Survey Report on Marine Biodiversity of Shell Bay, Trincomalee

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Arjan Rajasuriya

Research Officer

National Aquatic Resources Research and Development Agency

Contents

Summary

There are no records of a marine biodiversity study carried out in Shell Bay in the past. The findings of this survey indicate that Shell Bay contains highly diverse and rich marine life. Twelve colour variations of the giant clams were found among the nearshore reefs which indicate that the area may harbour hitherto unknown genetic diversity among Tridacnids in Sri Lanka. Fifty six (56) species of hard corals and 160 species of reef fish were also recorded. In addition there were many species of Sponges, Echinoderms and Molluscs. The marine environment of Koddiyar Bay and the surrounding area is directly influenced by the Mahaweli River waters and the deep canyon close to shore. The presence of megafauna also indicates that this is a special marine environment and this whole system should be studied as a single ecosystem.

Presently, there is low to medium scale fishing in the area. The main threats are from Illegal and destructive fishing practices that are taking place around Foul Point, east of Shell Bay. In addition climate change is already altering habitats and species composition. Proposed development in the land area to the east and southeast of Koddiyar Bay may pose a more serious threat through chronic pollution from shipping and ocean outfalls of industries. Development in this area requires careful planning by taking into consideration the sensitiveness of the coastal and marine environment. Establishment of core and multiple-use protected areas can control and reduce some of the negative impacts that are already taking place and those that might occur in the future.

Recommendations

- Establish a multiple-use marine protected area for Koddiyar Bay and create fully protected core areas for identified sensitive ecosystems in the surrounding area.
- Conduct thorough surveys of the Koddiyar Bay and associated ecosystems to understand the connectivity between them.
- Build a species inventory for this special region.
- Conduct further studies on genetic diversity, breeding and growth of giant clams, sponges, soft corals and echinoderms.
- Explore the techniques of in-situ and ex-situ culture of Tridacnids and other selected species.
- Study the oceanographic conditions that govern the marine ecosystems of this area.
- Determine ecosystem health indicators and establish a monitoring programme.
- Take immediate steps to stop the use of prohibited and destructive fishing methods.
- Conduct awareness programmes and develop extension material on the value of this special marine environment to educate the public, government officials and entrepreneurs.

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Introduction

Shell Bay is situated southeast of Trincomalee between Norway Point and Foul Point. The coastal waters of this area contain many reef habitats of various forms; rock piles, ridges, plateaus and patch reefs. They support a variety of fauna and flora including hard and soft corals.

The marine environment of Shell Bay is influenced by freshwater from the Mahaweli River which flows into the Koddiyar Bay. The area also contains mangroves, wetlands and a coastal lagoon. This area is unique because in addition to sensitive ecosystems there is a deep canyon close to shore and a relatively deep Inner harbour with several coves. Due to this special setting the area attracts megafauna such as whales, dolphins and sea turtles. However, very little is known about this special coastal region.

Some reef habitats in Trincomalee and Nilaveli were studied in the recent past. The status of coral reefs in the Dutch Bay and Pigeon Island National Park was documented in the wake of the 1998 coral bleaching event and the 2004 tsunami (Rajasuriya, 2005). But almost nothing is known about the status of reefs in the Shell Bay and Foul Point as that area was not accessible for scientific studies during the past twenty five years due to the internal military conflict that affected the country.

Trincomalee and its surroundings have been identified for rapid development based on tourism and other industries under the accelerated development programme of the government. The land area close to Shell Bay is targeted for industrial development and the establishment of a coal fired thermal power plant that have the potential to cause serious harm to the environment. Therefore it is imperative to obtain information on the present status of these ecosystems and to understand the connectivity between them in order to harmonize ecosystem health and development. This rapid survey was carried out from 28 September to 1 October 2010. It is a component of baseline studies of the ecosystems and marine biodiversity of the area.

Methods

Study area

The Shell Bay is about 1.5 km across and is located between Norway Point and Foul Point, southeast of Trincomalee (Fig. 1). It is close to the deep water canyon extending northeast from Koddiyar Bay. The northeast monsoon influences the area from October to February. Sandy beaches and rock outcrops characterize the coast of Shell Bay and the adjacent area. Rock boulders and ridges create the main substrate for reef building organisms (Fig 2). The survey sites were located within the areas ‘A’, ‘B’, ‘C’ & ‘D’ (Fig. 3).

Figure 1. Location of shell Bay, southeast of Trincomalee (Source: Google Earth)

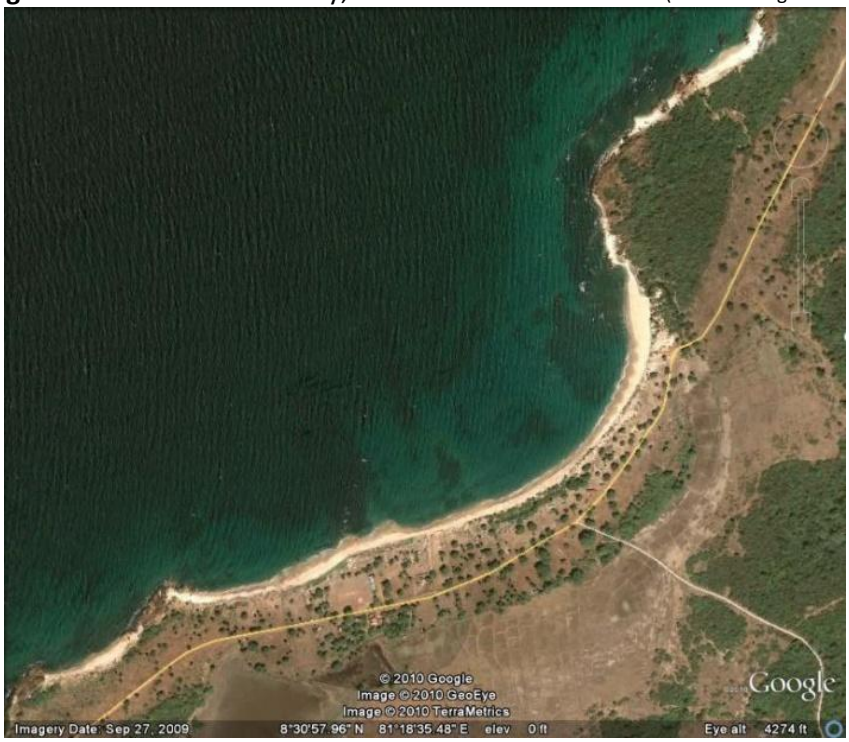


Figure 2. Aerial view of nearshore rock substrate in Shell Bay (Source: Google Earth)

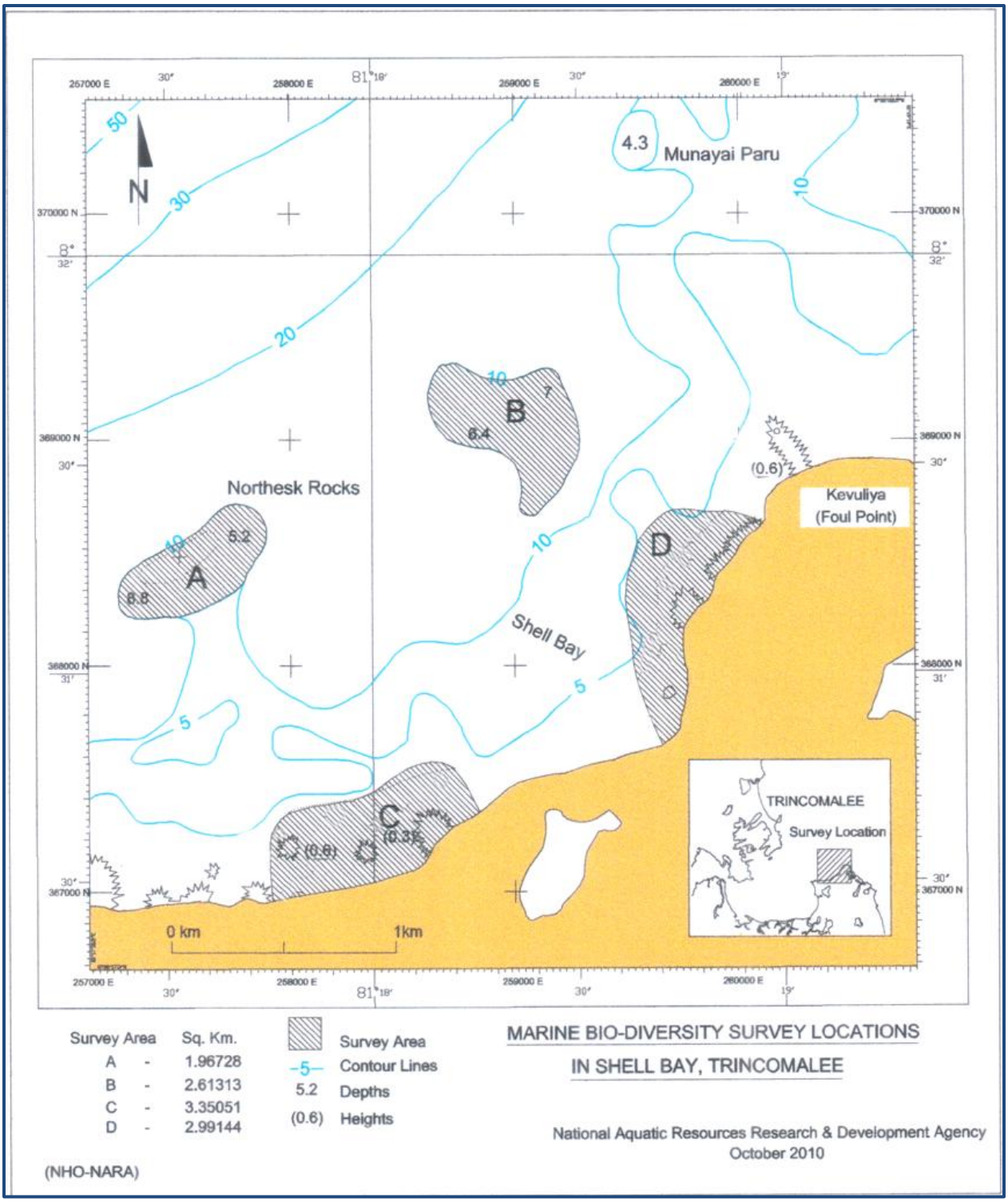


Figure 3. Survey areas (A, B, C, & D) in Shell Bay, Trincomalee

Sampling methods and survey sites

The survey was carried out by snorkeling and scuba diving. Substrate type and live coral cover was recorded along 50 m Line Intercept Transects. Mega- benthos (large invertebrates) was recorded using Belt Transects of 50 m x 2 m (English et al. 1997, Hill & Wilkinson 2004). Sampling was done at three sites on the offshore reefs (survey areas 'A' & 'B') and four on the nearshore reefs (survey areas 'C' & 'D') (Table 1). Species diversity and abundance of selected groups of invertebrates (spiny lobsters, Crown of Thorns starfish, and giant clams - *Tridacna* spp) were recorded by the roaming diver technique where the underwater data collector covered a wider area (500 m^2) around the belt transect to include 5 m on either side of the 50 m belt transect. Species diversity of reef fish was also recorded using the same technique. Underwater photographs and video were obtained to document habitat types and behavior of selected species.

Table 1. Geo-coordinates of sampling sites

Survey area	Geo-coordinates of sampling sites
Survey area 'A'	N 8.52028, E 81.29472
Survey area 'B'	N 8.52614, E 81.30489 & N 8.52767, E 81.30653
Survey area 'C'	N 8.50892, E 81.29911 & N 8.51194, E 81.30248
Survey area 'D'	N 8.51902, E 81.31154 & N 8.51902, E 81.31197

Pre-survey briefing

Conducting Line and Belt transects

Results

Survey areas 'A' & 'B'

The survey areas of 'A' and 'B' contained large rock piles rising up from depths of 10 to 15 m. Both areas have a high relief up to about 8 m. Rock boulders of various sizes and shapes formed a highly rugose habitat that supported a wide variety of marine life. Area 'B' contained more diverse communities of benthic organisms than area 'A'. The rock boulders were larger in survey area 'A' and thus provided greater hiding spaces for larger reef fish such as snappers and groupers.

Live hard coral cover in survey area 'A' was 23% and dead hard coral cover amounted to 11%. Most of the rock surfaces were bare 41% (Fig. 4). Survey area 'B' had a live hard coral cover of 52%, soft coral cover of 17%, bare rock surfaces 18% and dead coral 5% (Fig. 5). Large barrel sponges, *Xetospongia tesudinaria* were found in both survey areas but were common in survey area 'B'.

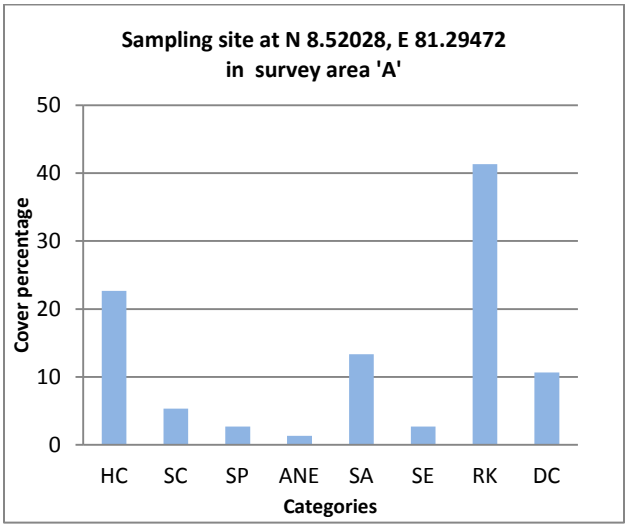


Figure 4. Benthic cover by categories in survey area 'A' – HC (Hard coral), SC (Soft coral), SP (Sponge), ANE (Anemone), SA (Sand), SE (Sediment), RK (Rock), DC (Dead coral).

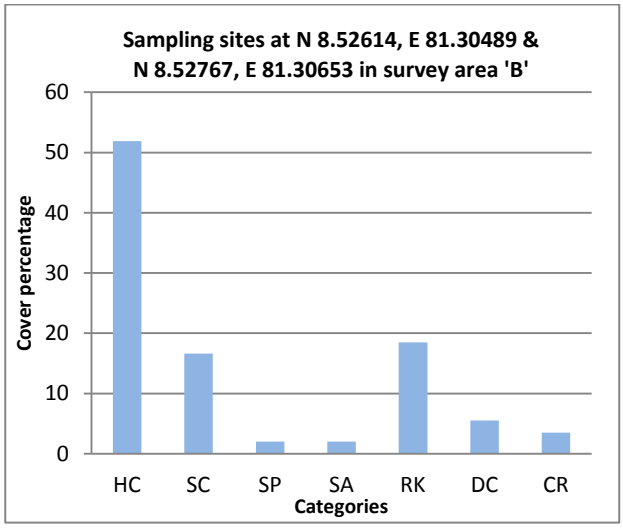


Figure 5. Benthic cover by categories in survey area 'B' - HC (Hard coral), SC (Soft coral), SP (Sponge), SA (Sand), RK (Rock), DC (Dead coral), CR (Coral rubble).

Survey areas 'C' & 'D'

Survey areas 'C' and 'D' are located in the western and eastern sections of Shell Bay. Both areas contain clusters of low relief rock boulders and ridges. The maximum depth in these habitats was about 5 m. Barnacles covered most rock surfaces (Fig. 6). Small patches of corallimorpharians and sponges were also present. A thin layer of sediment was observed on the reef substrate (Fig. 7). Hard and soft coral cover was sparse on the nearshore reefs (Fig. 8).

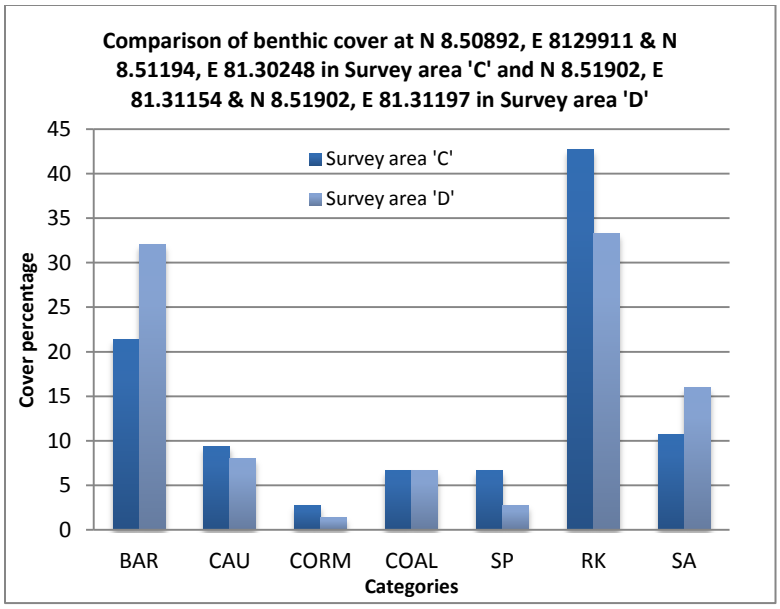


Figure 6. Benthic cover by categories in survey areas 'C' & 'D' – BAR (Barnacles), CAU (Caulerpa), CORM (Corallimorpharians), COAL (Coralline algae), SP (Sponge), RK (Rock), SA (Sand).

Figure 7. Sediment on nearshore reefs

Figure 8. Small scattered hard coral colonies in survey area 'D'

Fifty six (56) species of hard corals in 36 genera and 16 families were recorded. Faviidae was the most speciose family of hard corals which was followed by Acroporidae and Poritidae (Table 2). The largest colonies (>1.5 m diameter) were *Diploastrea heliopora*, *Porites lutea* and *P. lobata*. Most non- reef building corals; *Tubastrea micrantha* and *Dendrophyllia* sp were found on the sides of large rock boulders in sampling area 'A'. There were five soft coral genera; *Dendronephthya*, *Xenia*, *Sarcophyton, Sinularia* and *Lobophytom.* Survey area 'B' had the highest abundance and diversity of hard and soft corals (Fig. 9 & 10).

Figure 9. Hard corals in survey area 'B'

Figure 10. Soft corals in survey area 'B'

Table 2. Number of hard corals species of per family

Families	No of species
Acroporidae	7
Agariciidae	5
Astrocoeniidae	1
Euphyllidae	4
Dendrophyllidae	3
Faviidae	12
Fungiidae	4
Milleporidae	1
Merulinidae	1
Mussidae	2
Oculinidae	2
Pectiniidae	2
Pocilloporidae	3
Poritidae	6
Siderastreidae	2
Stylasteridae	1

One hundred and sixty (160) species of reef fish in 86 genera and 39 families were recorded. Survey area 'B' had the highest abundance (Fig. 11) and diversity while area 'A' had larger individuals such as *Epinephelus malabaricus* & *Plectropomus leopardus*. Large parrotfish (Scaridae) and surgeonfish (Acanthuridae) were present on nearshore reefs (Fig. 12). The most speciose groups belonged to Pomacentridae (19), Serranidae (14), Labridae (14), Acanthuridae (13) and Chaetodontidae (11) (Table 3). Shallow reefs close to freshwater runoff is preferred by some species such as the Koran angelfish (*Pomacanthus semicirculatus*), of which adults and juveniles were relatively common in Shell Bay (Fig. 13 & 14).

Figure 11. Highest diversity and abundance of reef fish was in survey area 'B'

Figure 12. Large parrotfish and surgeonfish in survey area 'C'

Figure 13. Adult *Pomacanthus semicirculatus* in survey area 'B'

Figure 14. Juvenile *Pomacanthus semicirculatus* in survey area 'D'

Table 3. Number of reef fish species per family

Families	No of species
Acanthuridae (Surgeonfish)	13
Apogonidae (Cardinalfish)	5
Balistidae (Triggerfish)	6
Blenniidae (Blennies)	7
Callionymidae (Dragonets)	1
Caesionidae (Fusiliers)	2
Carangidae (Jacks)	1
Chaetodontidae (Butterflyfish)	11
Cirrhitidae (Hawkfish)	4
Dasyatidae (Skates & Rays)	1
Ephippidae (Batfish)	1
Gerridae (Silverbiddies)	1
Gobiidae (Gobies)	3
Kyphosidae (Rudderfish)	1
Haemulidae (Sweetlips)	3
Holocentridae (Squirrelfish)	2
Labridae (Wrasses)	14
Leognathidae (Ponyfish)	1
Lethrinidae (Emperors)	1
Lutjanidae (Snappers)	9
Monodactylidae (Silver monos)	1
Mugilidae (Mullets)	1
Mullidae (Goatfish)	6
Muraenidae (Moray eels)	2
Nemipteridae (Breams)	3
Ostraciidae (Boxfish)	1
Pempheridae (Sweepers)	3
Pinguipedidae (Sandperches)	1
Plotosidae (Catfish)	1
Pomacanthidae (Angelfish)	6
Pomacentridae (Damselfish)	19
Pseudochromidae (Dotty backs)	1
Scaridae (Parrotfish)	7
Scorpaenidae (Scorpionfish)	1
Serranidae (Groupers)	14
Siganidae (Rabbitfish)	3
Synodontidae (Lizardfish)	1
Tetraodontidae (Pufferfish)	1
Zanclidae (Moorish idol)	1

Giant clams (*Tridacna* sp) were given special attention and the roaming diver technique described under survey methods was used to locate them. Almost all were found in the nearshore reef habitat; they were very rare on the offshore reefs. The largest was 18 cm while the smallest was 3 cm. The highest number (5 cm class) was recorded in survey area 'D' (Fig. 15).

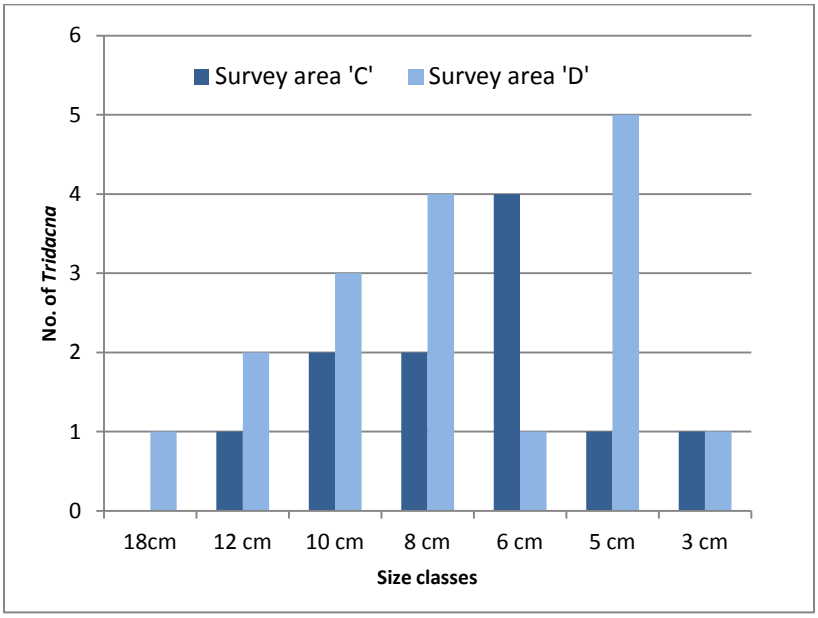


Figure 15. Number of *Tridacna* in different size classes in survey areas 'C' & 'D'

Twelve colour variations were observed among *Tridacna* (Plate 3). They were either nestled among the coral rubble next to rocks or were embedded in the old limestone substrate in the habitat (Figs. 16 & 17).

Figure 16. 12 cm giant clam among coral rubble

Figure 17. 6 cm giant clam embedded in limestone

Many other species of molluscs were present. These species included *Pinctada* sp, *Chicoreus ramosus*, *C. microphyllus*, *C. palmarosa*, *Lambis chiragra, L. truncata*, *Cypraea tigris, C. arabica* and *C. lyn*; some of them are shown in Plate 4.

Several species of starfish, crinoids, sea cucumber and sea urchins were present. Different species of crinoids (feather stars) in many colour variations were abundant on the offshore reefs where they were exposed to relatively strong currents (Fig. 22 & 23). *Echinostrephus* sp, *Echinothrix* sp, *Diadema* sp and *Stomopneustes variolaris* were observed. Sea urchins were not abundant in Shell Bay.

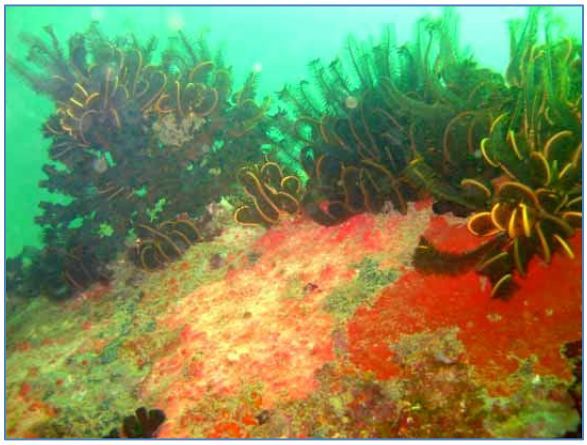


Figure 22. Numerous crinoids were present on the offshore reefs

Figure 23. Some were fully open and feeding such as this specimen

Four species of starfish, *Culcita novaeguinaea*, *Fromia* sp, *Linkia* sp and *Acanthaster planci*, two species of sea cucumber; *Holothuria edulis* and *H. atra* were recorded (Plate 5). Three *Acanthaster planci* were counted on the offshore reefs, but their feeding scars on live coral were not extensive. Many different species of sponges were observed of which the largest was *Xetospongia testudinaria.* Colonies grew to about 1.3 m high with a diameter of about 1 m (Plate 6). Survey areas 'A' and 'B' had several large sea anemones of the species – *Heteractis magnifica*. Other species were *Entacmaea quadricolor* and *Stichodactyla* sp. Corallimorpharians belonged to the genus *Discosoma* (Plate 7). Three species of sea slugs (nudibranchs), one flatworm, one species of tubeworm, *Spirobranchus* peacock worms and two species of reef shrimp (*Stenopus hispidus* & *Rhyncocinetes uritae*) were recorded (Plate 8). Eleven spiny lobsters (*Panulirus versicolor*) (app 10 cm carapace length) were present under two rock boulders in survey area 'D'.

Species in protected and restricted export categories

All anthozoans - hard corals, soft corals and gorgonians, gastropods – *Tridacna* spp, *Chicoreus palmarosa, Lambis* spp and *Cypraea tigris* listed under the protected species under the Fauna and Flora Protection Ordinance were present.

In addition all the groupers recorded at the location and one species of aquarium fish - *Centropyge flavipectoralis* are listed under the restricted export category of the Fisheries and Aquatic Resources Act of 1996.

Human impacts

Current use of the resources of the Shell Bay is very limited. As the land area is yet undeveloped only fishing operations occur in the coastal waters. During the survey period 3 to 4 boats (18ft FRP) and one catamaran were engaged daily in small scale fishing operations on the reefs between Shell Bay and Foul Point. Signs of netting were evident in survey area 'B' as parts of a net was found entangled on the reef.

Aquarium fish collecting is done near Foul Point by snorkeling and scuba diving. The main collecting area is in front of and to the south of Foul Point as there are more extensive coral reefs there. Aquarium fishermen operating in this area travel across Koddiyar Bay in 18 ft FRP boats from Trincomalee and Kinniya. According to them blast fishing is carried out regularly, particularly 1 to 2 km offshore to the east and south of Foul Point. An underwater blast in the distance was heard during the survey.

Natural impacts

A thin layer of sediment covered the reef habitat in the inshore areas of Shell Bay. Mahaweli River is the source of this sediment. River water comes into Shell Bay coast almost daily, because the freshwater drawn out of Koddiyar Bay by the low tide is pushed back towards shore during the high tide. However, organisms that are present there are adapted to this situation and whether there is a real adverse impact was not apparent.

Three, Crown- of- Thorns starfish were seen on the offshore reefs but there feeding scars were relatively small and does not seem to cause any serious decline in coral cover considering that the survey area 'B' had a hard coral cover of 52%. Population explosions of invasive species that cause reef damage was not observed.

The major threat to the reef organisms may come from impacts related to climate change where coral bleaching and loss of zooxanthellae in other organisms, including giant clams could result in the overall loss of coral cover and may alter habitats.

Discussion

Shell Bay is endowed with high diversity of marine organisms. A short survey such as this one conducted over a period of four days and covering four small reef areas yielded 56 species of hard corals and 160 species of reef fish, giant clams in twelve different colours and many other invertebrates.

Although coral cover was relatively high in survey area 'B' the inshore areas had very little corals. It is likely that the coral bleaching event in 1998 had a very heavy toll on the live corals in shallow water in this area. A survey conducted in Pigeon Island National Park in 1999 soon after the bleaching event revealed that the corals there were not affected, and it is likely that the temperature there was lower. The reason for this is unknown as long-term monitoring of oceanographic parameters is lacking. A rapid survey in May 2010 showed that hard and soft corals were severely bleached in Pigeon Islands and Dutch Bay in Trincomalee. However, judging by the size and appearance of coral colonies present in Shell Bay, today, it is likely that they recovered or escaped the bleaching in May 2010. It is possible that an upwelling of cooler water from the deep canyon nearby prevented a coral die-out in the Shell Bay coast. However, a relatively large scale coral die-out in the past must have occurred as indicated by some coral rubble strewn between the rocks in the nearshore area, the percentage of which has not been captured in the present study as most of this rubble is mixed with sand and the transects were laid to capture the extent of benthic organisms on the hard substrates.

Most zooxanthellate organisms including giant clams may have suffered during a large-scale bleaching event. Only one dead clam shell was found in the shallows during this survey, but most things falling onto sand can get buried very quickly. The next catastrophic event that occurred was the tsunami in 2004, which had the potential to obliterate most fragile organisms in shallow water, including hard and soft corals. The sizes of coral colonies present today indicate that they are relatively young; however some of the giant clams must have survived the tsunami for them to be more than 12 cm in length. *Tridacna maxima* grows 2 to 4 cm per year (FishNChips 1999). Therefore most of the clams in Shell Bay must have settled after the tsunami as the majority was less than 12 cm in length.

Corals can grow back relatively fast even after a severe bleaching event if there is a good supply of planktonic larvae and a suitable substrate to settle. The ability to recover relatively fast is shown by the recovery of tabulate corals in the Bar Reef Marine Sanctuary where nearly all of the corals in shallow water was destroyed during the coral bleaching event in 1998. Today some tabulate *Acropora cytherea* colonies at the Bar Reef are over 1.5 m across (Rajasuriya 2005, 2008; Wilkinson, 2008).

It is well established that river runoff with a lot of suspended particulate matter and nutrients increases the productivity of coastal waters. Sediment present in the shallow reef environment may favour the growth of species of filter feeding molluscs that require suspended food particles in relatively slow moving water. Such conditions are found in the calm nearshore area of Shell Bay. This could be one of the reasons for the occurrence of giant clams in the shallow reef environment more than in the offshore reefs where there are relatively strong tidal currents. Strong currents laden with food particles are favoured by organisms such as soft corals and crinoids (feather stars). Both these groups were common on the offshore reefs and were uncommon in the nearshore reef habitats. These observations point towards the influence of the Mahaweli River and currents on the distribution of species in this area.

There are two species of giant clams recorded for Sri Lanka; *Tridacna maxima* and *T. squamosa*. Separation of these two species in the field is difficult because identification of the living specimen is based on the morphology of scutes on the outer surface of the valves, which is often obscured when the shell is buried in the reef substrate. It is likely that both species are present in Shell Bay. The shell of a dead animal collected during the survey was identified as *T. maxima*. Relatively large Tridacnids with a shell length of about 30 cm have been found in the ancient coral deposits in Akurala and Hikkaduwa areas. However, all the Tridacnids recorded in the present are very much smaller, the largest being about 20 cm in length; most were in the size classes of 8 to 10 cm. Tridacnids are widespread in the coastal waters of Sri Lanka; but their abundance is low at any given location. Moreover their distribution is patchy. They have also been recorded in the Dutch Bay and Sampaltivu reefs. The limited amount of locations of distribution and abundance is partially due to lack of surveys targeting Tridacnids. However, observations based on coral reef surveys conducted in the past reveal that Tridacnids occur mainly in shallow reef environments with some coral growth and also influenced by periodic river runoff. In addition to Trincomalee, Tridacnids have also been observed along the south coast, where periodic river runoff during the southwest monsoon is fairly high. However as stated previously their abundance is very low and almost all previous records have been less than 12 cm in length. Tridacnids are very popular in the aquarium industry because of their multihued mantles; popular species are- *T. maxima, T. squamosa, T. derasa* and *T. crocea*. Of these four species, only the first two are recorded for Sri Lanka. Currently these two species are protected under the Fauna and Flora Protection Ordinance and any experimental culture requires special approval from the Department of Wildlife Conservation. Nevertheless it is important to explore the possibility of ex-situ culture as there is a good demand for cultured *Tridacna* internationally by the aquarium industry. Age at maturity of *T. maxima* vary from 3 to 7 years according to different authors (FishNChips 1999). Today the bulk of cultured *Tridacna* are supplied by Philippines and Indonesia (Mc Fadyen *et al*. 2005).

Sea urchins were not abundant in Shell Bay. Burrowing sea urchins such as *Echinostrephus* is uncommon because the substrate was mainly hard granitic rock. *Diadema setosum* was rare in Shell Bay although it is abundant in Trincomalee Inner Harbour and towards Chapel Rocks. The abundance of this species is low to rare on the eastern side of Koddiyar Bay including areas around Shell Bay. A probable reason for this variation is the constant influx of freshwater and sediment to the eastern side of Koddiyar Bay.

Resilience of marine ecosystems such as coral reefs, mangroves and sea grass beds depends on their health prior to disturbances and the degree of disturbance in a given area. If the disturbance is patchy, then larval dispersal from the surrounding areas can rebuild the damaged system. Moreover, a one-time event such as the tsunami does not cause continuous damage to a system (Baird et al 2005). However, chronic disturbance and damage through pollution and destructive fishing methods will not allow an ecosystem to recover easily and even if the cause of damage is arrested the system may not recover for decades. Repeated coral bleaching events due to temperature anomalies can have a similar effect; phase shifts in dominant species will totally alter habitats where a coral habitat will end up as a bed of algae. Such a situation can be seen in the southern coast in Kappratota, Weligama where the coral reef has been smothered by the calcareous algae – *Halimeda* (Rajasuriya 2005). In addition to climate change related problems the marine environment in Koddiyar Bay and adjacent areas is threatened by industrial

development. Therefore it is essential to raise awareness of the uniqueness of the marine ecosystems in the Koddiyar Bay and surrounding area and the connectivity of these ecosystems that support the high species diversity and productivity of the area. The whole system is influenced by the strong currents and upwellings due to the physical nature of the sea bed with the deep canyon. When all of the above is considered it is clear that this is a very special environment. The establishment of a multiple-use conservation area with smaller marine protected areas within can safeguard this area from anthropogenic impacts in the future.

Recommendations

- Establish a multiple-use marine protected area for Koddiyar Bay and create fully protected core areas for identified sensitive ecosystems in the surrounding area.
- Conduct thorough surveys of the Koddiyar Bay and associated ecosystems to understand the connectivity between them.
- Build a species inventory for this special region.
- Conduct further studies on genetic diversity, breeding and growth of giant clams, sponges, soft corals and echinoderms.
- Explore the techniques of in-situ and ex-situ culture of Tridacnids and other selected species.
- Study the oceanographic conditions that govern the marine ecosystems of this area.
- Determine ecosystem health indicators and establish a monitoring programme.
- Take steps to arrest banned and destructive fishing methods.
- Conduct awareness programmes and develop extension material on the value of this special marine environment to educate the public, government officials and entrepreneurs.

References

Baird HA, Campbell SJ, Anggoro AW, Ardiwijeya RL, Fadli N, Herdiana Y, Kartawijeya T, Mahyiddin D, Mukminin A, Pardede ST, Pratchett MS, Rudi E, and Siregar AM. 2005. Acehnese Reefs in the Wake of the Asian Tsunami. *Current Biology* **15:** 1926 - 1930.

English S, Wilkinson C, and Baker V. (eds.) 1997. *Survey Manual for Tropical Marine Resources. 2nd edition.* Townsville: Australian Institute of Marine Science. 390 pp.

FishNChips 1999. http://www.FishNChips.htm., July Issue 1999.

Hill J, and Wilkinson C. 2004. *Methods for Ecological Monitoring of Coral Reefs*. Australian Institute of Marine Science. 117 pp.

Macfadyen, G, Phillips, M, Haylor,G, 2005. International Seafood Trade: Supporting Sustainable Livelihoods among Poor Aquatic Resource Users in Asia (EP/R03/014). Output 3. *Synthesis Report with Pro-Poor Trade Research Findings and Policy recommendations*. Poseidon Aquatic Resource Management Ltd, Network of Aquaculture Centres in Asia-Pacific (NACA), and the STREAM Initiative, 68 pp.

Rajasuriya A. 2005. Status of coral reefs in Sri Lanka in the aftermath of the 1998 coral bleaching event and 2004 tsunami. In: Souter D and Linden O, eds. *Coral Reef Degradation in the Indian Ocean: Status Report 2005.* University of Kalmar, Sweden: CORDIO, Department of Biology and Environmental Science, University of Kalmar, Sweden. 83 - 96.

Rajasuriya A. 2008. Status of Coral Reefs in the Northern, Western and Southern Coastal Waters of Sri Lanka. In: Obura D, Tamelander J and Linden O, eds. *Ten Years after bleaching - facing the consequences of climate change in the Indian Ocean. CORDIO Status Report 2008.* Mombasa: CORDIO/Sida - SAREC. 11 - 22.

Wilkinson C. 2008. *Status of Coral Reefs of the World: 2008.* Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre. Townsville, Australia. 296 pp.

Survey team

Arjan Rajasuriya	Research Officer - Team leader
R.P.P.K. Jayasinghe	Research Officer
Chaminda Karunarathna	Diver Technician

Photographs

All photographs in this report were taken by Arjan Rajasuriya using a *Canon IXUS 90s*, except the photo with the caption 'Pre-survey briefing' on page 7, which was taken by the navy.

Acknowledgements

I wish to thank the Chairman and the Director General of NARA for institutional support to carry out this survey, the Sri Lanka Navy for providing all logistical support during the survey and to Mr. Ratnapala of the National Hydrographic Office for preparing the site map of Shell Bay.

Plate 1. Coast of Shell Bay & traditional fishing

1.1 View to the East, in the direction of Foul Point

1.2 View to the West, in the direction of Noarway Point

1.3 A section of rocky coast

1.4 Low rock formations extending into the intertidal zone

1.5 Upper beach and jungle

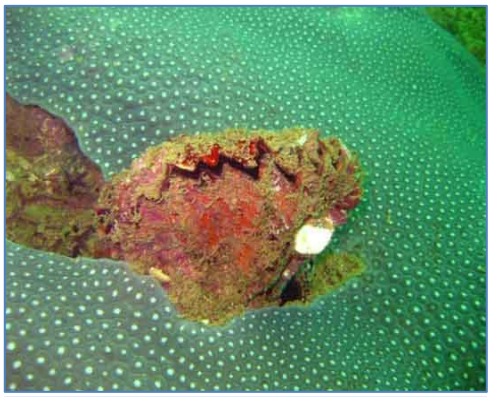
1.6 Coastal vegetation

1.7 Large rock boulders at the edge of the shoreline

1.8 Traditional fishermen

Plate 2: Hard and soft corals

2.1 *Acropora formosa*



2.2 *Diploastrea heliopora*

2.3 *Goniopora* sp

2.4 *Platygyra daedalea*

2.5 *Pocillopora verrucosa*

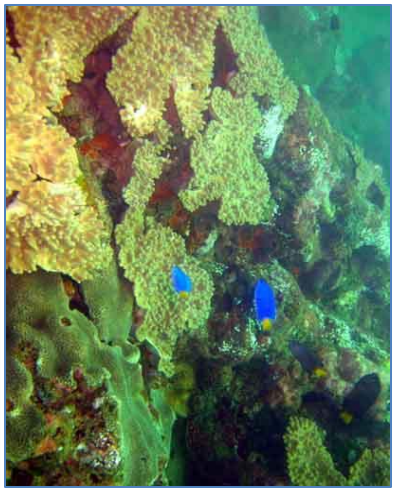
2.6 *Symphyllia radians*

2.7 *Fungia moluccensis*

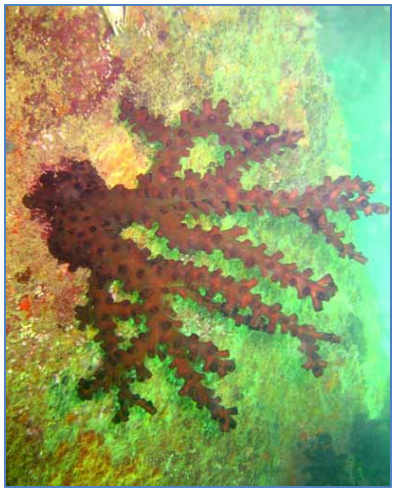
2.8 *Polyphyllia talpina*

2.13 *Dendronephthya* sp

2.11 *Sinularia* sp



2.9 *Tubastea micrantha*

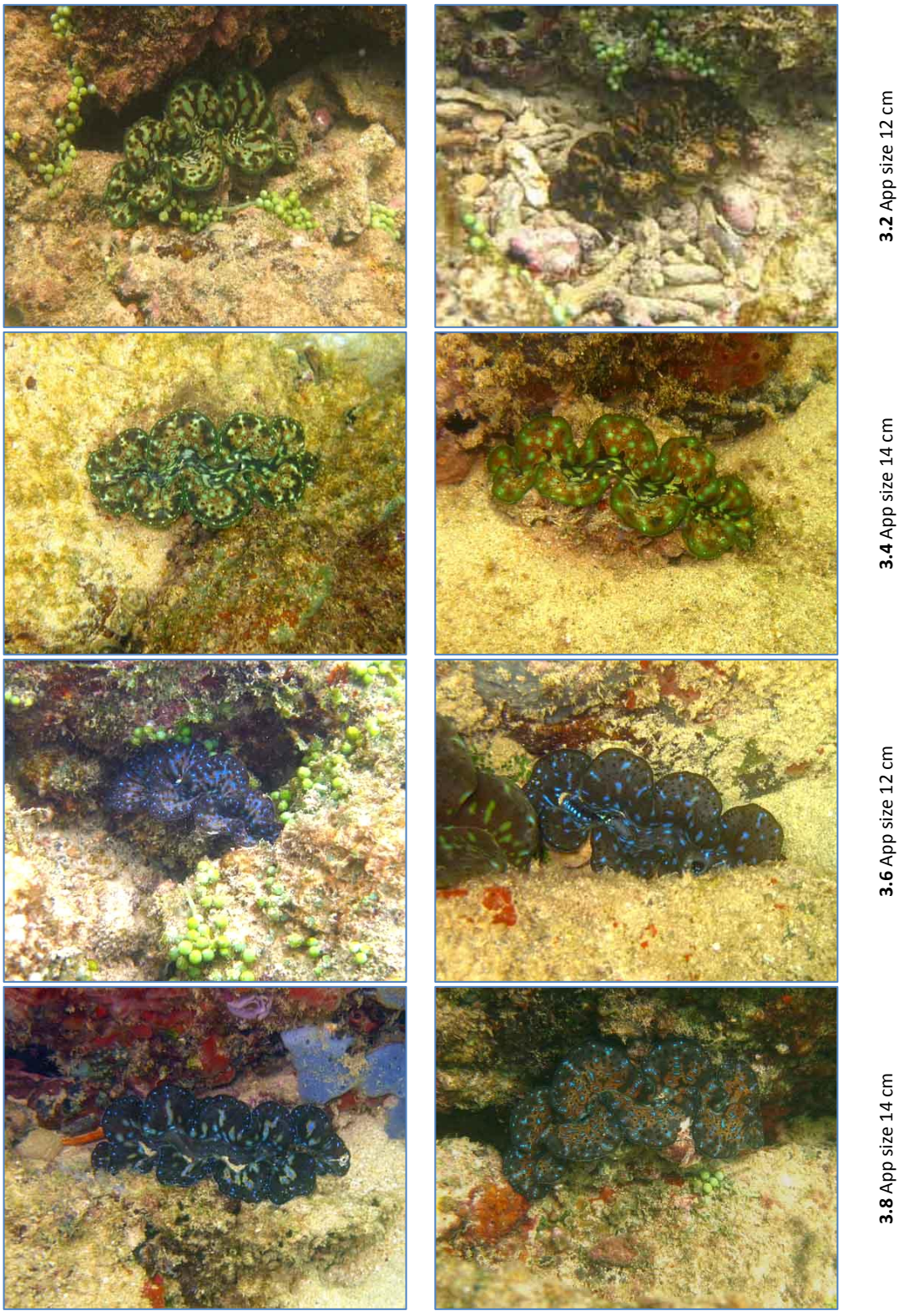


2.14 *Dendronephthya* sp

2.12 *Sinularia* sp

2.10 *Dendrophyllia* sp

Plate 3. Colour variations of giant clams (*Tridacna* sp) in survey areas 'C' & 'D'.



3.1 App size 12 cm

3.2 App size 12 cm

3.3 App size 6 cm

3.4 App size 14 cm

3.5 App size 8 cm

3.6 App size 12 cm

3.7 App size 12 cm

3.8 App size 14 cm

3.9 App size 15cm

3.10 App size 5 cm

3.11 App size 18 cm

3.12 App size 6 cm

All specimens shown here are from the shallow reefs of Shell Bay with a maximum depth of about 5 m. The immediate surroundings of the clams varied from coral rubble to limestone rocks. Some were embedded in the limestone. Their preferred micro environments are shown in the photographs of Plate 3. Giant clams are zooxanthellate and therefore depend on light for good growth.

Larger species (*T. gigas*) is used for food whilst the smaller species are being used as aquarium specimens.

In Sri Lanka, giant clams had grown to larger sizes in the past, as indicated by shells of giant clams from the ancient coral deposits in the Akurala and Hikkaduwa areas. Shells with a length of 30 to 50 cm have been unearthed from these pits.

Giant clams grow slowly, it has been estimated that their annual growth varies from 2 to 4 cm. If cultured for aquarium purposes they reach a marketable size in about 2 to 3 years.

Plate 4. Bivalves and Gastropods

4.1 *Pinctada* sp

4.2 *Pinctada* sp

4.3 *Lopha*?

4.4 *Lopha*?

4.5 *Cypraea arabica*

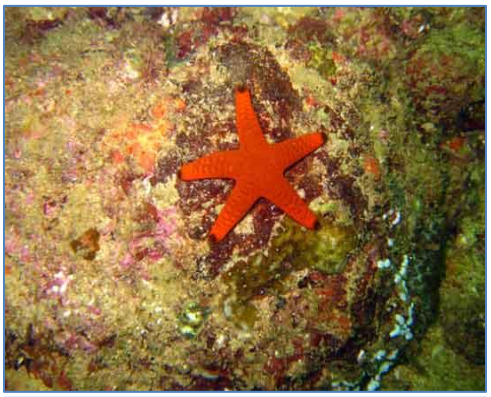
4.6 *Cypraea lynx*

4.7 *Cymatium* sp

4.8 *Chicoreus ramosus*

Plate 5. Starfish, Featherstars, Sea cucumbers & Sea urchins

5.1 *Culcita novaeguineae*



5.2 *Fromia* sp

5.3 *Holothuria edulis*

5.4 *Holothuria atra*

5.5 *Echinothrix* ?

5.6 *Diadema setosum*

5.7 Unidentified crinoids

5.8 Unidentified crinoids

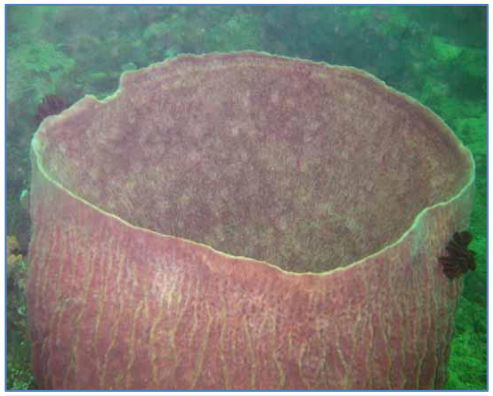
Plate 6. Sponges

6.1 Unidentified sponge

6.2 Unidentified sponge

6.3 *Xetospongia testudinaria* App 50 cm high

6.4 *Xetospongia testudinaria* App 100 cm high



6.5 *Xetospongia* sp App 75 cm across

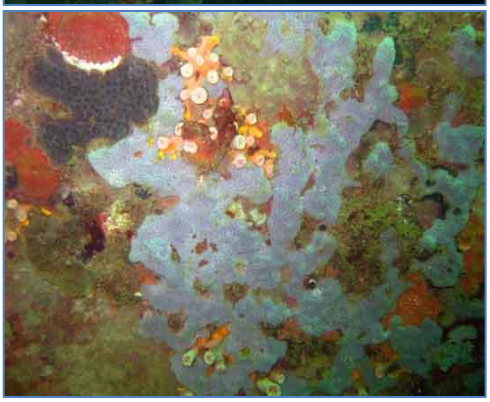
6.6 Unidentified sponge

6.7 *Siphonochalina ?*

6.8 Unidentified sponge

6.9 Unidentified sponge

6.10 Unidentified sponge under an overhang



6.11 Unidentified sponge sharing space under a rock with corals and bivalves

6.12 Unidentified sponge

Very little is known about sponges in Sri Lanka. They occupy almost all forms of reef habitats from the intertidal area to deep reefs below 30 m. The biggest threat to sponges is the use of bottom set nets to catch spiny lobsters, crabs and reef fish. Scores of small sponges get entangled on these nets and are discarded on the beach.

Plate 7. Sea anemones &, Corallimorpharians

7.1 *Heteractis* sp with *amphiprion clarkii*

7.2 *Stichodactyla* sp

7.3 *Heteractis magnifica*

7.4 *Heteractis magnifica*

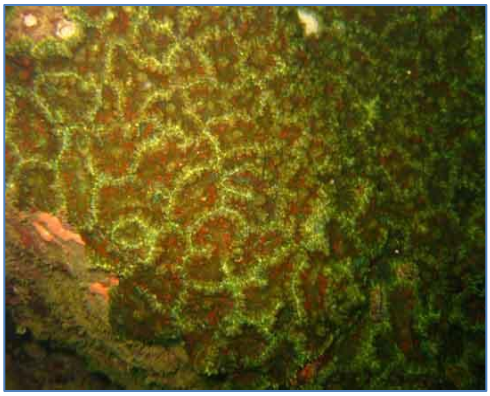
7.5 *Entacmaea quadricolor* with *Amphiprion sebae*

7.6 *Stichodactyla haddoni*

7.7 *Stichodactyla* sp.

7.8 *Stichodactyla* sp with commensal crab – *Neopterolisthes maculatus* & *Amphiprion clarkii*

7.9 *Discosoma* sp



7.10 Discosoma sp

7.11 Unidentified Corallimorpharian

The main threat to sea anemones is their removal for the aquarium trade. It has a direct impact on clown fishes (*Amphiprion* species) that live with anemones.

However there is no direct threat to corallimorpharians. They are also used in the aquarium trade but are shipped together with a part of the substrate 'Live rock'. Export of live rock is banned in Sri Lanka due to the negative impact on reef substrate. But there is potential to carry out ex-situ culture of live rock on artificial substrate to supply the aquarium trade.

Sea surface temperature anomalies due to climate change affect both groups because they contain zooxanthellae and bleach during high sea surface temperatures.

Plate 8. Nudibranchs, Flatworms, Tubeworms, Reef shrimp

8.1 *Phyllidia varicosa*

8.2 *Phyllidia ocellata*

8.3 *Phylidiella rosens*

8.4 *Thysanozoon* sp

8.5 *Sabellestarte* sp

8.6 *Stenopus hispidus*

Polyclads (flatworms) occur from the intertidal zone to deep water and occupy a variety of habitats; sand/mud bottoms, mangroves, sea grass beds and corals reefs. Almost nothing is known about Polyclads in Sri Lanka.

It is almost impossible to assess their abundance because they are so adapt at getting into tiny spaces in the habitat and are mainly nocturnal. Some are highly colourful and are visible when they occupy a substrate that contrasts with their body colour such as in photo 8.4 (Plate 8).