

PART 2

BIODIVERSITY AND CONSERVATION IMPORTANCE

2.1. INTRODUCTION

Biodiversity describes the diversity and variability within and between species, habitats and ecosystems. The high marine biodiversity at this site has been acknowledged for many years and confirmed during studies carried out under the Semporna Islands Project. The vegetation of the high islands is also diverse, and is particularly important to Sabah because it contains many elements that are not found elsewhere in Malaysia.

The proposed park includes a number of important ecosystems as described very briefly below:

Open water

All the areas in the park that lie outside the reefs can be classified as open water. Seabed depth ranges from about 50m in the south-west (between Sebangkat and Pulau Bum Bum) to over 130m off Kapikan reef in the east.

Open waters are the domain of squid, dolphins and pelagic fish such as tuna, mackerel and jacks. They carry plankton, including larval forms, from one area to another and also provide feeding grounds for seabirds and migratory routes for turtles. Open water resources are of considerable value for fisheries in the Semporna area.

Coral reef

Coral reefs are created from the accumulated calcareous limestone skeletons of animals and plants which build up to form substantial rocky structures. Stony corals are the main component, but many other organisms contribute to the reef building process. Only the upper crust of the reef is alive, the limestone structure below represents the accumulated remains of thousands of years of growth.

Coral reefs can grow only in relatively shallow water, but the base of the reefs is much deeper than this because of changes in sea level or movements of the sea floor. Conversely, reefs may become 'stranded' above sea level – for example, both Selakan and Sebangkat consist to a large extent of old eroded reef. Coral reefs are the most extensive and complex of all marine ecosystems in the proposed park, and their conservation importance and biological features are summarised in the next sections.

Seagrass beds

Seagrasses are the only type of flowering plant that can grow submerged in seawater. They grow in most shallow water, soft sediment habitats within the proposed park, between the shore and the reef flat. Several species of genera such as *Cymodocea*, *Enhalus* and *Halophila* are present. In some places they are mixed, while in others they form monospecific stands.

Seagrass beds provide shelter and food for a wide range of invertebrates and fish, including juvenile fish, and are also a source of food for green turtles. In addition, they help to stabilise the sand and also to clean up the water by slowing down water movement and causing small particles suspended in the water to sink to the bottom.

Mangrove

These distinctive communities occur in the intertidal zone between the land and the sea. They may be hundreds of metres wide at suitable localities, but in the Semporna Islands Park form only a relatively narrow zone along the coastline of the high islands of Bodgaya, Boheydulang and Tetagan. There are also isolated patches on Selakan. They occur mainly in spots sheltered from strong currents and in enclaves where some deposition of silt and mud is possible (Sugau *et al.* 1998).

Mangroves are important breeding and nursery grounds, providing food and shelter for fish, crabs, shrimps and other marine animals. Traditionally, mangroves are a source of firewood, building materials, dyes, medicines and other natural products. It is important to ensure that the relatively small stands of mangrove in the proposed park are protected and managed.

Coastal forest and scrub

Coastal forest is the richest plant community found on the islands, represented by at least 95 species of tree found in 63 plant families. Structurally, this coastal mixed forest reaches 20–30 m tall, with emergents 35–40 m tall protruding from the general canopy. The forest has developed on the porous, weathered volcanic soils on the steep slopes, and is noticeably taller in the moister valley sites. Low, scrub-like vegetation occurs on the main rock outcrops, particularly on the broad, gently sloping summits and ridges of the rock outcrops. Vegetation also occurs on the steep rock faces where the ledges and cracks accumulate some soil and allow some plants to thrive.

The forest and scrub are important refuges and feeding areas for insects, birds, small mammals and other wildlife. They also provide a range of useful resources for people living in the area.

2.2. CONSERVATION IMPORTANCE OF THE CORAL REEFS

One of the main reasons for establishing the Semporna Islands Park is to protect the coral reefs and marine life, which are considered to be exceptionally important. Some of the reasons for the high conservation value of the reefs are given below:

Ecosystem significance

Coral reefs are globally important ecosystems that support the richest diversity of species known in the sea. They provide food for millions of people around the world, and inspiration to many who visit reefs to enjoy the scenery and marine life. These attributes give coral reefs a huge economic value, and added to this are other assets, such as the role played by reefs in protecting adjacent land from storms and erosion.

Unfortunately, reefs throughout the world are under threat from human activities and their health is deteriorating. Coral reefs of South-east Asia, the most species-rich on earth, are the most threatened of any region (Bryant *et al.* 1998). More than 80% are at risk (under medium and high potential threat), and over half are at high risk, primarily from coastal development and fishing-related pressures.

Considering the importance of coral reefs and the fact that they are under such severe pressure, it is clear that action needs to be taken to promote their conservation and prevent further degradation and loss.

Establishment of a well-managed marine park incorporating the Semporna reefs will be a significant contribution to national, regional and global efforts to save these valuable but vulnerable ecosystems.

Size of the proposed park

Whilst protection of small reef areas can be effective, it is generally considered that larger areas have more value because they are more resilient and better able to absorb disturbances. They also contain a larger reservoir of species and individuals, which increases the likelihood of the presence of healthy breeding populations. The Semporna Islands Park will be significantly larger than any other marine protected area in Sabah.

Turtle Islands Park	17 sq km
Tunku Abdul Rahman Park	49 sq km
Pulau Tiga	158 sq km
Semporna Islands Park	350 sq km

The Semporna Islands Park will include about 100 km of reef front, which is the most actively growing and productive part of the reef. This compares with 5.67 km at Sipadan.

Diversity of reef habitats and communities

The proposed park incorporates an excellent range of reef habitats and communities. There are fringing reefs, patch reefs and a bank reef, each of which has its own characteristics. Apart from the many types of shallow water reef community, there are also unusual deep water ones not represented in other marine parks in Malaysia. The lagoonal reef habitats is also unique.

A very brief summary of some of the main reef communities is given in part 2.3., and full details are in the *Atlas of the Coral Reefs of the Semporna Islands* (Wood, *et. al.* 2001).

Rarities

Many of the reef species in the proposed park have a fairly widespread distribution across the Indo-Pacific or within the South-east Asia – Australia region. This is because nearly all marine species have a larval phase in which the young forms float freely in the water. Thus they are able to spread more easily than terrestrial species whose distribution is affected by land and sea barriers. However, some of the species occurring on the Semporna reefs have a more limited range, and a number have not been recorded from elsewhere in Sabah.

Allen (1992) found two new species of damselfish in the Bodgaya lagoon, and several of the sponges and soft corals found here are also new species, as yet undescribed. One sponge is reported to be very unusual and possibly endemic to the Semporna reefs (Kelly, 2000). The coral fauna shows a clear affinity with that found on Indonesian reefs, and a number of species are new records for Malaysia, including several rare species of *Acropora*, and the uncommon caryophylliid *Nemzophyllia turbida*.

Diversity of species

Diversity of species is one of the important measures of nature conservation interest, with high diversity increasing the value of a site. The proposed park lies close to the Indonesian-Philippines 'high diversity triangle', which is acknowledged as having the highest diversity of marine species throughout the Indo-Pacific. Reefs in this area should in theory support more species than elsewhere, but there is considerable variation from one site to another. The Semporna reefs, with their complex structure and profusion of habitats, provide many opportunities for colonisation.

It is clear from studies carried out so far that the diversity of marine species in the proposed park is very high. For example, 265 species of mollusc occur on and around the reefs (Meagher, 1992), and there may be as many as 140 species of sponge, 70 species of soft coral and at least 50 species of gorgonians (sea fans, sea whips) (George & George, 1987; Dipper, 2001). Diversity of echinoderms is also high, with a total of 109 species recorded (George & George, 1987; Marsh, 1992; Lane, 1998). Extensive data sets for these and many other groups are not available for comparative purposes, because of the difficulties of identifying the species, but a few examples of how the Semporna reefs rank in comparison with other areas in Sabah are provided in Table 1.

Group	Semporna Islands	Sipadan	Tungku A.Rahman
Starfish	24	12	12
Sea cucumbers	32	20	17
Sponges	140	80	?

Table 1. Total number of starfish, sea cucumber and sponge species recorded at reef locations in Sabah [Data from George & George, 1987; Marsh, 1992; Lane, 1994; Dipper & George, 1994; Lane, 1998; Dipper, 2001).

Further evidence of high diversity comes from looking at data on fish and corals – two of the most important groups occurring on reefs, and ones which are most often studied. An assessment of the reef fish population shows that the reefs of the proposed Semporna Islands Park support a greater number of species than all other reef areas in Malaysia for which records are available.

Total number of coral reef fish species					
Semporna Islands	Sipadan	Tungku A.Rahman	Redang	Tioman	Tinggi
528	409	364	209	233	219

Table 2. Total number of coral reef fish species recorded from reef locations in Sabah and West Malaysia [Data for Sabah is from Allen, 1992 and for West Malaysia marine parks from Harborne *et al.* 2000].

Information on hard corals is also available, and again, the Semporna Islands Park has the greatest diversity (255 species) of all other sites in Malaysia for which up-to-date records are available.

Total number of coral species					
Semporna Islands	Sipadan	Tungku A.Rahman	Redang	Tioman	Tinggi
255	189	?	149	183	155

Table 3. Total number of coral species recorded from reef locations in Sabah and West Malaysia [Data for Sabah is from Wood, 2001 and for West Malaysia marine parks from Harborne *et al.* 2000].

2.3. REEF HABITATS AND COMMUNITIES

This section provides a brief introduction to the range of reef habitats and communities found in the proposed park. Full details are in the *Atlas of the Coral Reefs*.

Back reef

Depth approximately 0.5 – 2m.

The back reef is a relatively sheltered zone situated between the shore and the seaward reef. Typical habitats include seagrass beds, rubble and sand patches, eroded limestone slabs and small coral outcrops (Figure 20). The back reef is hundreds of metres wide in some places, and there may be deeper pools forming small lagoons.

Reef flat

Depth approximately 0.5 – 1.0m

These shallow coral areas occur on the landward or inner side of the reef rim and are particularly well developed on the outlying islands and reefs, such as Church Reef (Figure 14), Kapikan reef and Mantabuan, and are also present on the reefs that fringe the main high islands. Typically they consist of coral-lined pools with sand patches and are home to a large number of small, colourful fish. They may be partially exposed at low tide.

Reef top and rim

Depth approximately 2 - 6m

The shallow, seaward-facing part of the reef is often the area with the most prolific coral growth. For example there may be many *Acropora* tables, staghorn and small compact clusters, mounds of faviid coral, *Porites* domes (sometimes several metres in diameter), and many other species and growth forms (Figures 13, 22, 24). These so-called ‘coral gardens’ are especially well developed on the outer, clear-water reefs such as Sibuan, Church Reef, Mantabuan and Kapikan, particularly on the northern and eastern sides where they may be several hundred metres wide. Soft corals are often common here, and there are usually numerous small plankton-feeding fish, especially damselfish and wrasse.

On some of the reefs the top and rim consists of a mixture of eroded rock, sand, mat-like soft corals, xeniids and various hard corals, especially heads of *Porites*. In these situations there are often large numbers of long-spined sea-urchins *Diadema*.

Upper reef slope

Depth approximately 6 – 20m

The upper reef slope is very variable. In some places it is very gently sloping with fine-branched corals that collapse easily. Wave-sheltered sites often have large fan and tube sponges (Figure 23) and foliaceous corals (Figure 25). Many reefs have a steeper profile and varied topography with low spurs and a wide range of hard coral species, growth forms and colony size, together with many soft corals, sponges and other groups. Some of the steeper slopes of about 50° have large eroded limestone outcrops (old corals) and spurs that are interspersed with rubble chutes carrying unstable material down the reef.

Figure 20. *Porites* mound and soft corals surrounded by sand on the back reef.



Figure 21. The gorgonian *Isis* growing on eroded limestone blocks at a wave-sheltered site.



Figure 22. Branching corals on the reef rim provide a suitable habitat for small fish such as cardinalfish (Boheydulang lagoon reef)

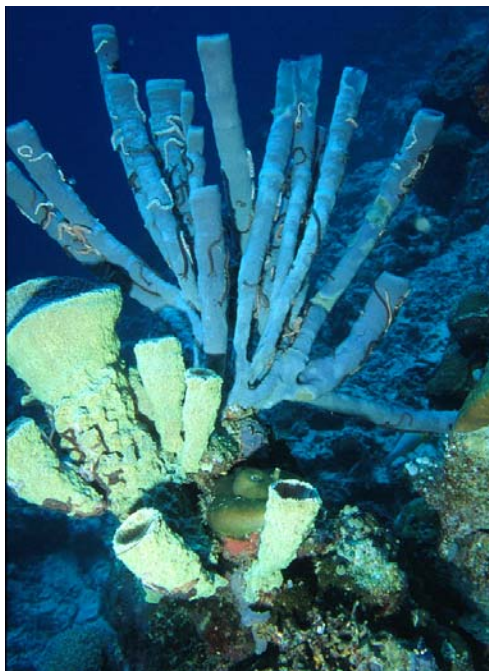


Figure 23. Large tube sponges on the upper reef rim, Church Reef.



Figure 24. Butterflyfish amongst mixed corals on the reef rim (Kapikan Reef).



Figure 25. Reef slope with large open bowls of *Montipora*.



Figure 26. Sea fan and rich reef life on the drop-off at Church reef.

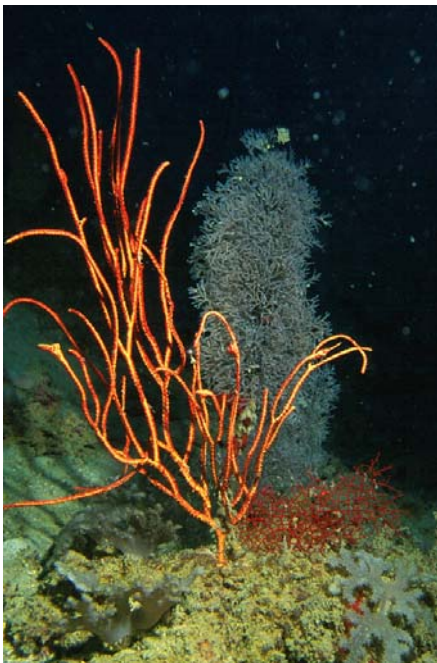


Figure 26. Sea whip and black coral 'bottlebrush' on deep, silty reef off Sebangkat west.

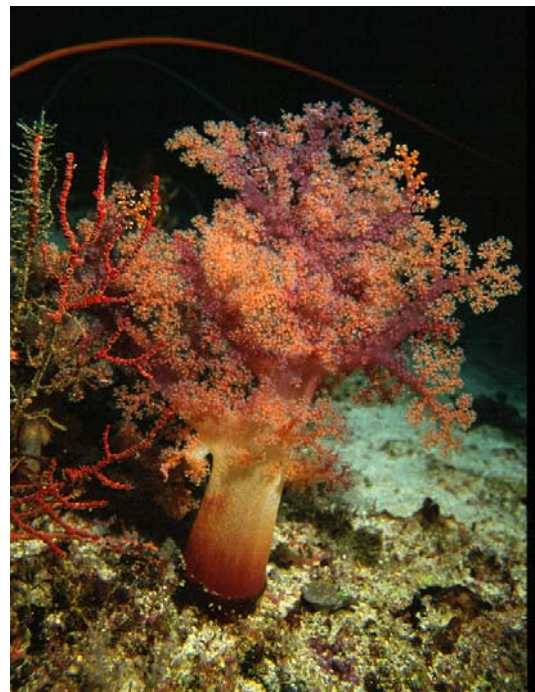


Figure 27 'Tree' soft coral (*Dendronephthya*) and small sea fan on sand and rubble reef off Mantabuan

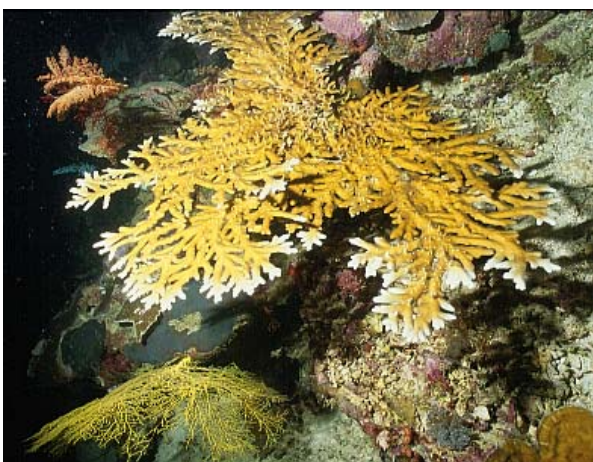


Figure 28. *Acropora elegans*, a new record for Malaysia, off Church reef at 35m depth.



Figure 29. Deep reef plateau, with plate corals and feather star. SW Church Reef.

At Church Reef west and Sebangkat north-west the reef drops down very steeply from the rim at about 4-6 m depth. A spur and groove formation is usually discernible. The grooves – comprising broad rubble chutes are poorly colonised, but steep faces on the spurs have a rich mixture of species. Hard corals gradually give way with increasing depth to black corals, sea fans and whips (Figure 26).

Lower reef slope

Depth approximately 20 – 30m

The lagoon reefs and those on the eastern side of Maiga and the Sebangkat-Selakan reef generally do not continue beyond 20m depth, but most of the other reefs have a deeper section. Some reefs have a flattish shelf or terrace between the inner and outer reef slope. This is characterised by reasonably high coral cover (e.g. to 60%), with a predominance of bowls, plates, scrolls, sheets and low heads. At Mantabuan east, Bodgaya north-east, Sebangkat west and some other sites there is a very gently sloping (c.10-20°) sand and rubble plain about 100m wide dominated by large barrel sponges, gorgonian whips and small to medium-sized sea-fans.

On the Mantabuan Bank are several interesting communities. For example on the south side from a depth of 20 – 26m, on a slope of about 30° or less, the substratum consists almost entirely of rubble colonised by calcareous, crustose red algae and visually dominated by fields of *Dendronephthya*, both small and large. There are also occasional *Sarcophyton* soft corals, small sea fans and corals, including delicate unattached *Acropora russeli*.

On steeper slopes of about 35-50° on the outer reefs such as Mantabuan north and Sibuan north there is often reasonable hard coral cover with range of growth forms including heads, branching colonies, crusts and plate-like forms. Sea fans and black coral bushes may also be numerous on these and steeper reef slopes.

Deep slope

Depth 30m +

Many of the outer reefs in the north of the proposed park area continue on down beyond a depth of 30m. Often the substratum is of coarse sand and rubble rather than rock, but at some sites there are fields of gorgonians, black corals, barrel sponges and large soft coral trees (*Dendronephthya*) (Figure 27). Fish life is generally sparse, but some interesting species are found in these situations.

On the west side of Church Reef is a very unusual feature, not seen at any of the other reefs in the area. Stretching out from the reef base is a flat plateau almost 100% covered by huge fan corals (e.g. pectiniids and *Montipora*) and beds of low-growing *Seriatopora*, *Acropora* tables and agariciids (Figure 29). At Church Reef west, Kapikan north-east and Bodgaya north-west the deep reef is a mainly vertical rock face with small caves. Most rock surfaces are coated in crusts and nodules of calcareous red algae. Sea fans are common and black coral bushes and whips present. There are also occasional *Dendronephthya* soft corals and encrusting or plate-like corals and sea fans.

2.4. TERRESTRIAL VEGETATION

Information in this section is taken from the report produced by the Forest Research Centre, following their survey of the islands in October 1998 (Sugau *et al.*, 1998).

Of the three central islands, the two largest (Bodgaya and Boheydulang) have by far the most diverse vegetation. The fringes of these two islands have been disturbed in places, but much of the rest of the land has rich and unusual assemblages of plant life. Tetagan has been completely disturbed but now has regenerating forest of potential interest.

Vegetation on the low, outlying islands has probably never been particularly diverse. Maiga, Sibuan and Mantabuan are dry, sandy islands while Sebangkat and Selakan have many areas that are stony or rocky. Selakan is reported to be quite fertile, but all of these outer islands have been significantly altered as a result of settlements and cultivation over the past one hundred years or more.

A number of species discovered on Bodgaya and Boheydulang have never previously been recorded for the Bornean flora, and two species new to science were found. Several species with a very restricted geographical distribution occur on the islands, and are considered very rare. Apart from their botanical interest, as many as 127 species of useful herbs, trees and other plants from 54 families have been identified from the islands (Guntavid and Galaip 1998).

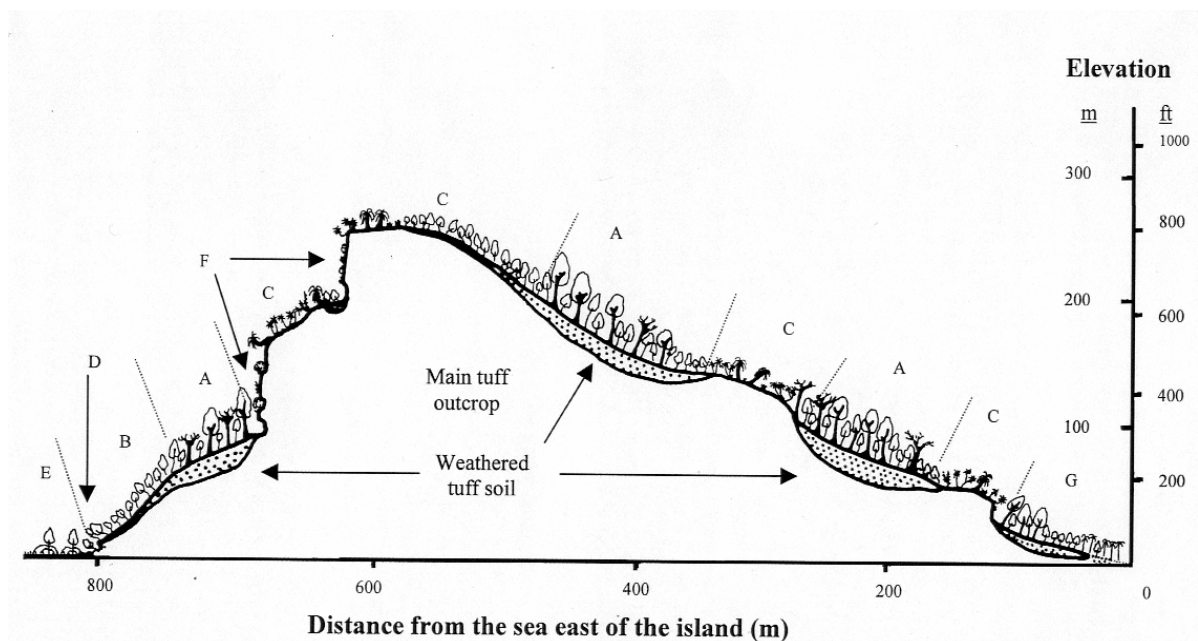


Figure 30. A typical west-east profile of Boheydulang illustrating the distribution of the various vegetation types according to site conditions. A = coastal mixed forest; B = secondary coastal mixed forest; C = scrub forest; D = beach vegetation; E = mangroves; F = rockface vegetation and G = agricultural crops. Taken from Sugau *et al.* 1998.

By virtue of their position at the extreme south-western end of the Sulu volcanic arc, the Semporna islands have interesting plant communities not found in other regions in Sabah or Borneo. The coastal mixed forest and scrub vegetation (see below) are considered to be particularly special. Five main vegetation communities are present on the islands: 1) coastal mixed forest; 2) scrub community; 3) rockface vegetation; 4) mangrove vegetation and 5) beach vegetation. These are described in the following pages.

Coastal mixed forest

This is the richest plant community found on the islands, represented by at least 95 species of tree found in 63 plant families (Figure 33). Physiognomically, this forest resembles mixed lowland mixed dipterocarp forest in Borneo, although floristically there were only three species of dipterocarps found during the survey (*Shorea guiso*, *Hopea beccariana* and *H. sangal*). The term 'coastal mixed forest' draws attention to the predominance of a number of species restricted to or more commonly found as big trees in coastal sites (e.g. *Garuga floribunda*, *Vitex pinnata*, *Mimusops elengi*, *Intsia bijuga* and *Canarium asperum*). A number of species of spiny plants were also well represented.

Structurally, this coastal mixed forest reaches 20–30 m tall, with emergents 35–40 m tall protruding from the general canopy. The forest is noticeably taller in the moister valley sites, with the tallest trees reaching 30–40 m. During the survey many standing dead trees were seen in this coastal mixed forest. This is thought to be associated with the severe drought episode early in 1998. Overall, these mortalities appeared restricted to the commonest species and therefore do not appear to pose any special concern over the survival of tree populations.

The smaller trees included scattered individuals of *Antirhea edanoi*, growing to about 5 m tall, a new record for Borneo and previously known only from Tawi-Tawi in the same arc of volcanic islands (Chaw & Darwin 1992). Also significant is the high density of wild individuals of the *langsat* fruit tree, *Lansium domesticum*, in the forest understorey in many places on Bodgaya island, and an equally impressive density of the trees, *Drypetes longifolia* and *Cynometra inaequifolia* in the forest understorey at some sites on the same island. *Lansium* is a much-cultivated local fruit tree and the wild populations here may not only generally represent important genetic material for improving the *langsat*, but also appeared to be relatively drought-resistant.

Woody climbers are common only in scattered sites, but of note was a species of wild peppervine, *Piper* sp with woody stems to 4 cm diameter. Three species of rattan were noted, but are not common. Epiphytes are mainly either ferns or figs and are not particularly abundant. The ground flora is sparse but here and there are localised patches of ferns, and an unusual rosette-forming herb on the weathered tuff slopes. Herbaceous groups that prefer moist substrates, such as the ginger, are noticeably absent. No erect palms were encountered in the forest on the islands, with the exception of small populations of *Arenga undulatifolia*, endemic to Borneo but a relatively common species.

Scrub vegetation

A scrub-like community is well developed on the two main islands, forming principally on the top of the major rock outcrops, on near-horizontal or gently sloping surfaces. It is totally absent on Tetagan. The most distinctive life forms apart from a few dominant tree species in this scrub community include the yucca-like cycad *Dracaena multiflora*, commonly growing to 10 m tall (Figure 32); the palm-like *Cycas rumphii* with stems to 4 m tall, and the cactus-like succulent *Euphorbia lacei*, growing to 6 m tall (Figure 35). *Dracaena multiflora* is particularly interesting because it is a new record for the Bornean flora, previously documented only for the Philippines (including the Sulu archipelago) and Sulawesi.

As a whole, this scrub community is special. The combination of these three key species does not occur anywhere else in Sabah or Borneo as far as is known, although it is to be fully expected that the same, or a very similar, scrub vegetation should thrive on the Philippine islands of the Sulu volcanic arc.

Although these species are principally found within the exposed scrub community, somewhat larger individuals of the same *Dracaena* (to 15–20 m tall) occur sporadically in forest shade just below the exposed outcrops that bear the scrub. Both the *Dracaena* and the *Cycas* can also be found growing at the sea fringe, on tuff boulders and cliffs.

Rockface vegetation

The vegetation on rockfaces includes small patches of scrub (see above), established on narrow ledges and in broad cracks, as well as a distinctive community that includes the true lithophytes (rock plants) such as an as-yet-unnamed species of *Paraboea* from the African Violet family (Figure 34). This species was found as small populations clinging to cliff faces, and is known only from the volcanic rocks of the Semporna islands and a limestone outcrop on Bukit Menundut in the Kinabatangan. It is regarded as an extremely rare plant.

Another lithophyte of note is *Selaginella tamariscina*, a small plant only 4–5 cm high, growing on exposed to partially shaded gently sloping rockfaces on both Bodgaya and Boheydulong. It is a new species record for Borneo (and Malaysia), and has a growth habit hitherto unknown among Bornean or Malaysian selaginellas.

Another new record for Borneo (and Malaysia) is the small brown fern *Cheilanthes javensis* that grows in completely open conditions, forming thick tussocks in cracks and depressions on the rock face. Another interesting species documented from the rock boulders was a *Hoya* sp. which was scandent from rock crevices and ledges and had conspicuous clusters of yellow flowers.



Figure 31. Mangrove trees on Boheydulang.



Figure 32. The cycad *Dracaena multiflora* on a ridge on Boheydulang.

Figure 33.
Coastal
mixed forest
on Bodgaya.



K.M. Wong



K.M. Wong

Figure 35. The cactus-like succulent *Euphorbia lacei* on Boheydulang.

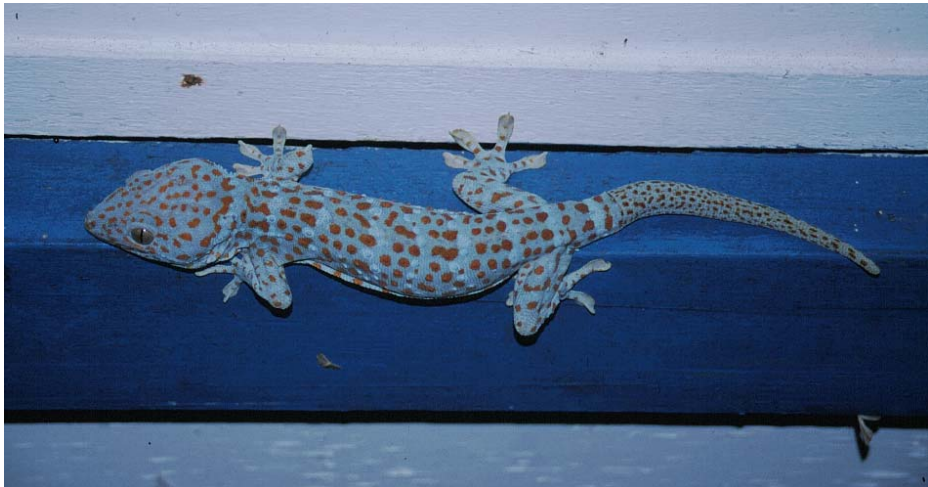


Figure 34. The rare *Paraboea* from the African Violet family, clinging to a volcanic rock face.



Figure 36. Well-developed beach vegetation on Sibuan

Figure 37. The tokay (*Gekko gekko*), at the old Pearl Farm.



Beach vegetation

The small sandy beach areas inspected, with the exception of those sites already disturbed by settlements, had good representations of the beach flora of Borneo. These are worthwhile preserving, particularly *Rhyssopteris timoriensis*, a new genus and species record for Borneo of a slender climber, which was found at one site on Boheydulang.

The typical sandy shore elements include a range of plants, but typical shore elements on the Bornean east coast sandy beaches such as *Pandanus odoratissimus*, *Pandanus dubius* and *Ipomoea pes-caprae*, were found but were exceedingly rare. Other beach elements, including *Casuarina equisetifolia*, *Argusia argentata* and *Barringtonia asiatica* were not encountered, possibly because they typify vegetation developing on deeper sand deposits.

Sibuan, Maiga and Mantabuan are very small raised coral beds that form relatively flat, white-sand islands where the vegetation is principally coconut. Sibuan, however, has a notable narrow strip of beach forest (Figure 36) formed mainly by *Pisonia grandis* trees (reaching 12–18 m tall) together with smaller *Premna foetida* and a narrow-leafed species of *Dracaena*. An individual of the strangling fig, *Ficus microcarpa*, was also seen there.

Mangrove vegetation

Like sandy beach vegetation, mangrove vegetation cannot be said to be well-developed around the islands of Tetagan, Bodgaya and Boheydulong. It occurs mainly in spots around the island sheltered from strong currents and in enclaves where some deposition of silt and mud is possible (Figure 31).

Thus, although *Rhizophora apiculata* (Rhizophoraceae), *Avicennia marina* (Avicenniaceae), *Lumnitzera littoralis* (Combretaceae) and *Sonneratia alba* (Sonneratiaceae) do occur and each can form nearly pure patches, these are restricted in area and often comprise of smallish individuals. The northern and southern shores of Bodgaya bear some fine patches of taller *Sonneratia* and *Lumnitzera*. The eastern shore of Tetagan has a tall stand of *Lumnitzera* worthy of note.

2.3. TERRESTRIAL WILDLIFE AND BIRDS

Information in this section comes from surveys carried out under the Semporna Islands Project (Davison, 1998; Lakim *et al.* 1998; Mohamed *et al.* 1999), with additional details from the 1980 survey report (Wood, 1981).

The central high islands of Bodgaya and Boheydulong have a much richer fauna than the small, outlying ones because they offer more space and shelter and a greater range of food and undisturbed habitats. Even so, the fauna on these central islands is generally impoverished in comparison with similar habitats on the mainland. This is to be expected, given the small land areas and fewer number of ecological niches, combined with isolation and chance extinctions.

Although the diversity and abundance of species recorded is relatively low, it is interesting to note the occurrence of long-tailed macaques, populations of bats in the numerous caves, an abundance of birds despite limited number of species recorded, and a variety of reptiles especially snakes and lizards. A solitary large (estimated 1.5m body length) monitor lizard (*Varanus salvator*) was observed swimming in mangrove habitat on Bodgaya. The natural island vegetation especially the abundance of figs that occur on Boheydulang and Bodgaya are thought to be important for supporting the current population of vertebrates.

Bodgaya and Boheydulang are refuges for a number of insect species that have never been recorded in any other part of Sabah including a couple which appear to be undescribed species.

Mammals

The commonest large mammal is the long-tailed macaque, *Macaca fascicularis*, which was also recorded during the 1980 survey. At least 2 groups occur in mangrove and forest areas on Boheydulang and another two on Bodgaya.

Local informants during the 1980 survey reported that the bearded pig (*Sus barbatus*) used to be common, but had become scarce. Its tracks were seen on both the main islands during the 1980 survey, but since then it has apparently been hunted to extinction. The sambhur deer (*Cervus unicolor*) has also suffered the same fate. A mouse deer (*Tragulus*) was seen on Bodgaya in 1999 by one of the survey teams, but the size of the population of these small forest-dwelling mammals is unknown.

Tracks of an otter (*Lutra* sp) were seen in mangrove on Bodgaya during the 1980 survey, and groups of up to 12 animals were seen sporadically around the old Pearl Farm on Boheydulang during the Semporna Islands Project. They emerged from the mangrove to hunt along the shallow back reef.

The nest of an unknown squirrel species was seen on a coconut tree on Bodgaya, and ‘black squirrels’ (possibly *Callosciurus prevostii*) have been seen on Boheydulang near to the old Pearl Farm. The rat (*Rattus rattus*) is also present here.

Three species of bats (*Ronsettus amplexicaudatus*, *Megaderma spasma* and *Hipposideros cervinus*) occur on the main islands (in comparison with 64 species that occur on the mainland). All these are insectivorous, and shelter in the many caves that occur on the two large islands. The largest population of the three species was *R. amplexicaudatus*. The roost of this species, a large cave (40 m height x over 20 m length) situated on the east side of Boheydulang Island, was estimated to hold more than a thousand individuals (Lakim *et al.* 1998).

Apart from wild vertebrate fauna, domestic mammals such as dogs, goats and cats have been introduced by local residents to Boheydulang and Bodgaya.

Birds

A total of 48 species comprising mainly resident birds have been recorded from the area (Davison, 1998; Lakim *et al.* 1998). The shallow seas should attract a number of seabirds, but there have been few observations to date. An interesting zoogeographical feature is the distinction between the bird fauna of the Semporna Islands and the Sulu Islands. Even though the maximum distance between any two islands is about 16 km, the gap between Sibutu and the Semporna Islands includes a deep sea trench which has evidently been an effective barrier to landbird dispersal during the Pleistocene. Sulu Hornbill, and Manatanani Scops-owl are two examples of about 20 species and subspecies that have not made it across to Sabah territory (Davison, 1998).

Of the families recorded on and around the Semporna islands, pigeons and doves (Columbidae) are particularly well represented – a typical feature of small islands. Pied Imperial Pigeon (*Ducula bicolor*) was the most common understory species observed in the forested area of Boheydulang and Bodgaya. Flocks of this species containing more than 20 individuals were observed in trees on several occasions. Both the metallic pigeon *Columba vitiensis* and Nicobar pigeon *Caloenas nicobarica* occur on the islands and are of particular conservation interest.

Tabon scrubfowl (megapodes- *Megapodius cumingii*) were observed on Boheydulang. These ground-dwelling birds are also of conservation interest, since their nests are often raided for eggs. Five active nesting mounds were found during a survey on Boheydulang, indicating the presence of a healthy breeding population (Lakim *et al.* 1998).

Other distinctive birds include the birds include the collared kingfisher *Todirhamphus (Halcyon) chloris* and the pied hornbill *Anthracoceros albirostris*. Sea eagles and other raptors, thrushes, flycatchers, sunbirds and bulbuls were also recorded. Shore birds were typically uncommon but included the common sandpiper (*Tringa hypoleucos*), striated heron (*Butorides striatus*) and lesser frigatebird (*Fregata ariel*).

Reptiles and amphibians

Surveys of reptiles and amphibians were carried out by the Sabah Museum (Wong, 1998), with additional information from Sabah Parks (Lakim *et al* 1998). The herpetofauna in the Semporna Islands is distinctly impoverished compared to the mainland, with fewer species and lower population density except for sea snakes. The central high islands of Bodgaya and Boheydulang have a richer fauna than the small, outlying ones because the bigger islands offer more space and a greater range of undisturbed habitats and food supplies.

No rare or endangered species of herpetofauna were found, but snakes and lizards were common. Five species of terrestrial snake were found (including pit vipers *Trimeresurus* spp., reticulated python *Python reticulatus*, green vine snake, *Ahetula prasina* and dog-toothed cat snake *Boiga cynodon*) together with at least six species of sea snake. Sea krait *Laticauda colubrina* are common around the jetty on Boheydulang, while the other species occur offshore.

Skinks and lizards, including the common water monitor lizards occur on the main islands. The most conspicuous of the lizards is the large tokay (*Gekko gekko* – Figure 37). Amphibians are apparently absent from the proposed park area, presumably due to the difficulty of reaching the islands, and the lack of permanent rivers or large pools for breeding.

Insects

Insects were investigated by the Sabah Museum (Lakim *et al.* 1998) and the Universiti Malaysia Sabah (Mohamed *et al.* 1999).

Butterflies (Lepidoptera) were particularly well represented, with a total of 52 species collected. This is about 5% of the Borneo fauna and is considered to be high diversity for the size of the islands. Some of the butterflies collected were a new record of species occurrence from Sabah (Otsuka, 1988; Kazuhisa Otsuka, pers. comm.). Moreover, one species from each family of Nympharidae and Pieridae are probably new species. These findings revealed the uniqueness of insect fauna in the area.

Beetles (Coleoptera), sucking insects of herbaceous plants (Hemiptera and Homoptera) and stinging insects (Hymenoptera) were also fairly common, and showed reasonable diversity but diversity of ant species was very poor.