *Melo amphora*), all of which are coastal species. Several mollusc species characteristic of offshore waters were collected in the Montebellos: *Semicassis rufa, Maculotriton serriale,* and *Conus miles. Conus miles* had previously been recorded from only five stations along the continental shoreline, but is common on offshore reefs.

The coastline of Western Australia can be divided into three biogeographical zones: a tropical fauna which extends north eastwards from North West Cape to the southern end of the Great Barrier Reef in Queensland; a temperate fauna which extends across the south coast from Cape Leeuwin to southern Queensland; and the west coast overlap zone, between Cape Leeuwin and North West Cape where the two biotas overlap. Superimposed on this is a small proportion of species which are endemic to Western Australia, some of which are economically and/or ecologically important. The proportion of endemic species varies between 10% in shallow water molluscs and fish up to 25% in echinoderms. Most of the endemic species are concentrated on the west coast, but some occur on the north and/or south coasts (Wells, 1980; Wilson and Allen, 1987).

Being located on the north coast of Western Australia, the marine fauna of the Montebello Islands is primarily tropical. For example, of the 633 species of molluscs collected, only one (*Thais orbita*) is a temperate species. Only 4.6% of the molluscs recorded from the Montebellos were Western Australian endemics, compared to a 10% level of endemicity for the state as a whole (Wells, 1980). One interesting find was the first record at the Montebellos of the Western Rock Lobster, *Panulirus cygnus*. The species had not previously been recorded this far north.

Marine Oligochaetes

Until recently, marine oligochaetes have been little studied in Western Australia. Prof Christer Erséus of the National Museum of Sweden participated in several of the marine biological workshops conducted in Western Australia and the Northern Territory from 1988 onwards, and published on the oligochaetes he collected. Sand samples were collected from 10 stations during the 1993 Montebellos survey and were forwarded to Prof Erséus. These were sorted in Stockholm, and a paper was written on the oligochaetes collected in the Montebellos and the Houtman Abrolhos (Erséus, 1997). Thirty-three species were recorded from the Montebellos, of which 20 species were described as new. The type localities of 18 of the new species are located in the Montebellos. A total of 79 species of marine oligochaetes are now known from Western Australia.

Specific Observations Made During the Survey

Green Turtles were abundant throughout the area, particularly small animals. No other species of turtle was recorded.

Sea snakes (probably *Aepysurus laevis*) were recorded in coral habitat at stations 24,30,31 and 34.

No dugongs were recorded and the sparseness of seagrasses suggests that large numbers could not be supported.

Bottlenose Dolphins were present in small groups.

Two Humpback Whales were observed at close quarters; others were sighted in the distance and vocalisation was heard while diving.

REFERENCES

Allen, G.R. (1996). New records of reef and shore fishes from northwestern Australia. *Records of the Western Australian Museum* **18:** 109–112.

Berry, P.F., and Wells, F.E. (2000). Survey of the marine fauna of Christmas Island, Indian Ocean. *Records of the Western Australian Museum,* Supplement No. 59: 69–127.

Berry, P.F. (Ed.) (1993a). Marine faunal surveys of Ashmore Reef and Cartier Island, north-western Australia. *Records of the Western Australian Museum, Supplement* **44**: 1–86.

CALM (1994). *A representative marine reserve system for Western Australia.* Report of the Marine Parks and Reserves Selection Working Group. Department of Conservation and Land Management.

Cresswell, G.R. (1991). The Leeuwin Current – observations and recent models. In: Pearce, A.F. and

Walker, D.I. *The Leeuwin Current: an influence on the coastal climate and marine life of Western Australia.* Journal of the Royal Society of Western Australia **74:** 1–14.

Deegan, P.M. (1992). *Montebello and Lowendal Islands – Marine Resources Summary Report.* Report prepared for the Department of Conservation and Land Management, 16 pages.

Done, T.J., Williams, D.McB., Speare, P., Turak, E., Davidson, J., DeVantier, L.M., Newman, S.J., and Hutchins, J.B. (1994). *Surveys of coral and fish communities at Scott Reef and Rowley Shoals.* Australian Institute of Marine Science, Townsville.

Ekman, S. (1976). *Zoogeography of the sea.* 2nd ed. Sedgwick and Jackson, London.

Erséus, C. (1997). Marine Tubificidae (Ologichaeta) from the Montebello and Houtman Abrolhos Islands, Western Australia, with descriptions of twenty-three new species. In: Wells, F.E. (Ed.). *The marine flora and fauna of the Houtman Abrolhos Islands, Western Australia.* Western Australian Museum, Perth. Pages 389–458.

Hutchins, J.B., Williams, D.McB., Newman, S.J., Cappo, M., and Speare, P. (1995). New records of fishes of the Rowley Shoals and Scott/Seringapatam Reefs, off north-western Australia. *Records of the Western Australian Museum* **17:** 119–123.

Hutchins, J.B., Slack-Smith, S.M., Marsh, L.M., Jones, D.S., Bryce, C.W., Hewitt, M.A. and Hill, A. 1995. *Marine biological survey of Bernier and Dorre Islands, Shark Bay.* Manuscript report, Western Australian Museum and Department of Conservation and Land Management.

Hutchins, J.B., Slack-Smith, S.M., Bryce, C.W., Morrison, S.M., and Hewitt, M.A. (1996). *Marine biological survey of the Muiron Islands and the eastern shore of Exmouth Gulf, Western Australia.* Western Australian Museum and Department of Conservation and Land Management, manuscript report. Pages 64–100.

Johnstone, R.E. (1990). Mangroves and mangrove birds of Western Australia. *Records of the Western Australian Museum Supplement* 32: 1–120.

Pearce, A.F. (1991). Eastern boundary currents in the southern hemisphere. In: Pearce, A.F. and Walker, D.I. *The Leeuwin Current: an influence on the coastal climate and marine life of Western Australia.* Journal of the Royal Society of Western Australia **74**: 35–46.

Russell, B.C. and Hanley, J.R. (1993). *The marine biological resources and heritage values of Cartier and Hibernia Reefs, Timor Sea.* Northern Territory Museum, manuscript report.

Semeniuk, V., Kenneally, K.F., and Wilson, P.G. (1978). *Mangroves of Western Australia.* Western Australian Naturalists Club, Perth.

Wells, F.E. (1980). The distribution of shallow-water marine prosobranch gastropod molluscs along the coastline of Western Australia. *Veliger* **22**: 232–247.

Wells, F.E. (1983). An analysis of marine invertebrate distributions in a mangrove swamp in northwestern Australia. *Bulletin of Marine Science* **33**: 736–744.

Wells, F.E. (1984). Comparative distribution of macromolluscs and macrocrustaceans in a north-western Australian mangrove system. *Australian Journal of Marine and Freshwater Research* **35**: 591–596.

Wells, F.E. 1997. *The Marine Flora and Fauna of the Houtman Abrolhos Islands, Western Australia.* Western Australian Museum, Perth.

Wilson, B.R. and Allen, G.R. (1987). Major components and distribution of marine fauna. In: *The Fauna of Australia Vol. 1A. General Articles* (*eds* G.R. Dyne and D.W. Walton) Bureau of Flora and Fauna, Canberra. Pages 43–68.

Woodroffe, C.D. (Ed.). (1994). Ecology and geomorphology of the Cocos (Keeling) Islands. *Atoll Research Bulletin* Nos. **399–414.**