Aldabra Marine Programme

Phase IV

The State of the Reef:

Five Years After Bleaching

Nigel Downing, Ben Stobart, Raymond Buckley, Larry LeClair and Kristian Teleki

Fondation D'ENTREPRISE TOTAL Pour la biodiversité et la mer

This report is dedicated to Guillermo Cryns who was an inspiration and support for the Aldabra Marine Programme from its beginning in 1999. He shall be greatly missed by all of us.

Phase IV

The State of the Reef:

Five Years After Bleaching

May 2003

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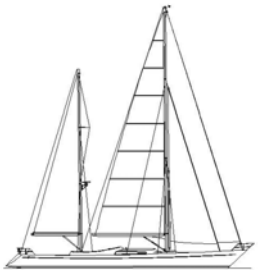

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Executive Summary

Five years after the El Niño bleaching event of 1998 the fourth survey of Aldabra's coral reefs has been completed. Severe weather forced work scheduled for February to be carried out in May, when conditions were poor. Seven of the eight Aldabra sites and two of the three lagoon sites were successfully surveyed. Assomption, Astove and St. Pierre were all visited for a second time but the original Astove site was not surveyed, although the *Caulerpa* bloom was found to still be there. A second site on the northwest of Astove was established and surveyed instead.

Coral cover data, obtained from Aldabra since the first 1999 survey, has been re-analysed. It shows that most of the increase in live coral cover can be attributed to soft coral, and to *Rhytisma* in particular. Some sites have shown a minor decline in live coral cover, while others have increased considerably, particularly in more sheltered areas. The greatest increase in hard coral cover is seen in the lagoon. Coral recruitment remains high and the rate of growth of coral recruits has changed little between 2001-2002 and 2002-2003. *Pocillopora* and *Acropora* growth rates are almost equivalent. St. Pierre has shown a greater increase in live coral cover than any of the Aldabra sites. This is attributed to high numbers of fast growing *Pocillopora* colonies. Coral cover at the new Astove site was very high, equivalent to the best lagoon site at Aldabra. At Assomption there has been little coral growth.

Although fish species diversity has remained very high, at Aldabra the total numbers counted have dropped since the last survey. However, if corrected for the species that dominates the counts, *Lepidozygus tapeinosoma,* average fish density is slightly higher than in 2002. Some species were notably absent. It is likely that there may be a seasonal effect which should be a priority for future research. Densities of fish at St. Pierre are even higher this year.

Two Aldabra Station rangers received intensive training in underwater fish identification and counting. Concentrating on two fish families at one site, they are providing regular counts of these fish which will lead to a better knowledge of seasonal and lunar cycle variation.

New temperature data loggers, deployed in 2002, have proven to be reliable. A continuous stream of water temperature data has now been successfully downloaded and analysed. Provided this continues, the information will be invaluable over the long term. A substantial deployment of these new loggers was achieved in 2003.

Introduction

The mass coral bleaching event of 1998 is now considered the most severe on record (NOAA 1998, ISRS 1998, Wilkinson 2002). Mass mortality occurred worldwide. An estimated 16% of the world's coral reefs were destroyed during this single event with most of the damaged reefs in the central to northern Indian Ocean, southeast and east Asia and the western Pacific (Wilkinson 2000, 2002). Since 1998 there have been further bleaching events in the Pacific in 2000 and 2002. Coral death reached 40% over much of Fiji and there was significant mortality along the Great Barrier Reef. Predictions for the future are not good, with the frequency of bleaching events set to rise rapidly in response to rising sea temperatures (Hoegh-Guldberg 1999). It is estimated that most regions will be experiencing bleaching conditions every year within 30-50 years.

It is now commonly accepted that elevated temperature was the primary cause of the 1998 and other mass coral bleaching events (Hoegh-Guldberg 1999). This was very apparent in the Indian Ocean where prior to the bleaching in 1998 there was a significant incursion of warm water from the Pacific Ocean fuelled by a severe El Niño Southern Oscillation (Teleki *et al*. 1998). Temperatures rose above the tolerance of many corals and remained high for enough time to cause lasting damage. The Indian Ocean was one of the worst hit areas with some of the most severe bleaching related mortality (Wilkinson 2002).

The large raised coral atoll of Aldabra in the southern Seychelles suffered approximately 40% bleaching as a result of the event (Spencer *et al*. 2000). The Aldabra Marine Programme (AMP) was subsequently formed in 1999 to monitor, over the long term, the outcome of the perturbation and the changes and recovery of the reef community. The first survey took place in November 1999, with subsequent surveys in February 2001 and 2002. During this period a total of 11 permanent survey sites were established at Aldabra, with a further three sites established at Assomption and Astove in the Aldabra group, and St. Pierre in the Farquhar group in 2002 (see Teleki *et al.* 1999, Stobart *et al*. 2001, Stobart *et al*. 2002). As well as the regular monitoring of fish and coral populations, AMP has also carried out echinoderm surveys, deployed a series of temperature data loggers at selected sites and produced a management plan for Aldabra. Copies of all AMP reports are available at www.aldabra.org.

This report details the observations and results of the fourth AMP survey in May 2003. All permanent survey sites were resurveyed, with the exception of three that had to be omitted due to poor weather and time constraints. One new site was established at Astove. Five years after the bleaching event we assess the state of the reefs at Aldabra and selected sites to the east.

The 2003 Aldabra Marine Programme Phase IV

Phase IV of the Aldabra Marine Programme was due to take place in two stages, one in February 2003 and another in May. Because of the activity of three cyclones in the area during February the work was all carried out between the 8th and 27th of May 2003. The research team was based on SY Thalassi.

The main objectives were to:

- Repeat the coral and fish transects at the eleven permanent survey sites established at Aldabra between 1999 and 2001, as well as at single permanent sites established at each of Assomption, Astove and St. Pierre in 2002;
- Establish a new permanent transect at Grande Passe, within the Aldabra Atoll lagoon;
- Re-measure juvenile corals tagged at selected sites at Aldabra in 2001, and tag 120 more corals;
- Re-measure adult *Acropora* colonies tagged at Astove in 2002;
- Conduct coral recruitment quadrats at all survey sites (Aldabra, Assomption, Astove and St. Pierre);
- Recover temperature data loggers deployed at all survey sites in 2002 and return them to the manufacturer for examination and downloading;
- Deploy temperature data loggers at 10m and 20m depths at all survey sites to establish a long-term temperature recording system; and
- Continue training Seychellois Rangers in marine survey techniques.

The secondary objectives of this phase were to:

- Mark two remaining transects with lead core line;
- Continue to monitor the *Caulerpa* bloom around Astove with further investigations into the apparent lack of coral recruits at this site; and
- Conduct a pilot study to determine how best to study "coralliths" within the lagoon.

Location Information

All AMP sites are located in the southern Seychelles Islands Group about 200-300 nautical miles to the north of Madagascar and 300-450 miles east of Africa (Figure 1). Basic locations are provided below but more detailed descriptions of the locations can be found at www.aldabra.org.

Aldabra Atoll

Aldabra Atoll (9°24'S, 46°20'E) is one of the world's largest raised coral atolls (34km long, maximum 14.5km wide, area 155km^2). It is located 1150km southwest of Mahé, Republic of Seychelles, and 426km north of Madagascar (Figures 1 and 2).

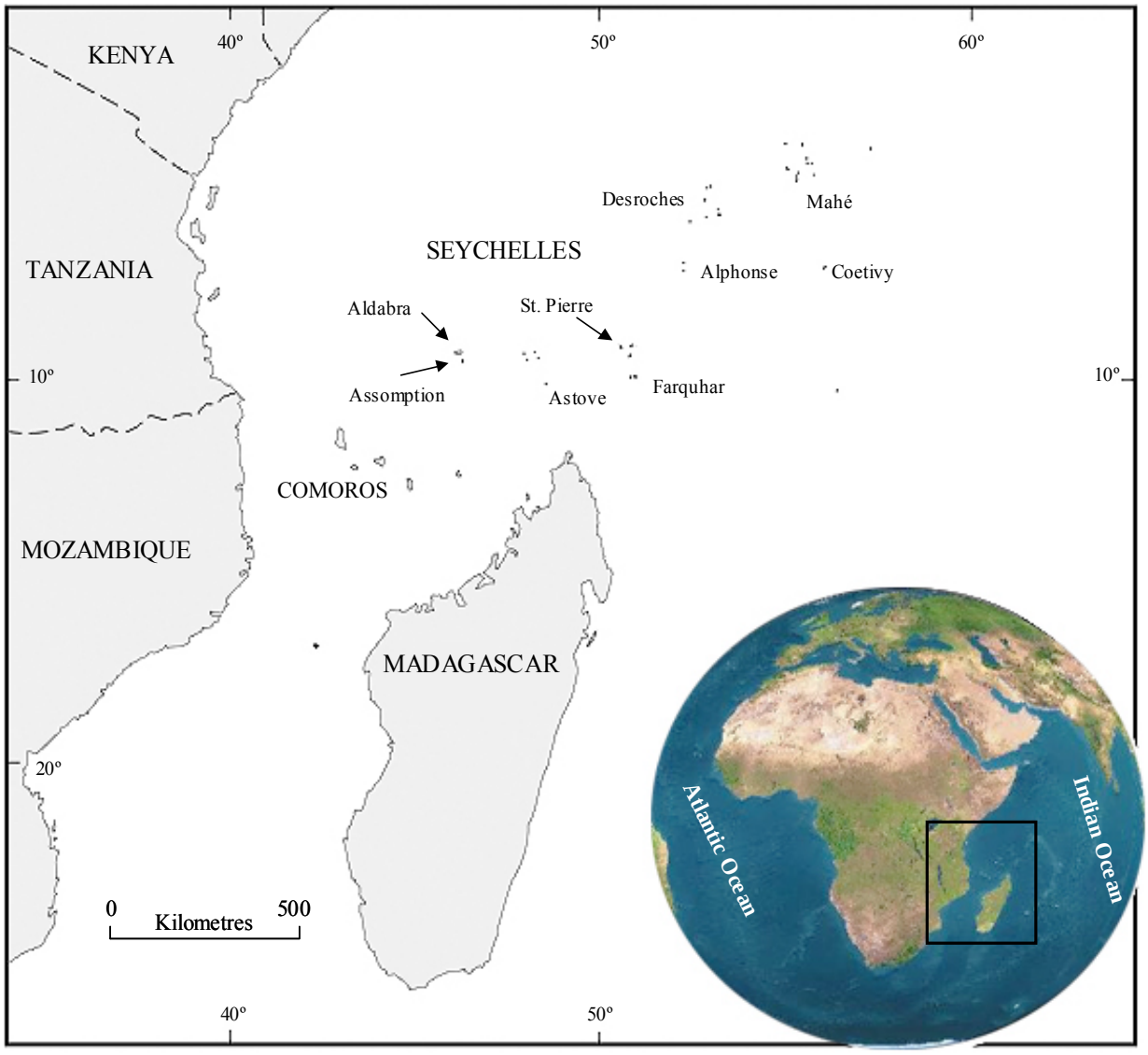


Figure 1. Location of AMP sites in the Western Indian Ocean.

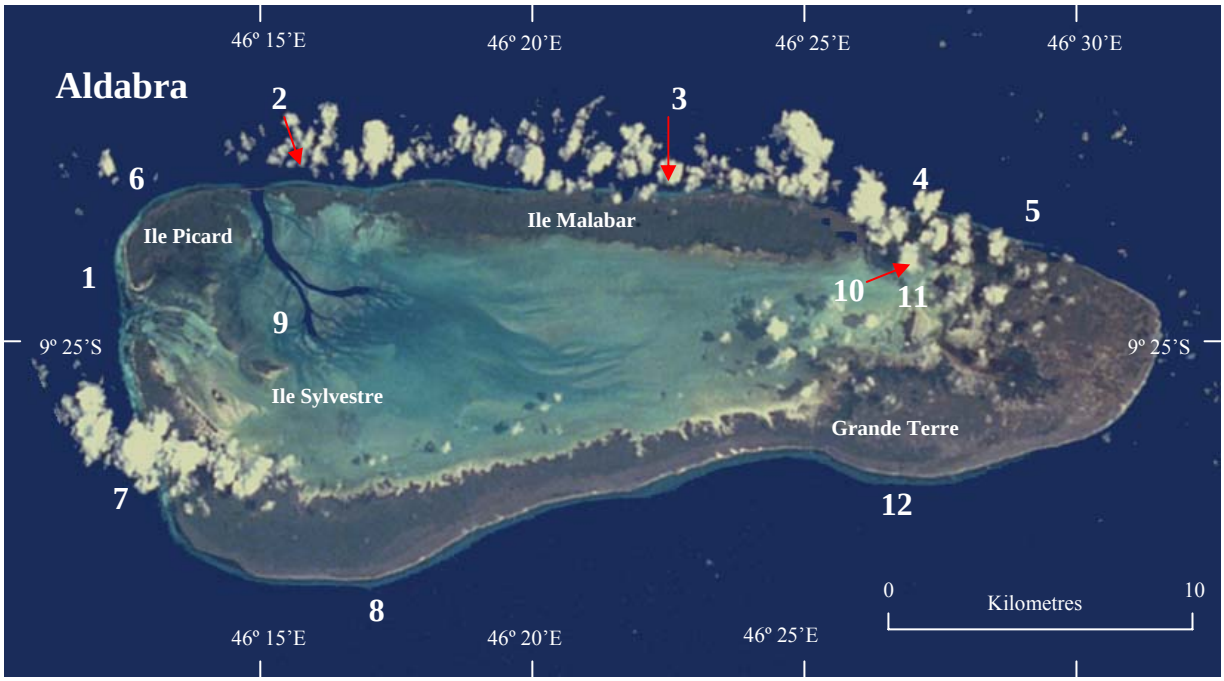
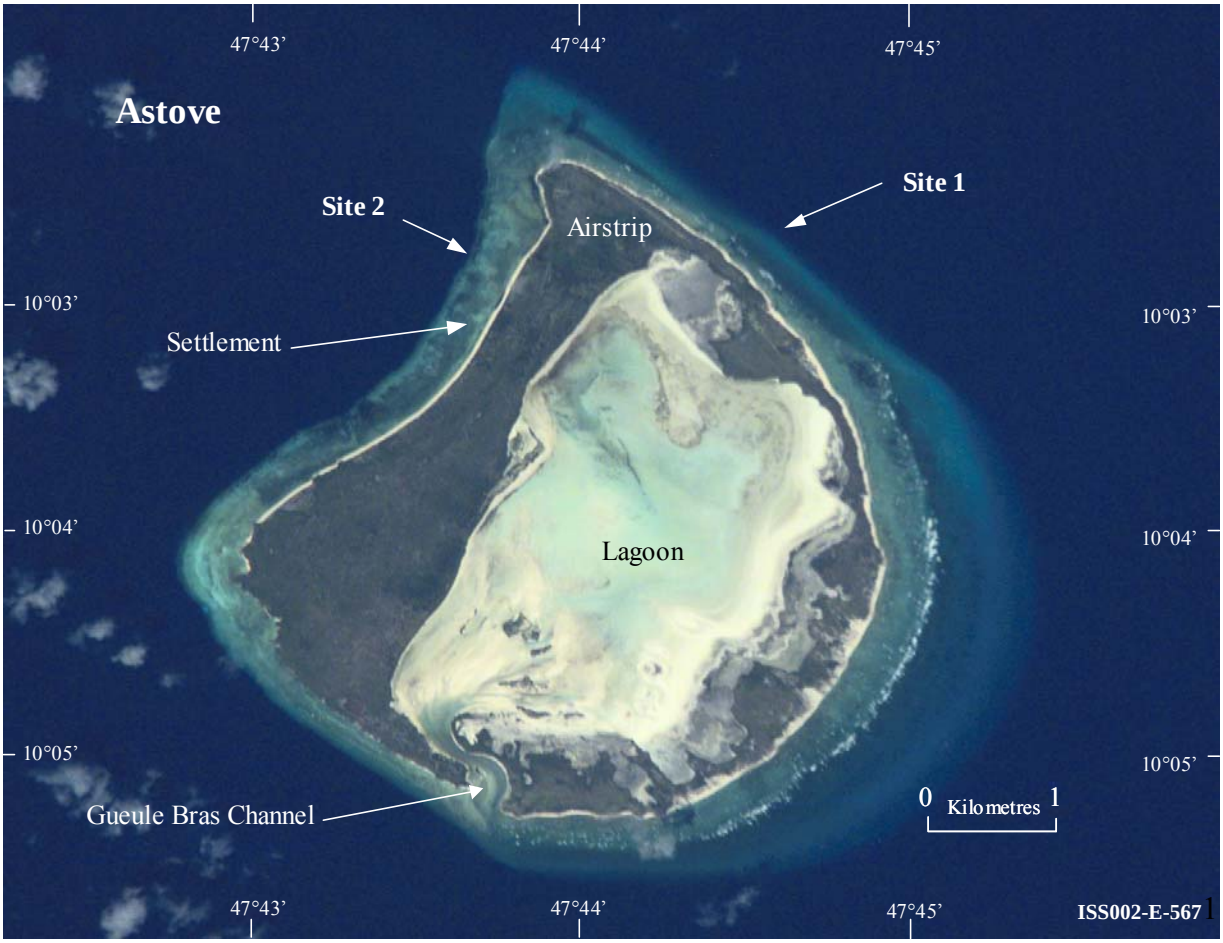


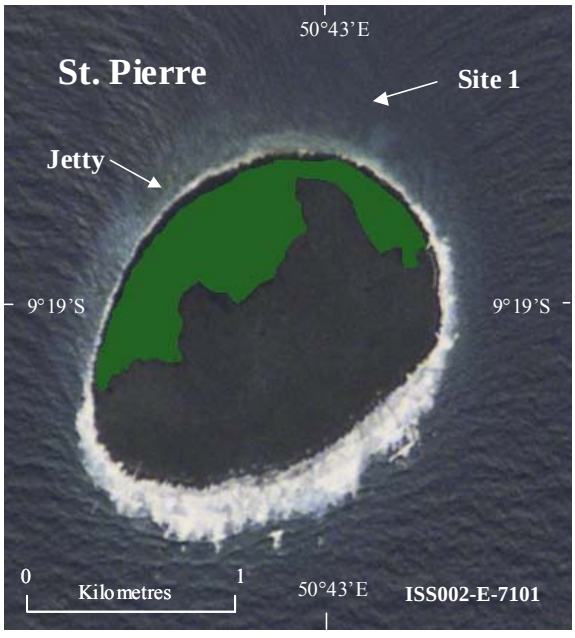
Figure 2. Aldabra atoll satellite Image with AMP monitoring sites.

Assomption, Astove and St. Pierre

Assomption, Astove and St. Pierre lie east of Aldabra (Figures 1 and 3). Assomption island is situated approximately 37km south of the eastern tip of Aldabra (9°43'S, 46°31'E). Astove lies 1056km from Mahé and approximately 185km ESE of Aldabra (10°04'S, 47°44'E). St. Pierre is approximately 704km from Mahé and 500km ENE from Aldabra (09°20'S, 50°43'E).

Photo montage of St. Pierre with site marked.





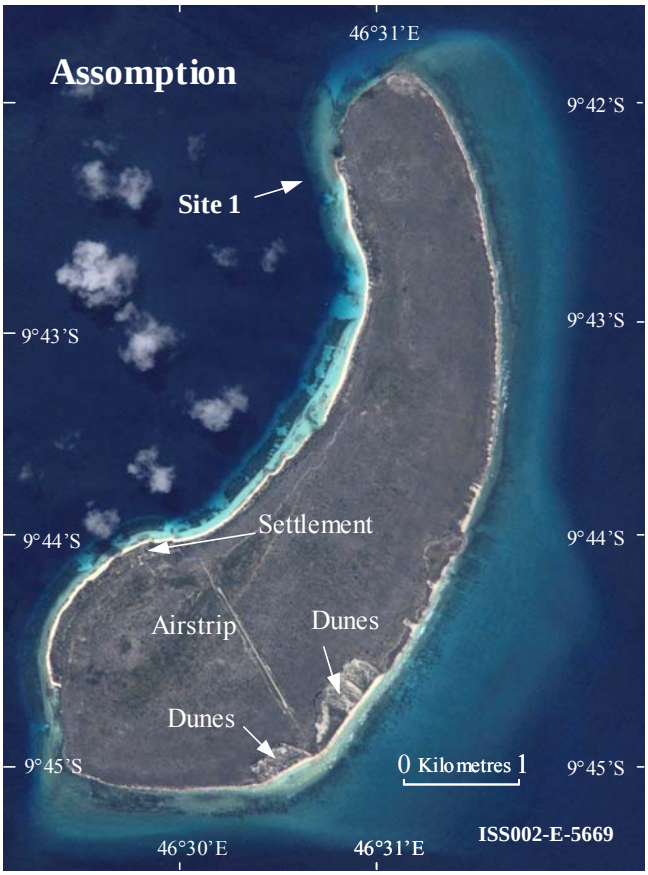
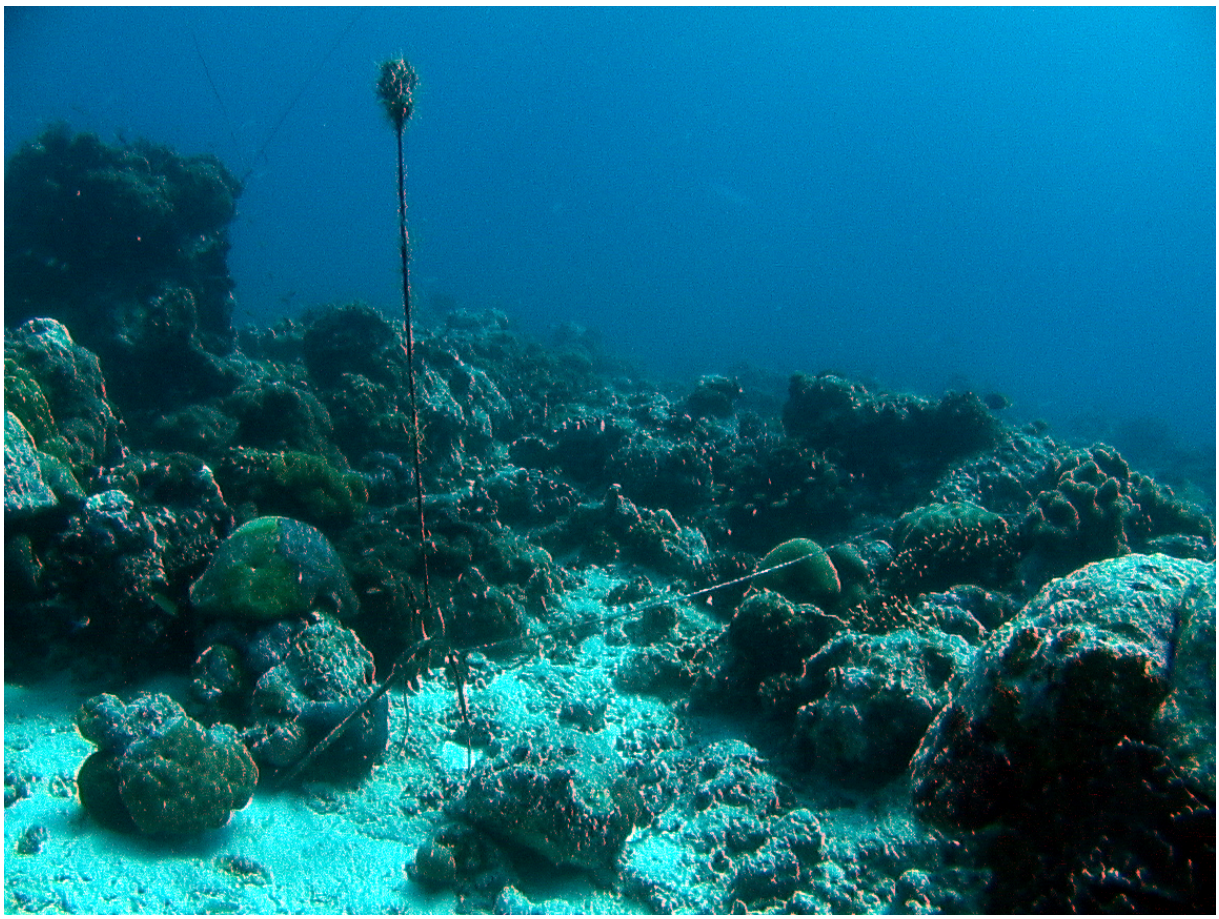


Figure 3. Astove, Assomption and St. Pierre site locations. Green zone on image of St. Pierre indicates extent of *Casuarina* forest. *Note: Photos courtesy of NASA, code on bottom right of images.*

Methodology

Coral and Fish Transects

The procedures used in the 2003 AMP survey to locate and mark permanent survey sites, and the methods used to quantify corals and fishes on the transects replicated those used in AMP Phase I (Teleki *et al*. 1999), AMP Phase II (Stobart *et al*. 2001) and AMP Phase III (Stobart *et al.* 2002). In previous years fish counts have taken place at approximately 10:00hrs and 14:00hrs. It must be noted that Aldabra and Assomption are on a different time zone to Astove and St Pierre (+ 2 and +3 hrs GMT respectively) and that the team used local time at all sites to decide on survey times.



AMP permanent monitoring site. End marker buoy and lead core line visible.

In 2003 one additional site was established on the NW coast of Astove (Astove Site 2, Figure 3). This site was selected as access to Astove Site 1 was not possible due to a strong southeasterly wind. Having a second site on the northwest would always allow access to one sheltered site on future surveys. This new site was established following the same procedure used for all other AMP permanent survey sites. A primary video transect was also conducted at Site 2 with tapes extended (total 32m) from 5m to 23m depth. Primary video transects are

filmed about 1m from the substrate and provide a record of the reef appearance for future reference. Depth was recorded at approximately 5m intervals along the tape and used to calculate the reef profile. The video was also used to determine which organisms were most abundant at each depth.

Coral Recruitment and Tagging

In 2003 coral recruits were monitored at all sites using sets of four 1m by 1m quadrats as in 2001 and 2002. Coral recruits were counted at 10m and 20m depth with approximately 24 quadrats surveyed at each depth (6 sets of four 1m x 1m quadrats). All corals less than 5cm maximum diameter were considered recruits. No counts were made at 6m due to time constraints and high swells.

During 2003, coral growth and survivorship for recruits tagged in 2001 and 2002 were estimated at four permanent survey sites (Aldabra Sites 1, 3, 6, and 7). Coral recruits tagged in 2001 and 2002 were relocated, measured, and a video still was taken of each one. Where time allowed new recruits were found and tagged with numbered perspex tags of a different colour to the previous year (Site 1, 20 tagged at 10m; Site 3, 6 tagged at 10m and St. Pierre, 20 tagged at 10m). Once again tag relocation proved very time consuming, though colonies marked with long cable ties in 2002 were easier to relocate.

Pocillopora recruit.

Temperature Data Loggers

AMP Phase IV used the HOBO Water Temp Pro® temperature data logger as the primary recording system, and the StowAway TidbiT® temperature data logger as a back-up recording system, to meet the objective of establishing a long-term sea temperature monitoring system at all of the AMP research locations. These temperature loggers, both manufactured by Onset Computer Corporation, were deployed in pairs at 10m and 20m depths at Aldabra, Assomption, Astove and St. Pierre in order to have redundancy in the monitoring system at all transect sites. The HOBO Water Temp Pro® measures water temperatures ranging from 0ºC to +50ºC, with an accuracy of ±0.2ºC, and can record up to 21,580 temperature measurements at a programmable interval. Although the StowAway TidbiT® loggers do not have the same accuracy and resolution, this model measures water temperatures ranging from -20ºC to +50ºC, with an accuracy of ±0.8ºC, and can record up to 32,520 temperature measurements at a programmable interval. To further guard against the loss of the temperature data, as was experienced in 2001 with the flooding of the Optic StowAway Temp® data loggers, the StowAway TidbiT® loggers were deployed in waterproof plastic sub-cases containing desiccant packs.

The temperature loggers were programmed to record data at 30-minute intervals, beginning at 18:00 hrs local time on the day of deployment. Both models of temperature loggers were attached near the base of the 10m and 20m transect line stakes that mark the start of the transect lines. The data loggers were not placed inside protective plastic-mesh cages as was done in previous years, because tests indicated there was minimal risk of loosing loggers to damage from large fishes grazing on encrusting organisms.

Ranger Training

Two Aldabra Rangers, Andy Dick and Terence Mahoune joined the AMP May 2003 Survey when it reached Aldabra. They were in turn berthed aboard SY Thalassi. The objectives were to:

- Provide an orientation of all the underwater surveys of corals and fishes that were being carried out by the AMP scientists at Aldabra;
- Familiarise the Rangers with the techniques for conducting underwater fish transect surveys;

- Help with underwater identification of fish from chaetodontid and serranid families;
- Set up a research protocol to provide monthly seasonal information on the abundance of the key indicator families Chaetodontidae and Serranidae at Survey Site 1 on the 10 m depth transect;
- Conduct at least one such survey with both Rangers working as a team, supervised by the AMP scientists.

Achievements

Most of the above objectives were achieved, but weather conditions were extremely poor, and underwater conditions suboptimal. At least one dive had to be cancelled for safety reasons.

The Station Research Officer, Rainer von Brandis, also joined the team and provided support and guidance for the above activities.

Each Ranger was given a surface briefing that covered the objectives of the fish and coral surveys and an outline of each of the AMP research activities. The initial dives were then made so that they experienced each of these activities with one or other of the AMP scientists. This included: coral surveys using the video transect method; coral tagging to provide information on recruitment survival and growth; quadrat surveys of coral recruits, and fish counting along fixed transect lines.

Once the above was completed, the lists of chaetodontids and serranids that have already been identified by AMP at Aldabra were studied, with frequent reference to the identification books, copies of which were previously donated to the research station library. The merits of using Latin names and local names were discussed. A supply of underwater paper and pencils was left with the Rangers. These can be printed on so that the surveys can be carried out with pre-printed sheets.

Project and Survey Protocol

Although a good baseline of fish data has been accumulated by the AMP surveys since 1999, the information that is missing is seasonal, monthly and diurnal variation. The suggested project will use the Site 1 50m long survey line at 10m depth. Site 1 is opposite the research station and therefore relatively easy to access. The two Rangers will work as a pair, using the same protocol as for the standard AMP fish surveys.

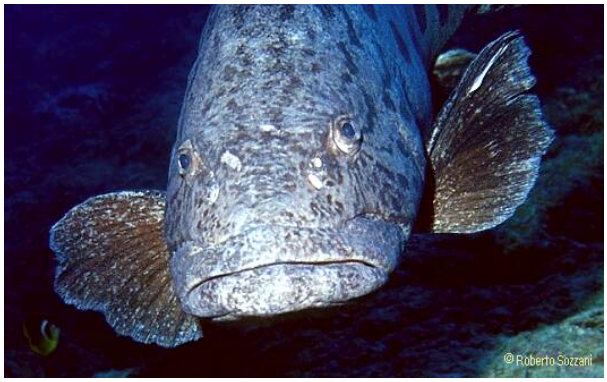
Working from north to south, each diver will survey one side of the line, in a 2m band extending out from the line across the bottom, and all the way to the surface. They will swim the entire 50m length of the line identifying and counting all chaetodontids in the survey "corridor". At the end of the line they will swim back to the start but this time identifying and counting all serranids seen in the same survey corridor, taking particular note of any hidden under corals. Any fish crossing the line will be counted just once by the diver into whose side the fish crosses.

Ideally these surveys should be carried out three times on **one specific day** per month, that of the full moon. The first count should be at the time of full tide, the second at 10am (GMT +3hrs) and the third at 2pm (GMT + 3hrs). Each dive should be no longer than 30 minutes.

Before this is undertaken, the two Rangers will be diving at least once per week to perfect the technique. Free swims (off the transect line) should be done to improve general identification. These can and should be done at a variety of locations. After each of these dives both Rangers need to immediately discuss with one another the fish they have seen, and to resolve any discrepancies in identification. The survey data is then entered into an Excel or other computer spreadsheet database in a format that keeps the survey data from each ranger as a separate record. Once confident of their abilities, they should then practice the survey technique along the 10m depth line until their results are consistent. The station Research Officer should monitor the surveys, if possible in the field, and judge when each Ranger is achieving consistent results. Only then should the surveys begin in earnest. It is suggested that the first monthly survey is planned for the full moon of July 2003.

Clown triggerfish - *Balistoides conspicillum.*

Potato cod - *Epinephelus tukula*.



Photos Roberto Sozzani

Results

New Permanent AMP Survey Site Established in 2003

Astove Site 2

The general profile of Astove Site 2 on the northwest coast is shown in Figure 4. This area of Astove has a reef flat approximately 200 – 300m wide that ends with a very pronounced drop-off that is vertical in places and has many caves. This "marine cliff" dominates the entire northwestern coast of Astove and drops to well beyond 100m depth. Coral growth is very abundant here, particularly on the shelf that lies between 10m to 13m depth. At 5m depth there is a predominance of coralline algae combined with abundant *Acropora* (*Isopora*) colonies and other hardy species such as *Porites*. From this depth there is an almost vertical drop to the shelf at 10m – 13m where there is abundant live coral, particularly large colonies of *Porites*, branching *Porites*, *Acropora*, *Montipora*, *Pocillopora*, *Millepora* and many faviids. From 13m down these species gradually decline in abundance and are replaced by foliose colonies on the steeper slope, primarily *Pachyseris*. *Porites* massive colonies remain abundant down to the 20m transect and beyond. There is evidence of past coral death at this site. In particular large dead *Porites* and faviid colonies remain intact and are now being colonised by new recruits (see photos page 26). Below 20m there is an increase in coral rubble on the steep slope and a consequent decline in live coral cover.

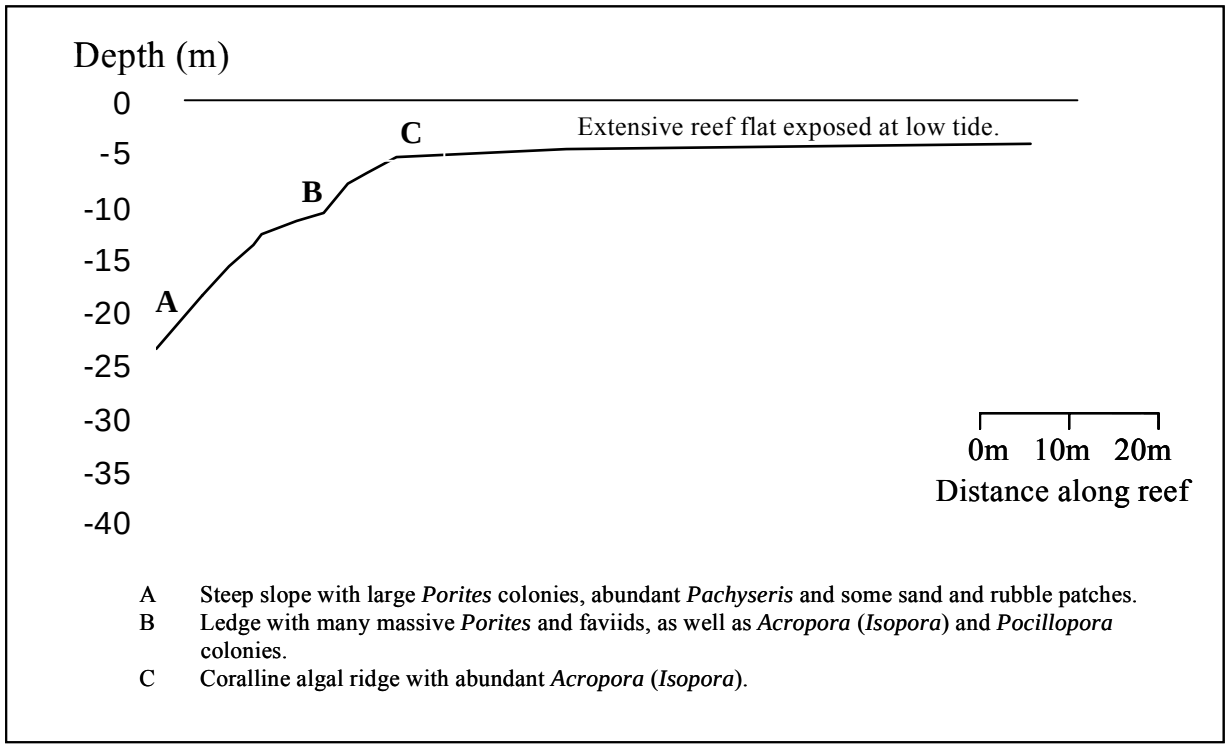


Figure 4. Reef profile for Astove Site 2 with corresponding coral species composition.

Coral Transects and Benthic Habitats

In May 2003, live coral cover around Aldabra ranged from 3% to 58% in shallow water and 0.4% to 52% in deep water (Figure 5). This contrasts slightly with data in previous AMP reports due to changes in the way data has been analysed. Note that this year hard and soft coral data have been separated. Re-analysed data for all years is therefore summarised in Figure 6 for shallow water and Figure 7 for deep water. Comparison of total coral cover (soft and hard corals combined) over the four years shows that cover has only increased substantially (more than 10%) at sites 2, 3, 6 and 7 in shallow water and 2 and 6 in deep water (Figure 8). Growth varied less than 5% at sites 1 and 5 in shallow water and 1, 4, 5 and 7 in deep water. Most coral growth occurred at Site 6 in shallow water and Site 2 in deep water. Yearly change in live coral cover averaged for all sites shows that between November 1999 and May 2003 coral cover has increased by 11.7% in shallow water and 4.9% in deep water, giving an average yearly increase of 3.3% and 1.4% respectively over the three and a half years. Calculating the same for hard coral alone one finds that in shallow water cover only increased by 0.3% and in deep water it decreased by 1.4%. The maximum increase in hard coral cover was only 4% in shallow water and 3% in deep water at Site 6 (Figures 9 and 10 respectively). Viewed separately it is clear that the changes in live coral cover over the past 3.5 years have been dominated by soft corals, and specifically soft coral of the genus *Rhytisma* (Family Alcyoniidae) (Figures 9 and 10). This genus is very abundant at some sites and forms an encrusting mat 2 - 4mm thick. Dead coral cover did not change between February 2002 and May 2003.

Between November 1999 and May 2003 algal cover has remained relatively constant at Aldabra with some exceptions. At most sites there was a considerable increase in coralline algal cover between 1999 and 2001 associated with colonisation of dead coral colonies and consolidation of coral rubble. This increase was most apparent in shallow water (Figures 9 and 10). Between 2001 and 2003 coralline algal levels remained stable and in some instances declined slowly between 2002 and 2003. Non-coralline algae, mainly *Halimeda*, have changed little over the study period, with the exception of Site 5 where levels dropped 25% in shallow water and 15% in deep water between 1999 and 2001 (Figures 9 and 10). Levels of *Halimeda* have also declined steadily in shallow water at sites 3 and 4 between 2001 and 2003.

Sand, rock and rubble levels have shown some changes over the study period. Levels at Sites 5 and 1 increased considerably between 1999 and 2001, particularly in shallow water. The increase at Site 5, which is primarily seabed covered with rubble, is directly associated with the changing levels of *Halimeda* cover and not a true increase in rubble quantity (*i.e.* the algae were removed by bad weather revealing rubble underneath for counting). However, the changes at Site 1 do represent true changes in sand, rock and rubble cover. Also notable was a 9% increase in sand, rock and rubble at Site 7 (shallow water) between 2002 and 2003 (6% in deep water). There was evidence of wave damage in shallower water in the form of shifted areas of sand and aggregation of rubble. The permanent survey line was also broken and many coral tags were missing at this site suggesting it had been affected by rough weather (possibly associated with the generating cyclone in February 2003).

Galaxea sp.

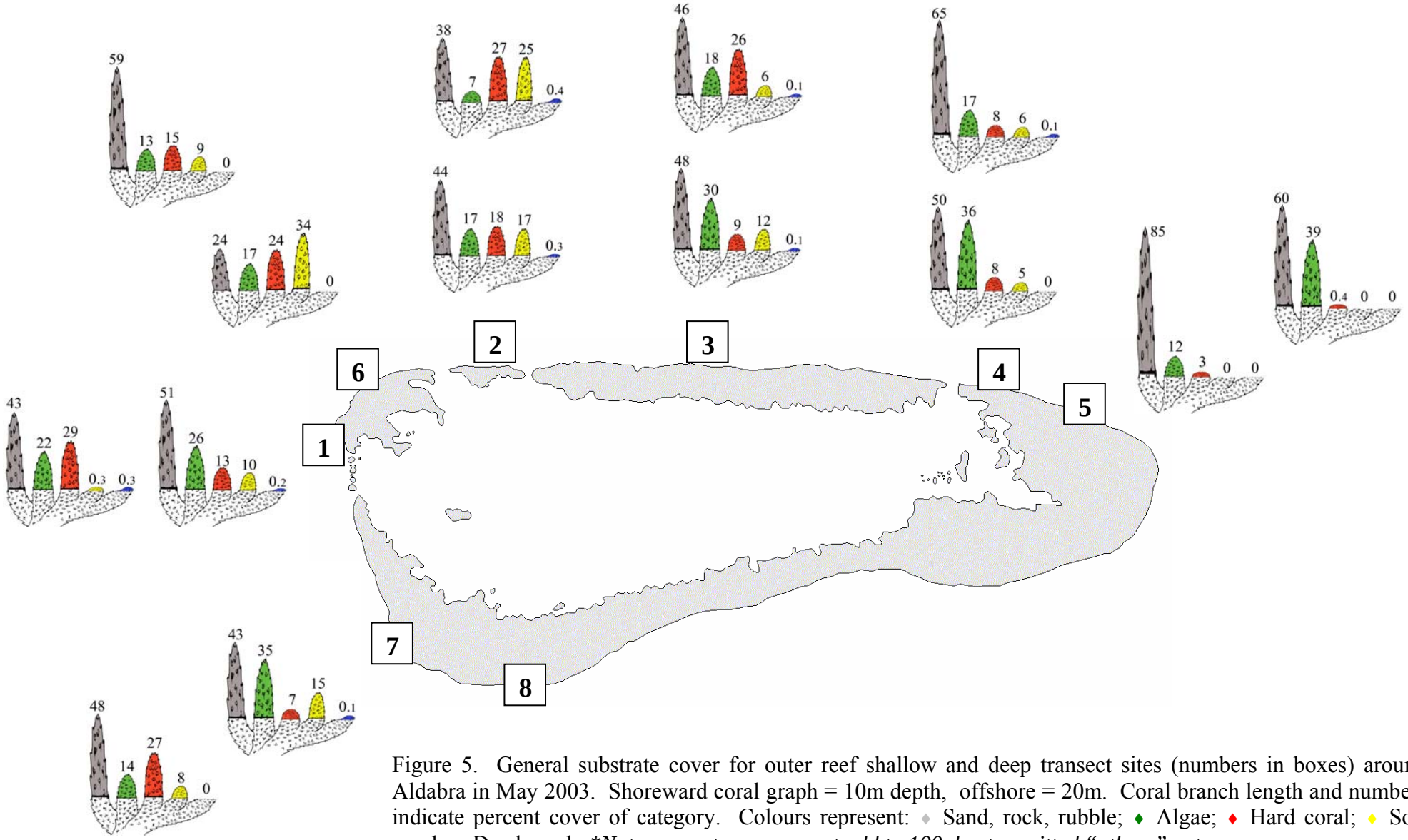


Figure 5. General substrate cover for outer reef shallow and deep transect sites (numbers in boxes) around Aldabra in May 2003. Shoreward coral graph = 10m depth, offshore = 20m. Coral branch length and numbers indicate percent cover of category. Colours represent: ♦ Sand, rock, rubble; ♦ Algae; ♦ Hard coral; ♦ Soft coral; ♦ Dead coral. **Note percentages may not add to 100 due to omitted "others" category.*

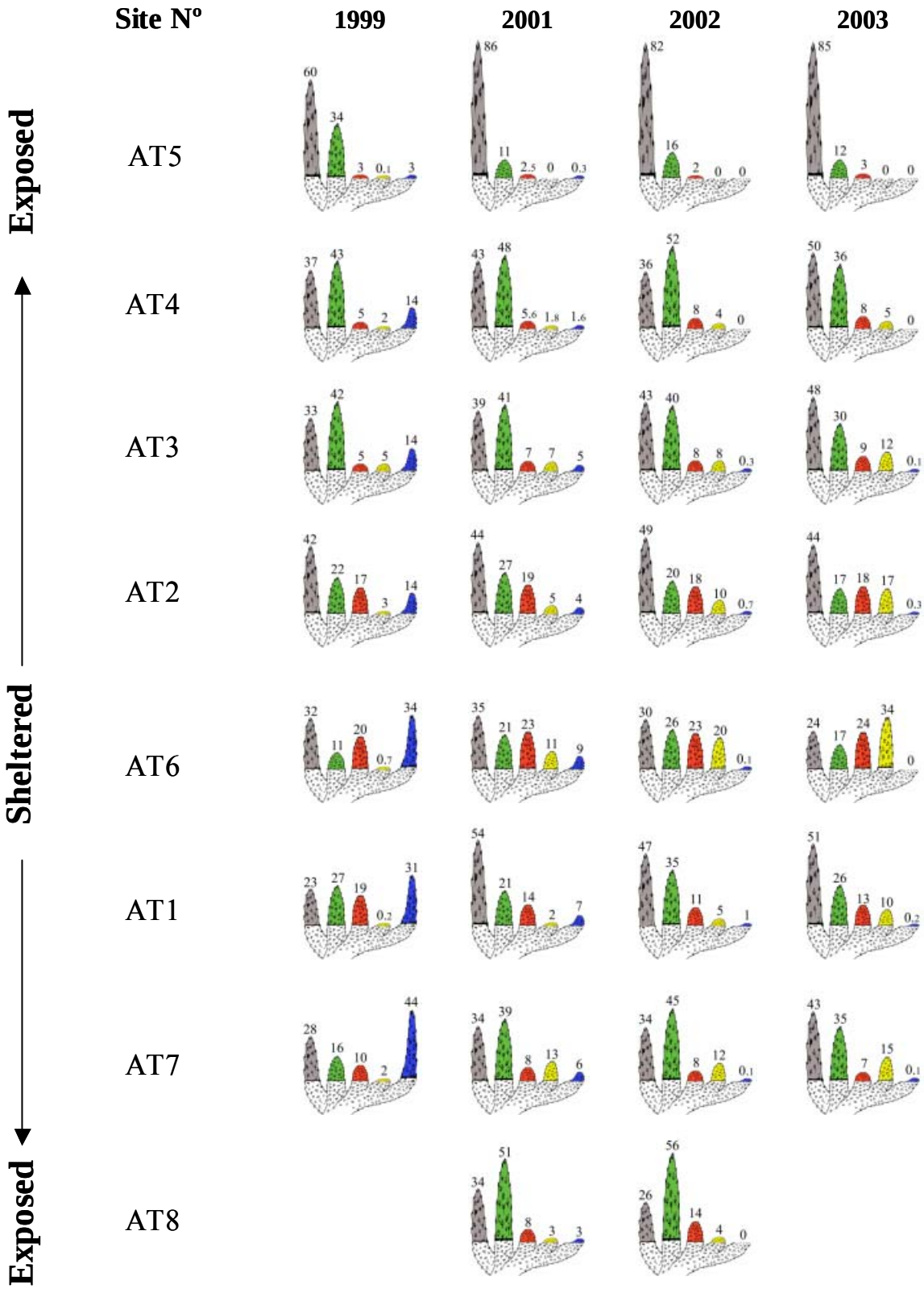


Figure 6. Calculated general substrate cover for outer reef shallow (10m) transect sites around Aldabra in November 1999, February 2001 and 2002, and May 2003. Coral branch length and numbers indicate percent cover of category. Colours represent: ♦ Sand, rock, rubble; ♦ Algae; ♦ Hard coral; ♦ Soft coral; ♦ Dead coral. * *Note percentages may not add to 100 due to omitted "others" category.*

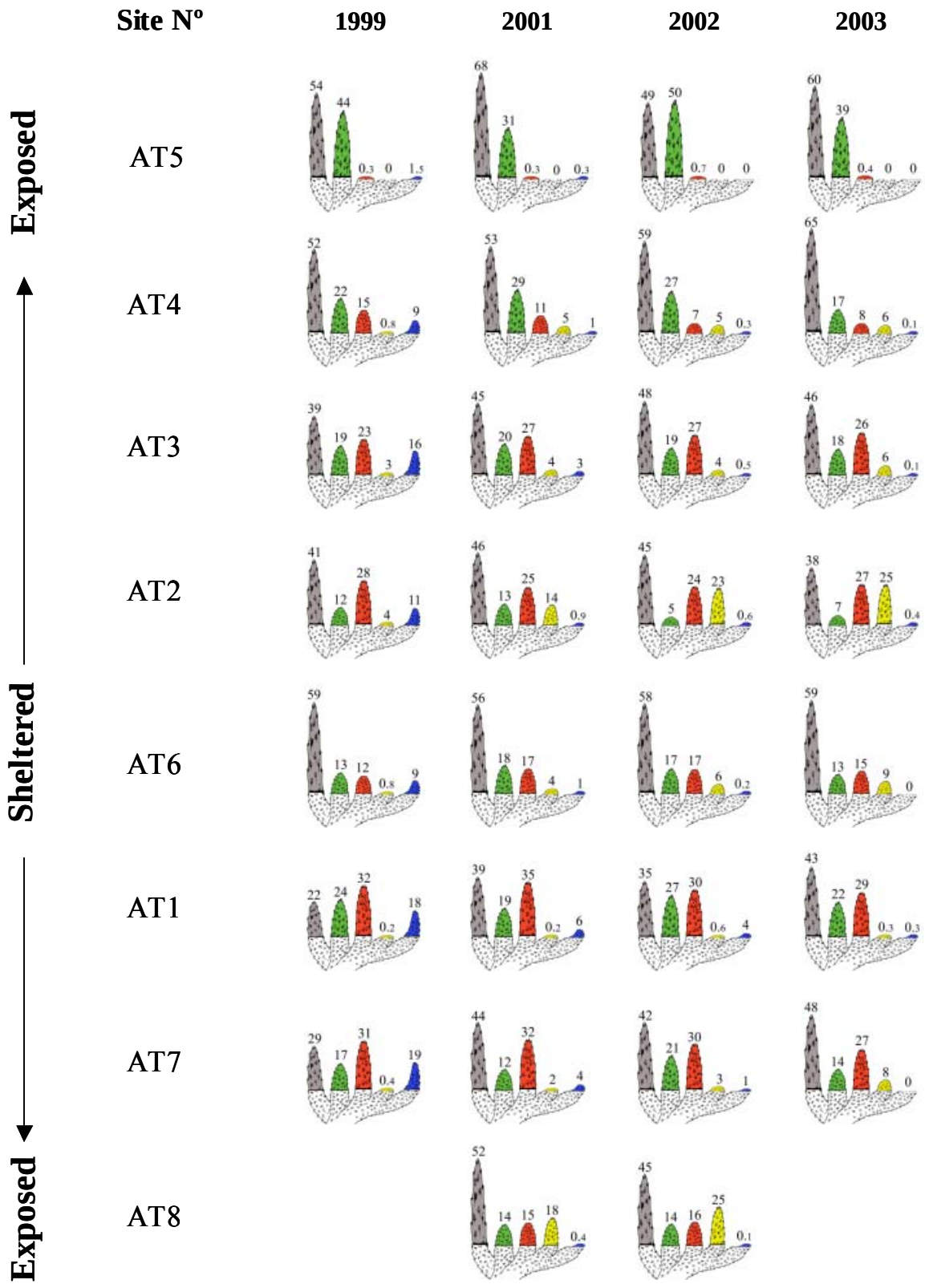


Figure 7. Calculated general substrate cover for outer reef deep (20m) transect sites around Aldabra in November 1999, February 2001 and 2002, and May 2003. Coral branch length and numbers indicate percent cover of category. Colours represent: ♦ Sand, rock, rubble; ♦ Algae; ♦ Hard coral; ♦ Soft coral; ♦ Dead coral. * *Note percentages may not add to 100 due to omitted "others" category.*

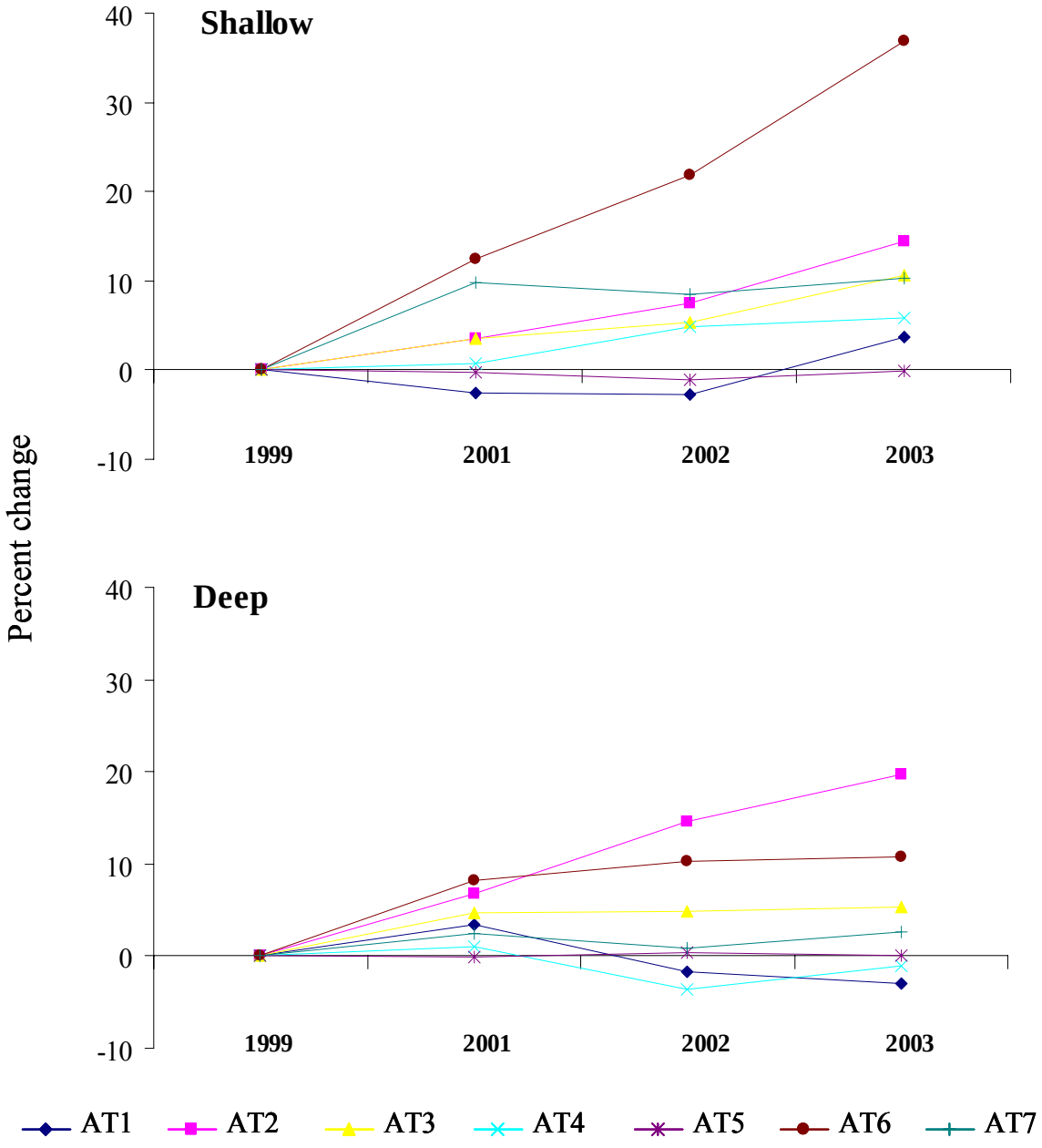


Figure 8. Percent change in live coral cover (hard and soft coral) at Aldabra Atoll between 1999 and 2003 in shallow and deep water. Legend shows site number by colour and symbol.

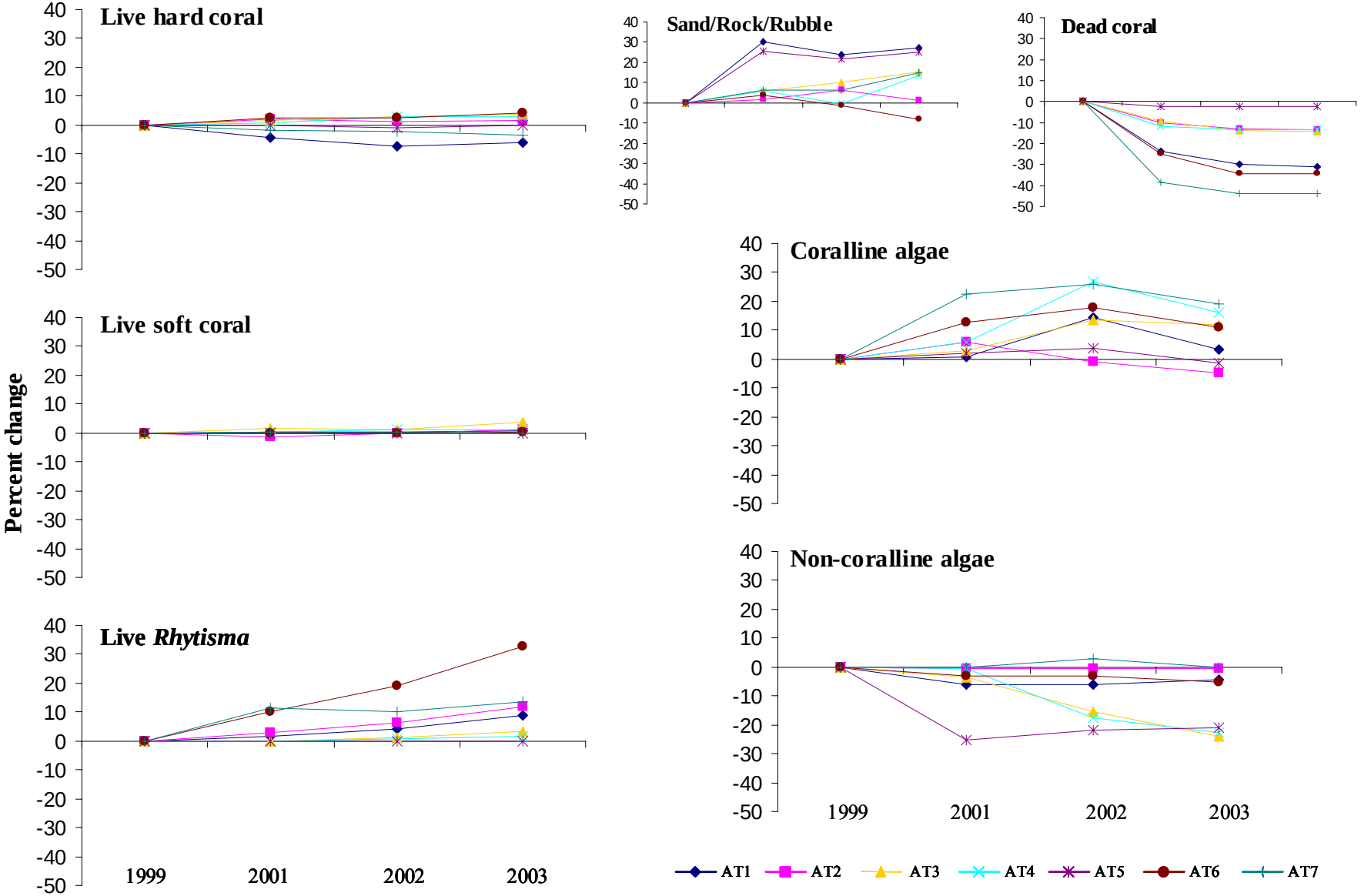


Figure 9. Percent change in benthic cover at Aldabra Atoll between 1999 and 2003 in shallow (10m) water. Legend shows site number by colour and symbol.

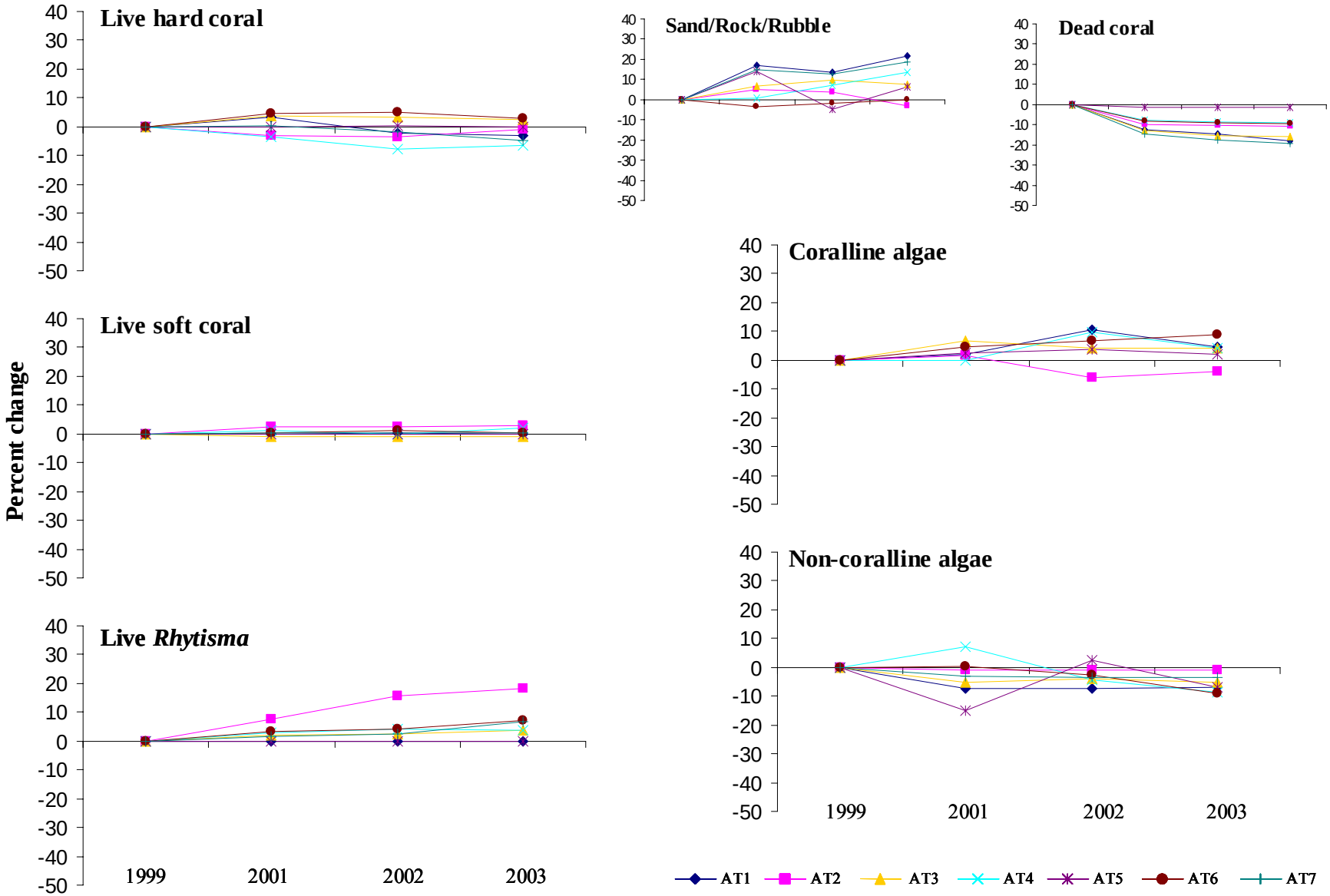
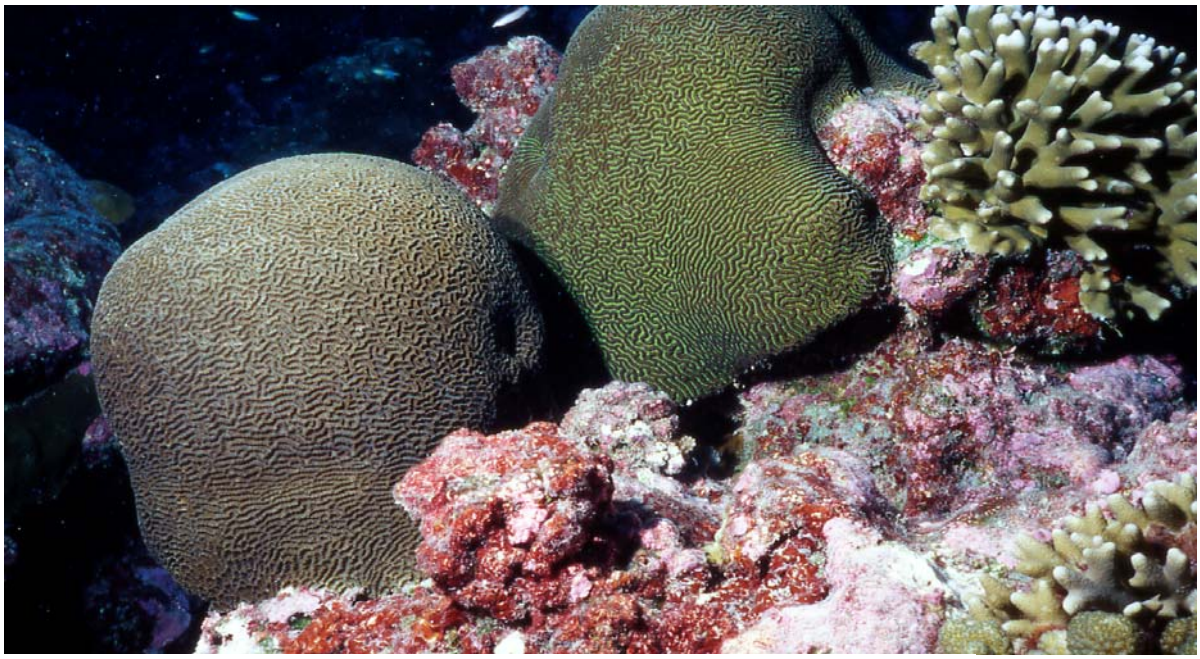


Figure 10. Percent change in benthic cover at Aldabra Atoll between 1999 and 2003 in deep (20m) water. Legend shows site number by colour and symbol.

Lagoon sites did not change significantly between February 2002 and May 2003 (Figure 11). Over the 3.5 year study period there is some indication of coral cover increase at Site 9 with an overall 9% increase during that period. It is worth noting that 4 *Acanthaster planci* were seen at Site 10. One of them had just consumed a *Pocillopora* colony but there was no evidence of intensive starfish feeding in the area.

The site at Assomption changed little since last surveyed 17 months earlier, with the exception of a 9% decrease in algal cover in deep water associated with an increase in sand, rock and rubble (Figure 12). Changes could not be assessed at Astove as Site 1 was not accessible, but the new Site 2 was notable for its very high hard coral cover comparable to that of the lagoon Site 9 at Aldabra. As at most other sites, there was evidence of high coral mortality in the past, with many large massive colonies showing signs of partial or total mortality. St. Pierre showed good signs of coral recovery with a 10% increase in hard coral cover in shallow water and 8% in deep water. Algal levels at St. Pierre remained the same.

Between 1999 and 2002 forty two scleractinian coral genera and 60 species were recorded (see www.aldabra.org for reports). During Phase IV only three new species of coral, *Pocillopora meandrina* (new record for this part of the Indian Ocean), *Psammocora obtusangula* and *Goniastrea peresi* were identified. This brings the total to 42 genera and 63 species.



Platygyra (Left & middle) and *Porites* (right).

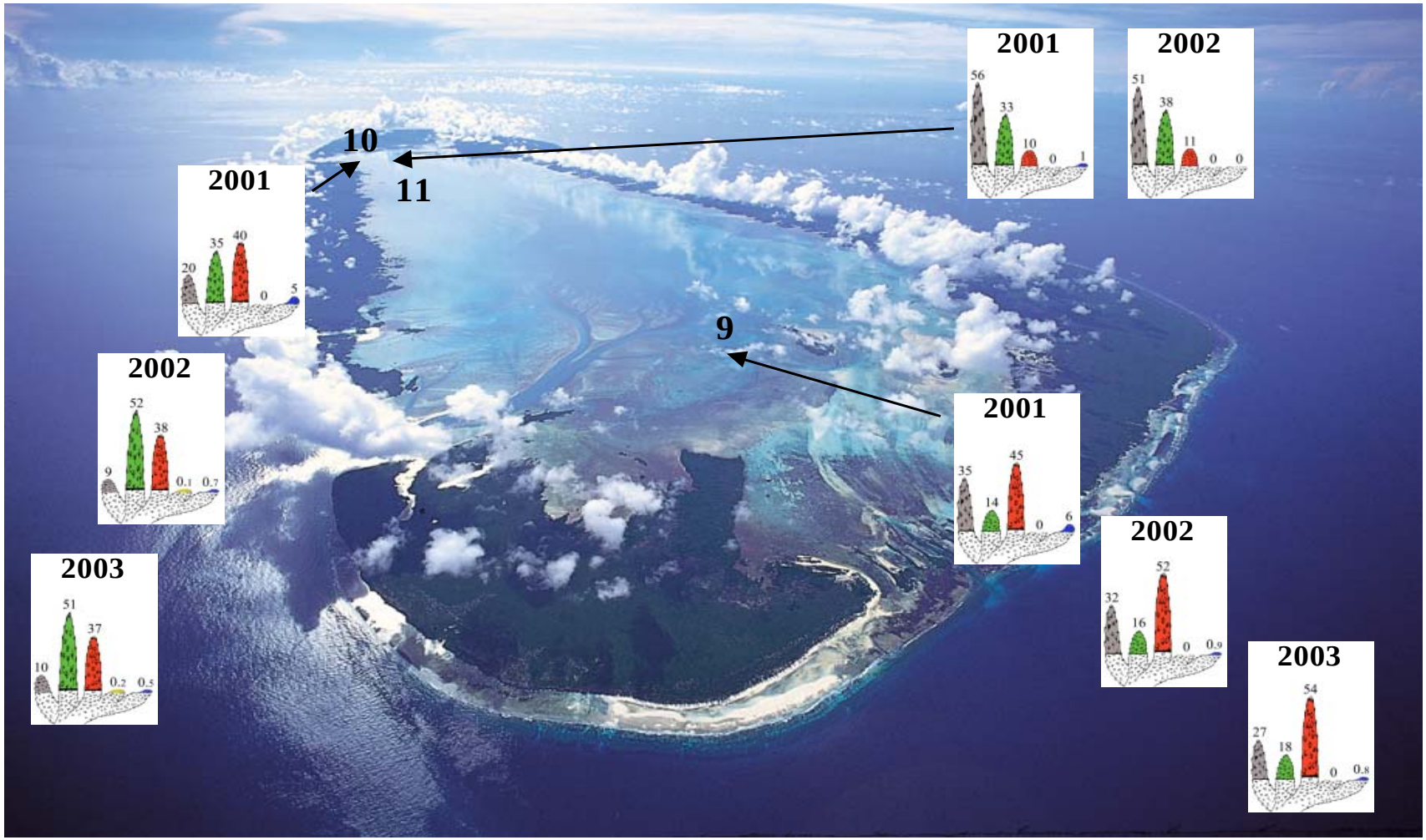


Photo courtesy of Camerapix Nairobi

Figure 11. Calculated general substrate cover for lagoon transect sites (numbers in boxes) at Aldabra in February 2001 and 2002, and May 2003. Coral branch length and numbers indicate percent cover of category. Colours represent: ♦ Sand, rock, rubble; ♦ Algae; ♦ Hard coral; ♦ Soft coral ; ♦ Dead coral. * *Note percentages may not add to 100 due to omitted "others" category.*