Reef Discovery and Utilization in Antongil Bay, Republic Of Madagascar

Located on the northeastern coast of Madagascar, Antongil Bay is a rich estuarine system that supports a diversity of marine life, including mangrove, seagrass and coral reef communities. Flushed with the warm currents of the Indian Ocean, the Bay spans an area of 2800 km^2 with depths ranging from 1-10 m near shore to 20-60 m in its central and southern reaches (Figure 1). The Bay is an important economic resource to the Malagasy people, supporting the traditional, artisan and commercial harvest of crustaceans, fin fish, and sharks for local consumption and export. The rich biological diversity of the region also attracts ecotourism revenue, particularly through whale-watching programs of the seasonal migration and calving grounds of humpback whales[1]. Additionally, the bay provides access to the Parc National Masoala (PNM), which contains the largest protected tract of eastern rainforest in Madagascar[2].

The Bay is an important economic resource to the Malagasy people

Within the Bay are two of the three PNM marine protected areas (MPAs), which were established in 1997 and were among the first MPAs in Madagascar. These marine parks, extensions of terrestrial protected areas of the PNM, harbor coral reef communities[2,3]. Field surveys conducted in order to designate the MPAs and to explore their ecological importance have focused on areas south of Tampolo (Figure 1), largely excluding the northeastern and western portions of the Bay[3,4].

During a recent Wildlife Conservation Society field expedition, several reefs were discovered in these areas of the Bay and were surveyed for benthic composition. Additionally, interviews with local fishermen were conducted in order to identify target species, historical fishing grounds and the extent to which the reefs are presently being fished.

Benthic surveys

Five reefs in the northeastern portion of the Bay (A-E, Table 1, Figure 3) and one reef in the western portion of the Bay (F, Table 1, Figure 3) were surveyed while snorkeling during February 2001. Eastern portions of the Bay are influenced by high turbidity and freshwater influx and typically sustain mixed coral/algal communities with comparatively higher species diversity than the western reefs (Table 2). The reef system in the western part of the Bay is made up of a network of patch and barrier reefs running parallel to the shoreline and reaching, at times, up to 100 m in length. Though maximum depth is about 10 m, most of the coral formations occur within the first 6 meters. The substrate typically consists

Figure 1 Typical species encountered within Antongil Bay include *Acropora* spp. (Photo by Priska Ketterer)

Table 1. Reefs surveyed in Antongil Bay. FW = fresh water influence; T = turbid; CC = coral cover. High coral cover >50%; low coral cover <50% estimated visually in ~100m^2 area. Locations correspond to reef sites in Fig. 2.

Reef	Location	Latitude (°S)	Longitude (°W)	Reef Type	Dominant Coral Species	Remarks
A	S of Navane	15º26'59.2"	49º54'08.6"	Fringing	*Porites, Pectinia*	T FW Low CC
B	NW of Ambianizana	15º37'55.5"	49º54'02.3"	Fringing/ Patch	*Porites, Tubinaria, Acropora*	FW Low CC
C	S of Ambianizana	15º37'43.1"	49º57'20.0"	Fringing/ Patch	*Porites,* Algae, Soft Corals	FW High CC
D	S of Ambianizana	15º38'41.9"	49º57'47.2"	Fringing	*Porites, Fungia, Favia*	High CC
E	W of Ambodiforaha	15º42'50.5"	49º57'39.0"	Patch / granite boulders	*Porites, Favia*	T Low CC
F	SE of Rantabe	15º45'52.7"	49º40'29.3"	Fringing	*Acropora* and branching species	High CC

of soft sediment and sand and the water column is generally turbid with a halocline detectable just below the surface due to fresh water runoff from adjacent rivers.

Invertebrate species diversity and coral cover increase moving south along the eastern side of the Bay (Tables 1 and 2). The forereefs of the northeastern are dominated by massive *Porites solida* colonies with diameters occasionally in excess of four meters. Hardy branching species of *Acropora* spp., *Stylophora* spp. and *Pocillopora* spp. occupy the shallowest portions of the fore-reef slope, at times forming extensive monospecific stands. In low flow, highly turbid areas (B,D,E, Figure 3), large tabular reef corals such as *Tubinaria* sp. and *Echinopora* sp. colonies abound. Areas closest to shore generally support shallow water, lagoonal species such as *Fungia* sp., *Galaxea* sp., *Goniopora* spp., and *Pectinia* spp., along with several species of colonial and solitary anemones and zoanthids. The reef south of Navane (A, Figure 3) supports a strip of seagrass a few meters wide that runs the length of the reef and maintains a community of sea cucumbers, pistol shrimp, commensal gobies and other invertebrate life. On the west coast, the reef south of Rantabe (F, Figure 3) extends for several kilometers and is characterized by very high coral cover (~80%) dominated by dense thickets of *Acropora* spp. with occasional patches of *Stylophora pistillata* and *Pocillopora* spp. Signs of bleaching were observed for all reefs surveyed, affecting various species of anthozoans including *Acropora* spp. and *Porites* spp. This bleaching event was likely due to abnormally high sea surface temperatures in the southern Indian Ocean near Madagascar during the month of February 2003 (visible on NOAA satellite imagery). Additionally, toppled colonies of *Porites solida* and *Favia* spp. were observed, a likely impact of the 2000 cyclone activity.

marine resources in Madagascar may suffer from increased utilization and habitat degradation

Fishing patterns and pressure

Interviews conducted throughout the survey region indicated that fishing pressure and fishing camp density was highest in the northern reaches of the Bay. At present, the fishery targets all common reef species (with the exception of poisonous species) with most of the harvest being consumed locally. Spearfishermen harvest common reef species such as butterflyfish (Chaetodontidae), parrotfishes (Scaridae), rabbitfishes (Siganidae), surgeonfishes (Acanthuridae) and angelfishes (Pomacanthidae), as well as sweetlips (Haemulidae) and damselfishes (Pomacentridae). Other reef species are caught using gill nets and hook and line and include squirrelfishes, (Holocentridae), big eyes (Centropomidae), snapper (Lutjanidae, Caesenidae), sweepers (Pempheridae) and small groupers (Serranidae). Additionally, local divers target lobsters, octopus, and sea cucumbers for food and export. Tridacnid clams and large carpet anemones (*Heteractis magnifica*) are also harvested for subsistence level

Table 2. Species of algae, sponges, cnidarians, mollusks, and echinoderms identified in Antongil Bay. Locations correspond to reef sites in Figure 3. Abundance for individual species ranges from occasional to common to abundant.

		SPECIES	LOCATION	ABUNDANCE
Algae		*Halimeda spp.*	A, B	Common
		Caulerpa spp.	A – C	Common
		Turbinaria spp.	B, D, E	Abundant
		Padina spp.	A – E	Abundant
Sponges		*Strepsichordaia radiata*	A – F	Common
Anthozoans	Hydroids	*Millepora spp.*	A – E	Occasional
	Lace Corals	*Stylaster spp.*	B, D, E	Occasional
	Anemones	*Heteractis magnifica*	C – F	Occasional
	Zoanthids	*Zoanthus spp.*	A, B	Common
		Palythoa spp.	A – E	Common
	Soft Corals	*Sarcophyton spp.*	B – E	Occasional – Abundant
		Sinularia spp.	A – C	Occasional
	Stony Corals	*Acropora spp.*	A – F	Common
		Echinopora spp.	B, D, E	Common
		Favia speciosa	B – F	Occasional – Common
		Favia favus	C, D	Occasional
		Favites spp.	C, D, E	Occasional
		Fungia spp.	A – F	Abundant
		Galaxea spp.	A – E	Common
		Goniopora spp.	A – E	Common
		Herpolitha spp.	D	Occasional
		Hydnophora spp.	A – E	Occasional
		Leptoseris spp.	A, B	Occasional
		Lobophyllia corymbosa	A – F	Common
		Pavona spp.	A – E	Common
		Pectinia lactuca	A – D	Common
		Platygyra daedalea	A – E	Common
		Pleurogyra spp.	B	Occasional
		Pocillopora verrucosa,	B – F	Abundant
		Pocillopora damicornis	A – F	Abundant
		Porites solida,	A – F	Abundant
		Porites cylindrica	D	Occasional
		Psammocora superficialis	D – F	Occasional
		Stylophora pistillata	A – F	Common
		Symphillia spp.	A – E	Common
		Tubinaria spp.	B, D, E	Common
	Octocorals	*Cirrhipathes sp.*	A – E	Common
Mollusks	Sea slugs	*Phyllidiella spp.*	B	Occasional
		Phyllidia spp.	B	Occasional
	Gastropods	*Lambis lambis*	A – E	Common
	Bivalves	*Hyotissa hyotis*	C – E	Common
		Tridacna maxima	B – E	Common
Echinoderms	Sea Urchins	*Diadema savignyi*	A – E	Occasional – Common
	Sea Cucumbers	*Holothurids*	A – E	Common
		Synaptids	A – E	Common
	Sea Stars	*Culcita schmideliana*	A, C, E	Occasional
		Fromia milleporella	A, D – E	Occasional

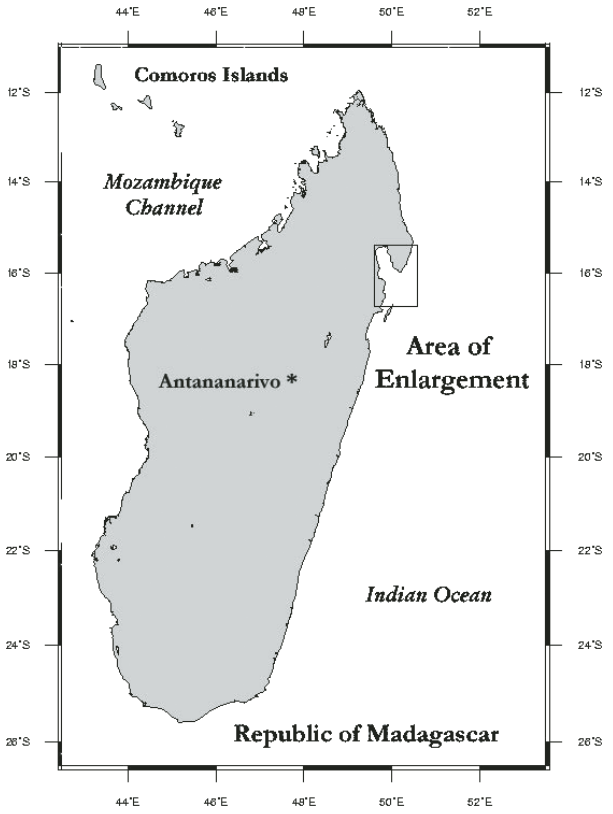

Figure 2 Republic of Madagascar

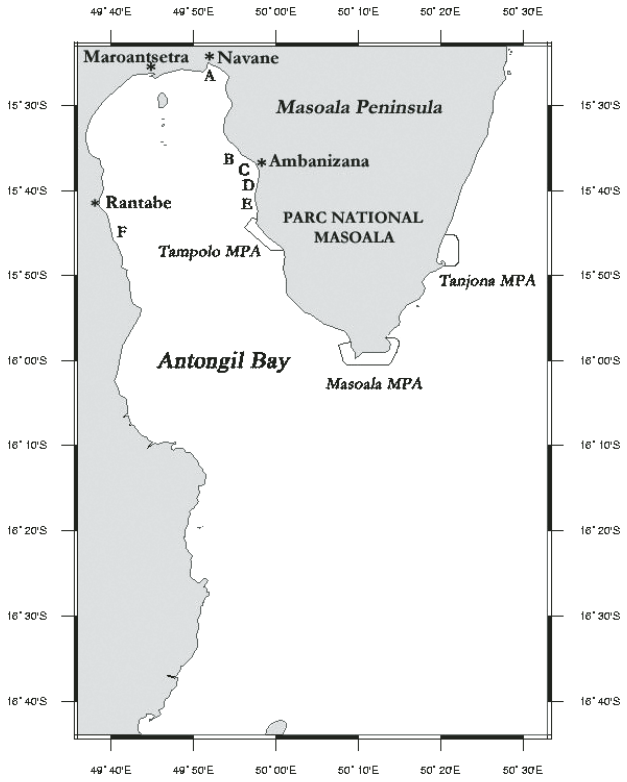

Figure 3 Antongil Bay where reef sites mapped in this study are lettered A-F and correspond to descriptions in Table 1.

consumption. Local fishermen point out that fishing of reefs closest to villages has been intense in the past and may have led to stock declines.

Antongil Bay has recently become the focus of numerous marine conservation efforts in an effort to protect the diversity and richness of its biological resources which, at present, are heavily exploited for local and commercial purposes[2,4]. These efforts are concentrating on the development of a comprehensive and adaptive ecosystem management plan that would include biological as well as socioeconomic factors. In order to develop the most comprehensive and encompassing plan possible, continued and in-depth research is necessary to better assess the extent to which reefs contribute to the overall productivity of the bay and their significance to local livelihoods. As terrestrial resources throughout Madagascar disappear at an unprecedented and alarming rate, and the current political crisis continues to cripple the economy, we predict that marine resources may suffer from increased utilization and habitat degradation, making their conservation and sustainable utilization through the development of appropriate management programs all the more urgent.

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