



The Teeming Mud of Roebuck Bay



Rarely has there been a study area blessed with such beauty as this location in the Kimberley region, on the north-west coast of Australia. Theunis Piersma, Grant Pearson and Marc Lavaleye have taken a closer look at life in the tropical mudflats.

by Theunis Piersma, Grant Pearson and Marc Lavaleye

The beautiful azure waters of the Indian Ocean spill into the shallow expanses of Roebuck Bay, where green mangroves, yellow beaches and deep red cliffs border vast intertidal flats. Mudflats are the major marine habitat in the tropics and are home to a wonderful array of small crawling creatures. These are feasted upon by large numbers of migratory shorebirds that link the Siberian Arctic with the Australian tropics. Roebuck Bay, near Broome, is one of the foremost internationally important sites for shorebirds in the Asia-Pacific flyway system. It is home to 150 000 shorebirds (or waders) in the non-breeding season. A series of wader banding expeditions during the past 10 years, and the establishment of the Broome Bird Observatory (BBO), a research and visitor centre on the shores of Roebuck Bay, have led to comprehensive assessments of the great ornithological importance of the area.

This research work into birds is now being followed by detailed studies of the mudflat ecosystem on which

they live. In a unique arrangement, two complementary research projects involving the Department of Conservation and Land Management (CALM), the BBO, the Netherlands Institute for Sea Research, and Curtin University of Technology, are under way to provide the first detailed mapping of benthic, or mud-dwelling, biodiversity on tropical intertidal mudflats. It aims to determine why and how so many birds are able to live in the mud of Roebuck Bay.

Below: Mangrove surrounded by a flock of bar-tailed godwits and terns.
Photo – Bill Bachman



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Main: Picnickers enjoying the beauty of Roebuck Bay's Crab Creek.

Photo – Bill Bachman

Inset: Ruddy turnstones—frequent visitors to the bay.

Photo – Jiri Lochman

In June 1997, a team of 30 volunteers and professionals joined forces for ROEBIM-97 (the Roebuck Bay Intertidal Benthic Mapping Program). Prior to this and beginning in March 1996, monthly visits were undertaken to gather mud samples from four sites in the bay. Many hours were spent sieving and sorting for the MONROEB (Monitoring of Roebuck Bay Benthos) Project 1996–2001'. In this study, the first of its kind ever undertaken in the tropics, we hoped to find out how benthic richness varied from season to season and at what time of the year the benthic animal populations recovered from the onslaughts of hungry shorebirds.



Right: Sampling at ROEBIM-97.

Photo – Marc Lavaleye

BEACHES, MANGROVES AND MUD

Roebuck Bay is bordered by Broome in the west, by beaches, rocky outcrops and steep eroded sandcliffs in the north, and by extensive mangrove forests in the east. The intertidal flats in the north and east of the bay cover approximately 200 square kilometres at spring low tides. There is a large variation in tidal range, varying from 10 metres at the full and new moon spring tides, down to half-a-metre during neap tides.

The sediment of Roebuck Bay is extremely muddy, especially in the east along the mangrove forests that separate the bay from the lowland Roebuck Plains. It gets sandier towards the south (near Bush Point) and towards the west (closer to the town of Broome). The quintessential intertidal experience at Roebuck Bay is to crawl knee-deep through grey mud, on the verge of collapsing with laughter, or exhaustion, and re-emerge as a greyish, mud-covered ghost.

SHOREBIRD HEAVEN OR HIDE-OUT?

The thousands of shorebirds that occupy Roebuck Bay from August to April come from a huge breeding range in the north, spanning an arc of about 130 longitudinal degrees, from western Siberia to arctic Canada. Most of the species breed at high latitudes and altitudes, and lay their four-egg clutches in June and July—the only time of the year that these regions are free of snow and rich in arthropod food. The young then travel 10 000 to 15 000 kilometres south to the intertidal lands of north-west Australia independently of their parents, establishing lifetime tracks that may continue for 20 to 30 years.

The very fact that so many shorebirds fly 30 000 kilometres per year at a speed of about 70 kilometres per hour (that is 429 hours, or 18 days of continuous flight) to get to and from



Roebuck Bay, suggests the bay has an abundance to offer, particularly of food. The congenial climate also ensures the shorebirds do not waste energy on keeping warm. These mudflats have much to offer shorebirds, but they may also be one of few alternatives. Intertidal lands are scarce, and ones that offer everything a shorebird needs (sufficient food and safety) are even scarcer.

To understand whether or not the shorebirds at Roebuck Bay live in a land of plenty, or find it hard to survive, studies have to be carried out into their foraging and to assess the quality of their food resources. This knowledge is essential if we are to achieve an insight into the extent that tourism, the reclamation of parts of the mudflats, and gradual

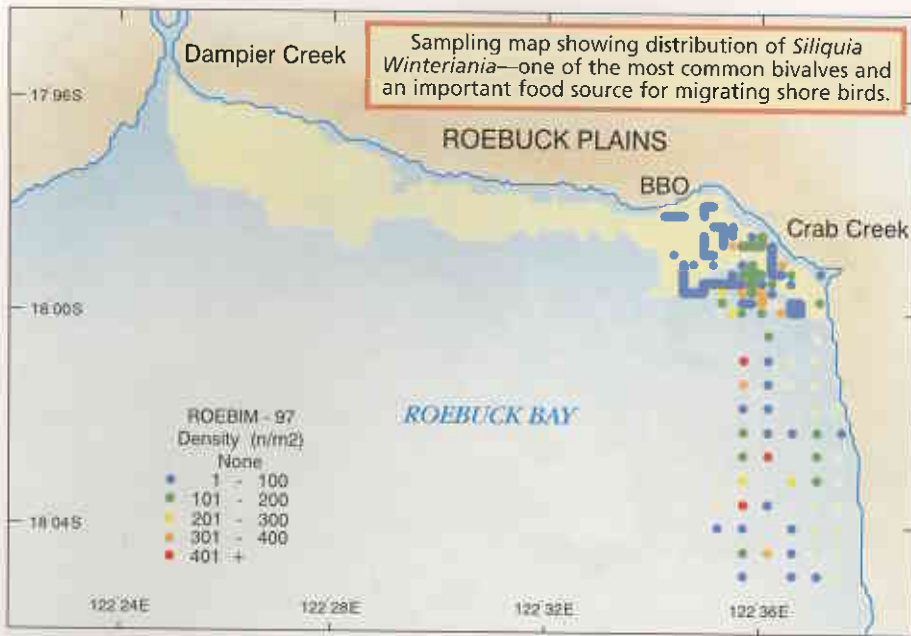
Above from left clockwise: Onuphis, a bristle worm taken out of his periscope-like tube.

The agile glycerid bristle worm, common everywhere on the flats.

The bivalve *Modiolus micropterus*, a strange representative of the mussel family because it lives deep in the mud. The common bivalve *Siliqua winteriana*, which teems in the fluid mud. Note the segmented siphon.

Photos – Marc Lavaleye

pollution of the bay, are likely to affect shorebird populations. By signing the Ramsar Convention and having Roebuck Bay listed as a 'Wetland of International Importance', Australia pledged to protect the environmental well-being of the bay at a time when human use of the area is increasing faster than ever.



The intertidal area of Roebuck Bay was sampled for benthic animals during ROEBIM-97 to increase our knowledge and evaluate the food stocks for migratory shorebirds. The results will provide the groundwork for future environmental impact assessments of the Roebuck Bay area.

A total of 17 700 individual animals were collected—10 000 were tubeworms. More than 200 different taxa (species, families, or larger taxonomic groupings) were found, suggesting a total diversity of 300 to 500 intertidal invertebrate species in Roebuck Bay. As the surveyed area was extended, the number of taxa grew. Most taxa appeared quite limited in their distribution, with each segment of Roebuck Bay intertidal flats offering a unique assembly and range of species.

VARIOUS WRIGGLY WORMS

Worms are without doubt the most abundant and diverse animals on the mudflats. A few of them, like the bright green phyllocoid, crawl unperturbed on the surface. Others mark their presence by tubes sticking out of the mud. The 'plastic worm' lives in a tube similar to a long, transparent drinking straw. The large *Onuphis* worms are easily recognisable because their tubes stick out of the mud like periscopes. They are one of the few bristle worms that are fixed in this way and have powerful jaws for gathering algae and animal prey. For shorebirds, these kinds of tubeworms are no easy prey. Instead, they focus on the many worms that are protected only by a cover of mud or sand. One of the more common worms is a glycerid bristle worm; a very agile animal, adapted to quickly burrow in mud with a pointed head and small feet with stiff bristles. The glycerid bristle worm finds its prey using four tiny papillae at the tip of its head and then grabs it with its jaws. After having disappeared into a bird's beak, these jaws are the only part of the worm that will ever be seen again... in the bird's droppings.



Centre: Some of the sample sites were only accessible by hovercraft.

Above left: The sorting of invertebrates in the mud samples.
Photos - Grant Pearson

Above: Wading through a knee-deep mud site at Crab Creek.
Photo - Theunis Piersma

Left: A small fiddler crab, probably new to science.
Photo - Marc Lavaleye

A BOUQUET OF BIVALVES

More than 50 species of bivalve molluscs, were found during the mapping, each with its own particular distribution. Some live close to the high tide level, others like sandy areas or are confined to the fluid mud. One surprise

discovery in the mud was a mussel of the family Mytilidae. Mussels are normally found fastened to rocks by special self-made threads called byssus. Another mussel, *Modiolus micropterus*, keeps an open connection with the overlying water through activities of the foot and a tube-like construction of byssus threads.

The most abundant bivalve was the thin-shelled, three-centimetre-long, *Siliqua winteriana*. It occurred in densities of up to 1000 per square metre, especially in areas of knee-deep mud. With its thin shell and elongated form, it seems easy prey for birds, but it also has an interesting means of escaping predation. Its segmented siphon was often found separated from the body in our samples, and it appears that a process of self-amputation, where part of the siphon can be separated, helps it survive. Upon touching this bivalve, instead of closing its valves (as most do), it begins frantic burying activity—extending and retracting its powerful foot to escape the enemy. All these adaptations indicate that shells and shorebirds have a long history of interaction.

No reference to the food resources of this extraordinary bay can be made without consideration for the customary



Above: Mangrove trees showing their tops during a reclining tide in Roebuck Bay. Photo – Grant Pearson

Below: Godwits—one of the most common shorebirds that use Roebuck Bay as a feeding area. Photo – Jiri Lochman

use by Aborigines. This was most clearly illustrated by the presence of masses of bivalve shells in numerous Aboriginal middens along the northern shore of the bay. The shells were predominantly of the large bivalve, better known as the bloody cockle (*Anodara granosa*), which was commonly found on the exposed mud at many sites.

CRABS FOR A MEAL

The large crabs of Roebuck Bay pose too much of a challenge for the birds. The diversity of fiddler crabs living in or near the mangrove forest is significant. In an area of 10 square metres, no fewer than six species were caught, one of which could be new to science.

The open mudflats harbour many





other crabs. The spider crabs (*Majidae*), although tiny and inconspicuous, were the most common among them. The transparent shell casings of this species provide their sole protection against the keen eyes of shorebirds.

UNRIVALLED BIODIVERSITY

The research conducted at Roebuck Bay reveals it to be among the richest mudflats in the world, but there is still a wealth of animal life to be discovered. Many animals were encountered only once, for although our sample area was around 45 square kilometres, the samples covered only 12.5 square metres, a futile fraction of the bay. Even from the samples themselves taken, millions of tiny animals were flushed through sieves because of the coarse (one millimetre) mesh. The bewildering diversity of the Roebuck Bay flats stands in stark contrast to that of similar habitats in temperate regions. For example, the Wadden Sea in Western Europe has only 10 per cent of the biodiversity found at Roebuck Bay.

CONSERVATION

Whether it is the unique tropical setting, the cosmopolitan nature, or the rich colours of the pindan plains along the breathtaking and unspoiled coastline, the town of Broome attracts more than 150 000 tourists annually. It is likely that only a few per cent of the

tourists, those that make the trip to the Broome Bird Observatory, will be aware of the thousands of other visitors of the feathered kind on Broome's doorstep. The coming together of many people and shorebirds may lead to conflict, particularly if human-use disturbs the feeding and breeding patterns of the birds. Local initiatives are under way to help reduce this disturbance and make the bay a welcome retreat for migratory birds. Efficient and effective management of a wonderful resource like Roebuck Bay is vital—as such, the bay is a proposed marine park under the Wilson Report recommendations.

By studying the behaviour and survival characteristics of this unique ecosystem, we can develop base-line

The contrasting colours, beauty and exposed tidal flats attract tourists and shore-birds, but for very different reasons. Photo – Col Roberts/Lochman Transparecies

information that will significantly help plan for the future development and management of the bay. It is also very clear that Aboriginal interests and concerns for conservation of the bay need to be taken into account in the development of the management strategy. This combined information will serve as a guide to ensure an effective balance between conservation, tourism and sustainable harvest of resources. The richness of this area will never be greater and it remains up to us to ensure this richness is conserved.

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The benthic research in Roebuck Bay was largely self-funded by the participants. ROEBIM-97 received logistical and limited financial support from the participating institutions, and some private grants. We thank C. Benck, T. Butler, L. Coshell, T. Costello, P. de Goeij, S. Foster-Nixon, K. Fletcher, B. Gilbert, C. Hassell, B. Hickey, P. Honkoop, J. Lane, C. Keating, H. MacArthur, E. Oldmeadow, A. Pentelow, M. Pepping, D. Rogers, M. Russell, G. Sandwell, I. Snadden, J. Sparrow, O. Vachez, and R. Watkins for their great efforts and company. C.J. Camphuijsen prepared the maps. ROEBMON progresses due to hard work by A. Pentelow, P. de Goeij and P. Honkoop.

LANDSCOPE

VOLUME THIRTEEN NUMBER 4, WINTER 1998



'Conserving the western ringtail possum' tells a story of rehabilitation, release and repopulation.



Discover the fascinating world of 'Starfish, Urchins and their Relatives' on page 10.



'The Art of Interpretation' on page 36 discusses how interpreters use a variety of techniques to enrich our experiences.



What have rabbits done to our land and what have we done about them? Find out in 'Run, Rabbit' on page 49.



Learn about a study of life in the tropical mudflats of Roebuck Bay on page 16.

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Illustration by Philippa Nikulinsky



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 Printed in Western Australia by Lamb Print
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Published by Dr S Shea, Executive Director
Department of Conservation and Land Management,
50 Hayman Road, Como, Western Australia