SHELL COLLECTING ON THE GREAT BARRIER REEF

FINAL REPORT

to the
GREAT BARRIER REEF MARINE PARK AUTHORITY

JANUARY 1989

BRYONY BARNETT

ACKNOWLEDGEMENTS

This study was conducted as a consultancy to the Great Barrier Reef Marine Park authority. I wish to thank all staff members of the Authority who advised and assisted me during the course of the study, in particular my supervisors Leon Zann and Sally Driml, and Steve Hillman for his help with data processing. Special thanks are due to shell club members who co-operated and enabled me to participate in their activities. Those who proferred valuable information and assistance include Thora Whitehead, Kevin Lamprell, Richard Willan, Alan Limpus, Blanche Boorman, Ena Coucom, Jean Offord, Barbara Collins, Maureen Hagarty, Glenda Rowse, Phil Robson, Lorraine Rutherford, Noel Gommershall and Von Vandenberg. I thank managers of South Molle and Daydream Resorts, Whitsunday Rent-A-Yacht, and staff of QNPWS at Airlie Beach for their assistance in the Whitsunday Visitor Activity Survey; and Gordon La Praik and fellow Marine Park officers at Heron Island for their role in the Capricornia survey. Mike Fainzilber (Israel) communicated valuable information on managment issues.

"The Mollusca, in general, seem to be animals of inferior development: hebetous (dull, stupid) and incapable of active exertion, they maintain themselves amid living beings principally by their fecundity, and the tenacity with which they retain life."

Baron Georges Cuvier, 1863

EXECUTIVE SUMMARY

Shell collecting on the Great Barrier Reef Marine Park is undertaken predominantly by specimen shell collectors, casual collectors, commercial collectors and trawlermen. A total of 596 specimen shell collectors, with a preference for live shells, have membership with one or more of the eleven Queensland shell clubs and Discussion Groups. Approximately 150 members are active collectors. Club members are expected to conform to the rules of a collecting code. Principal shells collected belong to the families Cypraeidae, Volutidae, Muricidae, Olividae and Conidae.

Casual collectors include local residents, tourists, divers and sailors. Casual collectors are inclined to collect dead, beach shells and are less familiar with the identity of shells. A survey of tourists groups in the Whitsundays identified 26.5% as casual collectors: 23.8% collected dead beach shells, 2.7% collected 2-10 live shells. Activities of casual collectors are concentrated on accessible coastal and island fringing reefs.
Two commercial licences are on issue to collectors in the Marine Park: only one of these to an active party, collecting with a trawl and dredge in the Mackay/Capricorn Section. An unidentified number of small-scale commercial collectors (including an estimated 50 interstate visitors) currently collect commercially without a licence.

Intertidal and shallow water shell collecting is seasonal and is correlated with monthly daytime periods of extreme low tide from May to September. The heaviest collection recorded for 1984-87 occurred in the Cairns Section, at Undine and Rudder reefs. The only commercial charter vessel specializing in shell collecting trips is based in Port Douglas and serves collectors in the Cairns Section. Extensive collecting in the Central Section occurred on the coastal site of Dingo Beach. Collecting in the Mackay/Capricorn Section centres on the Keppel Islands and the fringing reefs of the Capricorn/ Bunker Islands where camping is permitted: Masthead, North West, Tryon and Lady Musgrave.

Since their introduction in 1982, by the Great Barrier Reef Marine Park Authority, a total 469 recreational shell collecting permits have been issued to cover approximately 1,300 people. 68% allowed collecting in the Cairns Section, 42.6% in the Capricornia Section and 20% in the Far Northern Section. The majority of individual permit holders were shell club members. Collection returns were received from 19.4% of the permit holders, recording 221 collecting occasions to 38 different sites in the Marine Park. Collection data records the taking of 12,509 live shells (327 species, 56 different families).

The majority (85.5%) of the 40 most commonly collected species in the Cairns, Central and Capricornia Sections are considered common species with an Indo-Pacific distribution. The remaining 14.5% are endemic to Australia or uncommon shells, 9% of which are Cypraea species.

Evidence of the detrimental impact of shell collecting in the Marine Park is largely anecdotal. Reliable reports of depletion focus on the coastal sites of Dingo Beach, Four Mile, and Kurrimine Beach, and Langford Reef, Heron, North West, Tryon and Lady Musgrave Islands. Habitat destruction by inexperienced reef walkers is seen as much to blame for depletion in high-pressure

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eas. An assessment of impact of, and resilience to, overcollection at the species level is frustrated by lack of biological information. The propensity for specimen collectors to target rare species, such as many Cypraea species and all Volutidae, make them the most vulnerable. The family Volutidae is particularly vulnerable by nature of its reproduction by direct development, which forfeits a high dispersal potential. The majority of Australian Volutidae are afforded a degree of protection by their deep-water existence.

The Australian shell trade is based principally on imported shell, predominantly from the Philippines, Japan and India. Queensland shell dealers derive less than 10% of their income from dealings in local shells, most of which are obtained from trawlers. The most highly priced shells from the Marine Park are collected by trawlers working new deep-water grounds in the Capricorn Channel.
Recommendations for future management of shell collecting include:
. that collection of dead shells be allowed in the General Use zones without a permit,
. that permits be retained for limited collecting ("the taking of not more than five live shells of any species within a 28-day period") of live shells in the General Use zones,
. that an emphasis be put on controlling casual collectors through education of the basics of reef behaviour, through development of extension programmes on the lines of the Marine Parks course initiated in the Cairns Section,
. that commercial operators be encouraged to contribute towards the development of extension material for their own use,
. that regional officers involved in day-to-day management develop responsibilities for user groups (eg. shell collectors), by aquainting themselves with their activites, and affecting liaison between the users and the agencies,
. that consideration be given to developing a monitoring programme at the coastal site of Dingo Beach, encouraging shell club participation under guidance by a representative of the GBRMPA.
. that provision be made for temporary closure of areas, as the need becomes apparent, on a shorter term (eg. two years) than is allowed for in the zoning review process.
. that shell collecting groups throughout Australia be kept well informed on agency decisions relating to their activities, through club newsletters.
. that further research, on the biology of the most vulnerable taxa (Volutidae and Cypraeidae) and the most heavily exploited species listed, be encouraged in the form of supportive funding.

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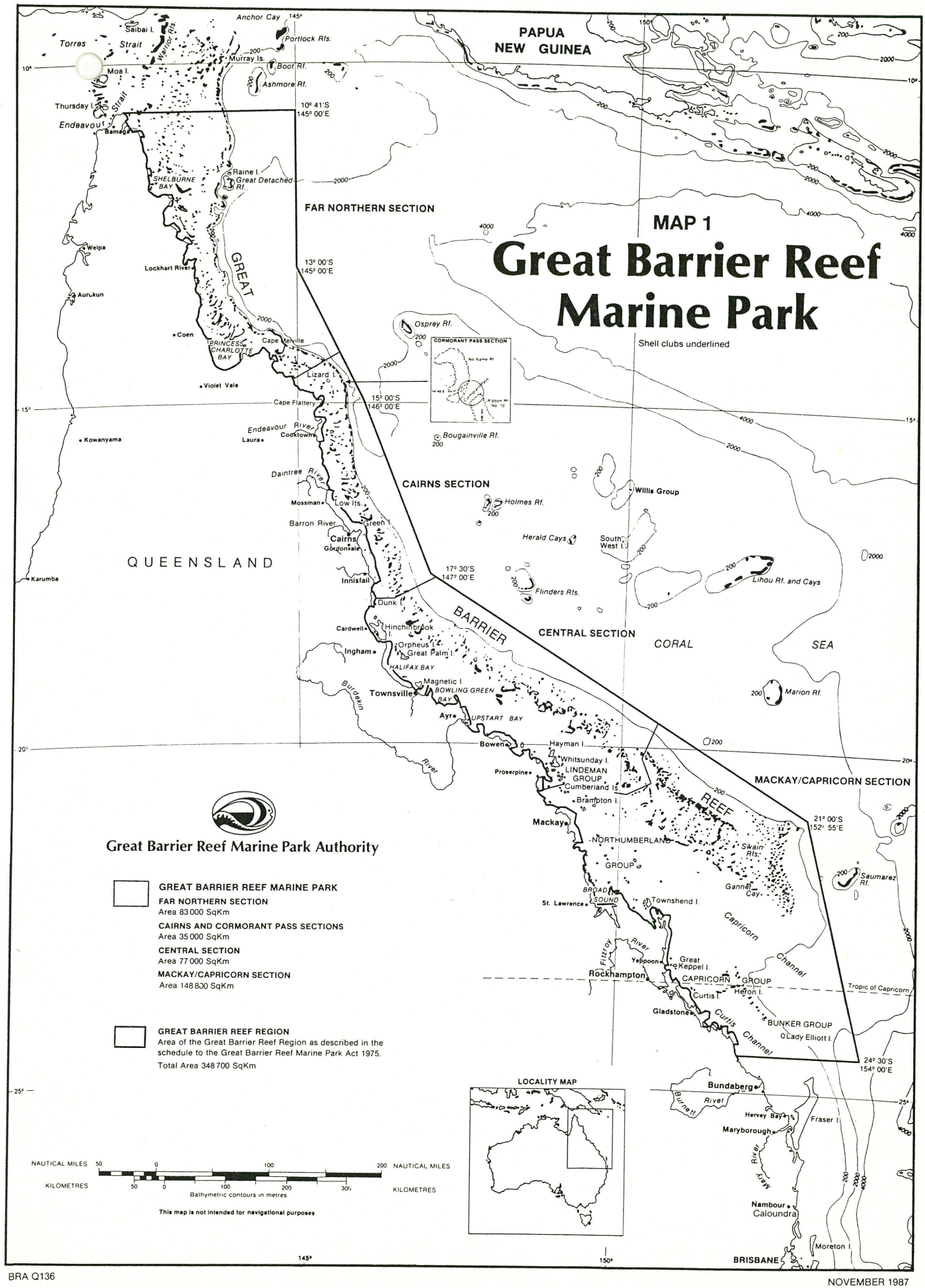


Great Barrier Reef Marine Park Authority

GREAT BARRIER REEF MARINE PARK

FAR NORTHERN SECTION
Area 83 000 SqKm

CAIRNS AND CORMORANT PASS SECTIONS
Area 35 000 SqKm

CENTRAL SECTION
Area 77 000 SqKm

MACKAY/CAPRICORN SECTION
Area 148 800 SqKm

GREAT BARRIER REEF REGION
Area of the Great Barrier Reef Region as described in the schedule to the Great Barrier Reef Marine Park Act 1975.
Total Area 348 700 SqKm

BRA Q136

NOVEMBER 1987

INTRODUCTION

The reefs and surrounding waters of the Great Barrier Reef are known to support over 4,000 species of shell-bearing molluscs (GBRMPA, 1981). The distribution patterns and abundance of shells varies according to factors such as the climate, the physical nature of the reef, proximity to the coast, human settlements and island resorts, and the biology of the molluscs themselves. The Queensland coast supports tropical forms to the north, the majority of which are wide-ranging with an Indo-WestPacific distribution. To the south the tropical and temperate forms overlap. A number of endemic species are found in both groups.

These molluscs provide a focus for visitors to the Marine Park with an interest in shell collecting. The definition of shell collector used in this report is "any individual who removes a shell, dead or alive, from its natural environment". The scale of collection varies from that of the casual collector or tourist in search of a reef souvenir, through the more serious specimen shell collector whose prime objective is that of building up a collection of quality shells, to the commercial collector who gathers more than 5 specimens of each species within a 28-day period, for the purpose of selling.

In recent years there has been a marked increase in visitor numbers to Queensland. Domestic and international travel to Queensland increased by 21.5% and 51% respectively in the 5 years to 1984/85. Island resort tourism increased by 36% in the period of 1982/83 to 1984/85 (Driml, 1987). A major contributing factor to tourist interest in the north is the Great Barrier Reef Region, 98.5% of which has been declared as a Marine Park, under the planning and management of the Great Barrier Reef Marine Park Authority. The Marine Park is designated as a multiple use area, the key objective of its management being "conservation with reasonable use". Shell collecting, within defined limits, is regarded by the Great Barrier Reef Marine Park Authority as a reasonable use. As an extractive activity of a non-finite resource, however, due consideration must be given to shell collecting in the development of management plans for the Marine Park.

The initial zoning plan developed for the Capricornia Section in 1979 placed restrictions on shell collectors which included a permit requirement to collect in General Use Zones only. As an additional management procedure placed a bag-limit of two shells per species was introduced, which raised considerable opposition from established shell collectors. The need for further information on shell collecting on the Great Barrier Reef prompted the Great Barrier Reef Marine Park Authority to commission this study, the objectives of which are outlined below.

1. OBJECTIVES OF STUDY

The objectives of this study are as follows:

a) to establish a profile of the specimen shell "industry" on the Great Barrier Reef,

b) to identify major target species and collection localities,

c) to identify those species susceptible to overcollection,

d) to develop appropriate guidelines for management,

e) to identify future monitoring needs.

Definition: **Specimen shell collecting** is the taking of shells of selected taxa for personal reference collections and for exchange with other collectors. This study has been expanded to include **souvenir shell collecting,** the less selective taking of dead or live shells by the casual collector, and **ornamental shell collecting,** the collection of a variety of shells for sale as ornaments or manufacture into decorative items. **Commercial shell collecting** is the taking of more than five shells of each species in any 28 day period, for the purposes of selling.

1.1 History

Molluscs have been valued by man since prehistoric times, as a source of food, as sacred objects, ornaments, artifacts and currency. The historic value of molluscs as a food source for Australian Aborigines is evidenced by the widespread occurrence of shell dumps, or middens, along the coast of Australia. Such middens document the shell species comprising the staple diet of Aborigines living on Australia's coastal fringe for the past 30,000 to 40,000 years (Meehan 1985). Molluscs have also been used by Aborigines as food and water carriers, cooking containers, scrapers, spoons rattles and body ornaments (Schall 1985).

In more recent years pearl oysters, helmet shells and trochus shells have been exploited for jewellery, for pearl farming and for the manufacture of buttons and cameos, a use which peaked in Europe in the Victorian Period (Abbott 1980). The trochus fishery in East Australian waters began in 1912 in the Torres Straits region and expanded subsequently to include Barrier Reef Waters, with peaks of production of over 1,000 tonnes per annum (Nash 1985). A trawl fishery for scallops, based in the southern reef region, began in the mid-1950s. Less than 2% of Queensland fishermen are now involved in this industry, which has seen wide fluctuations in annual catches since 1980 (Hundloe 1985).

Mollusc shells have long been appreciated for their aesthetic appeal, particularly by shell collectors. Specimen shell collecting as we understand it today dates back to the 18th and 19th Centuries. The history of shell collecting worldwide is well documented by Dance (1987) who traces the activity back to the "Golden Age" of the 19th Century. The popularity of shell collecting was greatly influenced by the availability of material. The collection of shells in South America, Polynesia and the Philippines by Cumming in the early 19th Century brought

an abundance of unusual material into circulation. The number of described molluscs increased from 700 in 1758, largely the work of Linnaeus, to a figure of 44,482 by 1891. The number had increased to 50,000 by 1900, a figure which doubled by the 1960s (Dance 1987)

The history of specimen shell collecting in Australia began with early voyages of discovery to Western Australia by Dutch explorers at the beginning of the 18th Century. The subsequent voyages of Captain James Cook in the 1770s, to the coast of New South Wales and Queensland led to the collection of the first material from these waters. Specimens thus collected were included in private museums and collections, afforded only by the European aristocracy. Subsequently explorers like Flinders, and governors Phillip and Bligh mentioned extensive shell collecting, also a major activity of the French nauralist Peron in the early 1800s. The mid 18th Century saw the beginning of efforts to establish permanent records of native molluscs within Australia (Coleman 1976). Since the turn of the 19th century descriptions and naming of Australian molluscs have been made by a number of naturalists and museum staff and Associates. The names of McGillivray, Bednall, Hedley and Iredale are acknowledged in shells which bear their names, a practice which continues today with descriptions of new material.

1.2 Literature review

Today the level of interest in shells and shell collecting may be gauged by the number of books on the subject in print. In America only four such books were available in 1935. By 1980 there were 200 books on the market dealing with the identification and biology of molluscs (Abbott 1980). Whilst Australia does not have the same wealth of literature there are numerous books on the Australian fauna, which are of interest worldwide.

1.2.1 Specimen shell collecting

A popular practical guide to shell collecting in Australia is given by Coleman (1976) who provides practical information on all types of shell collecting, from benthic to terrestrial, and fossil collecting, with additional information on collecting equipment and the cleaning and display of shells. More detailed information on collection by hand dredge and net is given by Williams (1980) and Parkinson (1982). Coleman also provides information on collector groups in Australia. Though dated, most groups listed are still active, several of which produce regular newsletters. These represent a good source of material on club activities and local shell distribution.

1.2.2 Identification

The Australian molluscan fauna has been estimated at 7,000 species, with roughly 2,000 being non-marine (Willan 1986). Though many groups are poorly known the more heavily collected families are covered extensively in a number of popular, well-illustrated reference books (Allan 1950, Wilson and Gillett 1974, 1982, Coleman 1975, Hinton 1977, Short and Potter 1987). For more detailed treatment of popular shells a series of monographs and specialist books covers the Conidae (Marsh and Rippingale 1964, Walls 1978), the Cypraeidae (Allan 1956, Burgess 1970, 1985), the Volutidae (Abbottsmith 1969, Weaver and Dupont 1979),

the Muricidae (Fair 1976, Radwin and D'Atillio 1976) and the Spondylidae (Lamprell 1987). More general references to Pacific and worldwide shells are given by Cernohorsky (1967, 1972, 1978) and Abbott and Dance (1983).

1.2.3 Biology and Ecology

To date there is a paucity of literature relevant to the biology of Australian molluscs at the species level. The emphasis has been on the commercially exploited species Trochus niloticus (Nash 1985, Honma 1987), tridacnid clams (Yonge 1975, Heslinga 1979, Munro and Nash 1985), saucer scallop Amusium balloti (Williams and Dredge 1981, Rose, Campbell and Saunders 1988), and the pearl shell Pinctada maxima (Pass, Dybdahl, and Mannion 1987).

Broad-scale distribution of reef molluscs in different localities has been described by Endean, Stephenson and Kenny (1956), Kohn (1959, 1981, 1983), Levitan (1978), Taylor (1978), and Sheppard (1984). More detailed work on the biology and feeding of cone shells (Conidae) at Heron Island includes references by Marsh (1971), Reichelt (1982) and Reichelt and Kohn (1985), and growth studies of Heron Island gastropods are described by Frank (1969).

The red-lipped stromb, Strombus luhuanus has been the subject of studies by Catterall and Poiner (1984, 1985) and Ritchie (1986) who based much of their field work on populations at Heron Island. Work on the breeding of Australian and Indo-Pacific cowries includes that of Ostergaard (1950), Natarajan (1954), Kay (1960) and Wilson (1985). Papers by Schilder and Schilder (1966, 1967, 1968) on the distribution of East Australian cowries were achieved with cooperation from members of the Keppel Bay Shell Club. Biological information is also recorded in the newsletters of the Malacological Society of Australia and the Keppel Bay Shell Club.

1.2.4 Ornamental and specimen shell trade

A study of the sea shell trade in Australia was commissioned in 1986 by Australian National Parks and Wildlife Service and conducted by the Council of the Malacological Society. In the resultant report Willan (1986) estimated the shell trade to be worth $2.5 million, $2 million of which comes from the specimen shell trade through dealers, the other $0.5 million including the ornamental shell trade. More than 90% of the trade in Australian molluscs comes from the sale of endemic species. A further study of the economic characteristics of the Great Barrier Reef region shell trade (Herbert 1986) emphasised the insignificance of North Queensland shells in the local trade, a business which is heavily dependent upon cheap imports.

The most popular shells sold in the worldwide ornamental shell trade are the large, colourful gastropods such as helmet shells, volutes, cones, cowries and spider shells, most of which are reef dwellers (Abbott 1980). Analysis of foreign trade statistics by Wells (1978, 1979, 1981, 1982a,b,c,d,e, 1986) and Wells and Alcala (1986) revealed that the Philippines, which exported 23,000 tonnes of shell in 1981, was the major exporter , with the United States as the principal consumer (over 1,000 shell dealers were recorded in the USA). Mexico and Haiti became important exporters in the 1970s, with other major exporters listed as Japan, Taiwan, South Korea, India and Australia (Wells 1981). Dramatic development of the shellcraft industry in Italy in the 1970s has increased the use of helmet shell, Cassis cornuta, and cowries for cameos and carving (Wells and Alcala 1986).

1.2.5 Impact of shell collecting

The impact of molluscan exploitation worldwide has been sumarized by Wells and Alcala (1986). A number of papers report local depletion of shells as a result of overcollection and habitat destruction (Evans, Knowles and Pye-Smith 1977, Hedlund 1977, Mills 1977, Asigau 1988). With a boom in tourism in Hawaii in the 1970s the shell trade increased, resulting in continuous habitat destruction there and decrease in shell numbers on accessible reefs (Mills 1977). Likewise, overcollection of shell on the Kenya coast has had a dramatic effect on local molluscan populations (Evans, Knowles and Pye-Smith 1977) as it has in Guam (Hedlund 1977) where the increase in coastal pollution is seen as much to blame. Heavy exploitation of the edible red-lipped stromb, Strombus luhuanus, has resulted in depletion on inshore reefs of New Guinea (Asigau 1988). Overharvesting of the queen conch, Strombus gigas, in Florida Keys depleted the reserves until control measures were taken (Abbott 1980). Mollusc species with apparently restricted ranges, such as the famous Golden Cowrie, Cypraea aurantium, from the Philippines to Polynesia (Wells and Alcala 1987), and the Australian Volutidae (Barnett 1987), much sought-after by collectors, are particularly vulnerable to over-exploitation. There is concern that several species of cowrie of the Zoila group are under threat from overcollection in south west Australia by divers who dive at night to depths of 43 metres (Antram 1985).

Some specimen shells, such as the glory-of-the-sea cone, Conus gloriamaris, have been very valuable to collectors because of their rarity. With new trawling techniques, scuba gear and the use of tangle nets (Dan 1978) the shells are now more numerous on the market and, in many cases, have dropped in value.

Further to the immediate effect of depleted populations of molluscs, the removal of a link in the food chain has been seen to cause imbalance in East African coral reefs (Kendall 1985). Removal of predatory gastropods has meant increases of echinoderms (Diadema sp.) which, in turn, have been known to feed on coral. Less well proven, but well advertised, the current population explosions of the crown-of-thorns starfish, Acanthaster planci, have been attributed by some to overcollection of a major molluscan predator, the giant triton, Charonia tritonis (Endean 1977). The recovery of marine sustems under exploitation is highly variable. Intertidal communities in Transkei, South Africa, where regular removal of shellfish has lead to an increase in species diversity, have a high recovery potential (Hockey and Bosman 1986). In Australia Caterall and Poiner (1987) predicted levels of resilience to collection in shellfish populations on northeastern Australian intertidal flats, emphasising the advantages of attributes such as free-swimming larvae, burying juveniles and high mobility.

1.2.6.Management

The recognition that shell collecting has had an impact on molluscan populations on several reefs emphasizes the need for management of the limited resource, to ensure the sustainable utilization of valuable reef species. Consideration of appropriate management strategies must take into account the economic environmental and cultural factors (Kenchington and Hudson 1984) in addition to the biology of the species concerned.

Basic data on breeding, life-cycles, population size and growth are limited for most molluscan species. Johannes (1981) has

suggested the need to make use of knowledge accumulated by experienced collectors, most of whom collect gastropods in preference to bivalves.

From the sociological standpoint the shell trade is labour-intensive and generates high economic returns (Wells 1986), making it a potentially valuable industry for local populations in the Pacific. In Fiji and New Guinea the specimen shell trade has been initiated by the government, on the recommendations of Parkinson (1982). The resultant development of the shell trade in New Guinea, whilst unique in its emphasis on conservation and maintenance of sustainable yields, has lacked efficiency and profit and still relies heavily on government subsidies (Wells 1982e). In such areas consideration has been given to education of the natives on appropriate collection and conservation techniques, but the wide distance between settlements makes management difficult.

Studies of the existing shell trade have been made in Florida (Abbott 1980), the Philippines (Annonuevo et al. 1982), Kenya (Evans et al. 1977, Wells 1978) and Australia (Willan 1986), and management recommendations detailed. In countries with a well-established shell trade management options include : controls or restrictions on the existing commercial trade; the establishment of marine reserves; the implementation of education programmes; mariculture. (Wells 1986). To date, controls have concentrated on the commercial shell trade, with the imposition of quotas, size-limits, closed seasons and sanctuaries (Heslinga et al. 1984, Nash 1985).

1.2.6.1 Controls and restrictions

The queen conch fishery of Florida, depleted by overfishing and overcollection, for food and specimen shells, has been controlled in various ways; by export restrictions, closed collecting seasons, closed areas, fishing gear controls, minimum size and bag limits, and small-scale mariculture (Brownell and Berg 1978, Abbott 1980, Brownell and Stevelly 1981, Iverson and Jory 1985). Seasonal and long-term closures implemented in Palau to control the trochus fishery have been largely ineffective due to non-compliance and lack of suitability of the sanctuary sites (Nash 1985).

Some species are protected from collection by legislation. In Queensland collection of tridacnid clams, the helmet shell, Cassis cornuta, and the triton shell, Charonia tritonis is prohibited. Protection of C.tritonis has also been proposed for Guam waters (Hedlund 1977). Similarly, the triton shell is protected in Fiji and the Seychelles, with a minimum size limit of 200mm in Vanuatu. Tridacnid clams, listed as Endangered Species in Appendix II of CITES, can only be exported from countries participating in CITES with a valid permit. In Australia export of all shells is regulated under the Wildlife Protection Act 1982 which allows for limited export of shells by dealers, museums and members of shell clubs, subject to obtaining permission from the director of the Australian National Parks and Wildlife Service. The reliability of data supplied in fulfillment of the conditions of these permits has been questioned by Willan (1986) who observed misidentification and taxonomic and typographic errors on such lists. The logistics of enforcement is a problem by itself. The policing of export regulation of South Australian cowries is an example, where the Fisheries and Wildlife Department is aware of illegal collecting activities but does not have the resources to control it.

Recreational shell collecting in the USA is controlled by state legislation, as in Australia. Collection of live shells in California requires a permit and bona fide membership of an approved malacological organization (Burch 1987).

As Wells (1982e) points out in reference to management of the Philippines shell trade , the lack of research on the biology of the shell species makes it difficult to propose suitable management procedures which can be enforced and will also be effective. Quotas and closed seasons can only be recommended on the basis of general information on molluscan reproductive biology and levels of harvest which can be supported.

On the Kenya coast extensive shell collecting, which has been popular since the early 1960s has resulted in the drastic decline of local molluscan populations (Brown 1977, Evans et al. 1977). In 1968 permits for collection of shells were introduced and by 1974 a total ban on collection and sale of shells was imposed, but this was lifted by 1975, under pressure from traders who had lost their livelihoods. Current legislation is unclear but appears to include collector and trader licences, a bag limit of 5kg of shells at any one time- almost impossible to enforce- and the need for export permits to take shells out of the country, also poorly enforced (Wells 1978). More recently, whilst reporting massive exports of many tons of shells by large trading companies, Kendall (1985) made a call for a total ban of the export of shells from Kenya, where it can no longer be justified as a significant cash source for local people since collectors are being exploited by the dealers.

1.2.6.2 Marine Parks and Reserves

The establishment of sanctuaries, marine parks and reserves is seen as a more satisfactory alternative of preserving breeding stocks , though effective siting requires some knowledge of the biology of the target species, including larval dispersal, and also of local current patterns.

The earliest marine parks established were those at three sites off the coast of Kenya where all marine organisms are protected. Despite reports of poaching and poor enforcement by park wardens it is believed that mollusc populations are higher inside than out (Evans et al.1977). The development of marine reserves in Indonesia as a means of protecting coral reef invertebrates currently under exploitation was recommended by Usher (1984), the first of which is proposed for Cenderawasih Bay, Irian Jaya, to protect giant clams and mother-of-pearl shells.

The Australian Government has adopted a system of zonation within the Great Barrier Reef Marine Park, in which non-commercial shell collecting is confined to "General Use" zones. General Use "A" Zone, the least restrictive, provides for all reasonable uses, including shipping and trawling. Prohibited activities are mining, oil drilling, commercial spearfishing and spearfishing with underwater breathing apparatus. General Use "B" Zone provides for reasonable use, including most commercial and recreational activities. Trawling and general shipping are prohibited, as well as those activites not allowed in General Use "A" Zone. Shell collecting is conditional upon the issue of a permit which requires the holder to complete an annual return. Subject to review every five years, the management procedure is expected to evolve with changes in the environment and the users' needs. The extent of the Great Barrier Reef Marine Park and the

inaccessibility of many reefs contribute to the difficulties of policing such restrictions.

1.2.6.3 Education

Education of reef users is seen to be a high priority (Wells and Alcala 1986). Hedlund (1977) recommended the development of a public information programme to educate shell gatherers into the basic rules of shelling in Guam.

Many shell clubs have adopted an educational role by the production of newsletters such as the Hawaiian Shell News and the Keppel Bay Tidings, both of which have a wide circulation. The ethics of collecting are emphasised in the "Shellers' Creed" of the Hawaiian Malacological Society and the responsibilities of the collector further discussed by McKay (1976), Smith (1976), Penniket (1978), Ring (1979), and Kendrick (1983), but it is unlikely that such literature will reach the eyes of a casual collector.

The East African Wildlife Society has taken steps in the right direction by the production of a series of posters for display in Kenyan hotels and resorts, illustrating the damage caused by shell and coral collecting (Wells and Alcala 1986).

In Papua New Guinea, the shell trade is government controlled, and guidelines to collecting on a sustainable basis have been developed. The initial impetus in the project, however, was not maintained (Wells 1982e). A similar booklet has been developed with recommendations to the Government of Fiji (Parkinson 1982).

1.2.6.4 Mariculture

The remaining management option, mariculture, could provide a solution to overexploitation of commercially collected molluscs such as the queen conch, Strombus gigas (Abbott 1980), giant clams (Munroe and Heslinga 1982), and Trochus niloticus (Nash 1985). Rearing techniques for trochus and clams are being researched at Orpheus Island Research Station, Queensland (Nash 1985). Such techniques have not yet been extended to the specimen shell trade and there is still a great deal to be learnt about the biology of the molluscs concerned before mariculture is seen as an effective management option.

2. SHELL COLLECTING ON THE GREAT BARRIER REEF

2.1 Current status

At the time of writing shell collecting on the Great Barrier Reef, like most activities, is regulated by the current zoning plans for each of the six sections of the Marine Park. Under Commonwealth legislation the Marine Park Act 1975 covers all waters within the defined boundaries below the mean low water mark. Tidal lands and tidal waters are under state legislation which are covered by the Queensland Marine Parks Act 1983. Compatible zoning plans have been developed by both the Commonwealth Agency, the Great Barrier Reef Marine Park Authority, and the Queensland Government. The zoning plans have been developed for one section at a time to allow for review of the management options. As a consequence the regulations for some activities may differ between sections for a period of time.

Such is the case for shell collecting. In the Mackay/Capricornia Section, declared in July 1981 and currently under review, the Cairns and Cormorant Pass Sections, declared in November 1983, and the Far Northern Sections, declared in August 1985, shell collecting is permitted in General Use Zones "A" and "B", subject to possession of a permit obtainable from the head office of Queensland National Parks and Wildlife Service (QNPWS), North Quay, Brisbane, or through the Great Barrier Reef Marine Park Authority (GBRMPA), Townsville. Permits are issued for the duration of a calendar year (July to June) and allow for limited collecting for private use and limited exchange. On expiry of the period permit holders are required to provide QNPWS with information on collection dates, locality and numbers of each species taken. Certain species of shelled molluscs are protected, namely the tridacnid clams, the triton shell, Charonia tritonis, the helmet shell, Cassis cornuta, and all shells on eggs.

In the Central Section of the Marine Park, declared in October 1987, limited collecting is allowed in General Use Zones "A" and "B", without a permit. "Limited collecting" is defined as

> "collecting of shells (etc.) in accordance with the bag limit or any other limitations declared in the regulations (not more than five of any species shall be taken in any 28-day period or had in possession whilst in the Marine Park, using the hand or a hand-held implement) made under the Great Barrier Reef Marine Park Act 1975 of the Commonwealth for the purposes of the definition of 'limited collecting' contained in any zoning plan prepared by the Great Barrier Reef Marine Park Authority in pursuance of section 32 of that Act".

Collectors wishing to take more than five shells of any species in a 28-day period are required to be in possession of a permit, obtainable from QNPWS.

In addition to the three protected species referred to above the Queensland Fisheries legislation prescribes a minimum size limit on green snail Turbo marmoratus (280 gms, live weight), golden lip pearl oyster Pinctada maxima (16cm), trochus, Trochus niloticus (6cm base), and the oyster Saccostrea commercialis (5cm). Any person aged 15 years and over may use a shell dredge provided the greatest width is no more than o.6m and the tines or teeth do not exceed 7.5cm.

Commercial shell collectors on the Great Barrier Reef must obtain a Commercial Shell Collecting Permit from the QNPWS, and a Fish or Marine Products Permit which covers commercial collecting in tidal waters, from Queensland DPI Fisheries Management Branch in Brisbane. Such permits are treated on an individual basis and permit holders are required to lodge collection returns with the agencies at 3-monthly intervals. At present no charge is made for any of these permits.

Commercial Fishing Licences for the collection of trochus shell, Trochus niloticus, (by hand only) are currently on issue to four operators from Port Douglas, working in 12 prescribed areas on the northern reefs. In addition six Master Pearlers and their vessels, operating from Port Douglas (1), Cairns (3), Bundaberg (1) and Townsville (1), are licenced to collect pearl shells, Pinctada maxima and P.margaritifera. The northern scallop fishery, which targets Amusium balloti, involves approximately 43 licenced fishermen operating out of Bundaberg and Gladstone (Hundloe 1985). All commercial fishery licences, on a controlled number basis, are issued by DPI Fisheries Management Branch.

The export of shell from Australia, which is regulated by Australian National Parks and Wildlife Service under the Wildlife Protection Act (Regulation of Exports and Imports)1982, is presently under reconsideration. As an interim measure certain shell club members and dealers have, on application, been supplied with authority to export shells . Any individual, club member or dealer wishing to send or take shells out of the country must obtain permission from the above authority prior to each consignment, and must supply a list of all shells exported. These details are published regularly in the Commonwealth Gazetteer.

2.2 Background

In July, 1981, the Mackay/Capricornia Section Management Plan became effective. Shell collectors were faced with restrictions on their collecting activities, being required to obtain a permit from QNPWS in order to collect in General Use "A" and "B" Zones only. Individual permits were required for each collecting trip and locality specified. Permit requirements specified that no more than two shells of each species (dead or alive) were to be taken and collection of the following was prohibited: Tridacnid clams, Cassis cornuta (helmet shell), and Charonia tritonis (triton).

At the same time the GBRMPA funded a short term investigation of shell collecting in the Townsville/Cairns area. The resultant report (Southgate, 1981) summarized the views of Townsville and Cairns club collectors and concluded that shell collecting was on a minor scale in North Queensland and unlikely to have any adverse affect on molluscan populations.

In the early stages of administration of the permit system the conditions of permits issued were assessed on an individual basis; bag limits and collections limits of live/dead material varied, which did little to promote support of the system. The general misunderstandings being felt by shell collectors were reflected in subsequent representations made to the GBRMPA during the development of management plans for the Cairns and Cormorant Pass Sections, the Far Northern Section, and the Central Section. Most participants opposed the bag limit and requested that permits be issued at regional offices for a 12-month period.

These points were raised at a special meeting of club members and Authority representatives in 1984. Club members, as a visible group of collectors, felt that they had been singled out of a much larger group of active non-club collectors. As an outcome of the meeting the bag limit was lifted and shell collecting permits were issued for a 12-month period, authorizing the "taking of shells for the private collection of the permittee and for limited exchange" (QNPWS Guidelines for Recreational Shell Collecting, October 1985).

With the continuing development of zoning plans for unzoned sections of the Marine Park new groups of collectors were being affected and confusion over the permit system persisted. Despite the relaxation of restrictions on shell collecting club members remained concerned at the loss of favoured sites, particularly in the Cairns Section and the Central Section. The increasing level of concern over perceived threats to shell collecting as a hobby was apparent in the greater number of representations made during the Central Section Public Participation Programme in 1985.

In view of the concern by shell collectors the present study was commissioned by the Great Barrier Reef Marine Park Authority to address the questions:

1. Who are the collectors of live shells?
2. What are the main target locations for collection?
3. What are the main target species for collection?
4. What are the taxa susceptible to overcollection?
5. What impact is occurring?

3. SHELL COLLECTORS

Those who exploit shells on the Great Barrier Reef may be broadly categorized as follows:

1. Specimen shell collectors,
2. Casual collectors,
3. Commercial and "quasi commercial" collectors,
4. Trawler Operations
5. Researchers.
6. Aboriginal and Islander groups.

3.1 Specimen shell collectors

Specimen shell collectors are those whose prime objective is that of making a collection of good quality shells, local and worldwide, representative of selected taxa. The majority of such collectors belong to clubs and discussion groups of which there are ten on the Queensland coast, listed north to south:

Cairns Shell Club,
Innisfail Shell Club,
Townsville Shell Club,
Port Denison Shell Club (Bowen),
Proserpine Shell Club,
Whitsunday Shell Club (Mackay),
Keppel Bay Shell Club (Rockhampton/Yeppoon),
Port Curtis Shell Discussion Group (Gladstone),
Burnett Shell Discussion Group (Bundaberg),
Queensland Branch of the Malacological Society of Australia (Brisbane).

3.1.1 Shell Clubs

Information on Queensland shell clubs has been obtained by personal interview, attendance of shell club meetings, shell shows and field collecting trips, and by questionnaire.

3.1.1.1 Survey Objectives

Two questionnaires were developed early in the study, a club questionaire and an individual questionnaire. The club questionnaire sought information on membership, past and present, active and non-active ("active" members are those who have collected shells in the current calendar year), and on club collecting trips in 1984, 1985 and 1986 (date, destination, participants, cost).

The questionnaire to be circulated to individual club members sought the following information:

. duration as a shell collector,
. collecting activities over the past three years (1984-1986),
. collection methods,
. research interests,
. specialization in shell groups,
. exchange of shells, interstate and overseas.

Collectors were also questioned on whether they had noticed any increase or decrease in shell numbers in the same period and how their activities had been affected by the zoning of the Marine Park.

A significant inclusion in the questionnaire was an "Economic Section", designed to focus on this aspect of shell collecting on behalf of an Honours student, Ms. Kylie Herbert, at Griffith University. Ms. Herbert's study "The economic characteristics and significance of the Great Barrier Reef Region shell trade", which received augmentative funding from the Great Barrier Reef Marine Park Authority, sought detailed information on individual costs of collecting activities and shell transactions.

The questionnaire was discussed in its intended format with members of both Townsville and Cairns shell clubs prior to distribution and subsequently modified, the "Economic Section" being simplified as an "Exchange Section".

3.1.1.2 Survey Methodology

At the commencement of the study letters of introduction were sent to all shell clubs, outlining the objectives of the project and the intention to distribute questionnaires at a follow-up visit. Club questionnaires were mailed to the relevant secretaries whilst individual questionnaires were distributed in person (excepting Innisfail shell club to whom they were mailed) at club meetings or shell shows. At each meeting the investigator introduced the study and encouraged discussion between potential participants. Distribution and retrieval took place between June and December 1986. A single letter of reminder was sent to each of the clubs participating shortly before the deadline.

3.1.1.3 Survey Results

Nine of the ten club questionnaires distributed were returned without prompting by the club secretaries. A reminder produced no response from the Port Dennison shell club at Bowen.

Eight shell clubs participated in the individual survey: the clubs at Bowen and Caloundra could not be contacted and most members of the Cairns and Innisfail clubs refused to participate at the outset. This effectively reduced the total number of questionnaires distributed to 81, after an initial circulation of 106. Members of the Cairns club openly voiced their resentment to the study at the introductory meeting. A few vocal members saw the questionnaire as an invasion of their privacy and were particularly critical of the "Exchange Section". Likewise, all but one of the Innisfail shell club refused to participate after prompting by a prominent member at a club meeting.

Distribution and retrieval:

Shell club	Nos. distributed	Respondents
Cairns	13	1
Innisfail	14	1
Townsville	13	3
Proserpine	15	0
Whitsunday	16	4
Keppel Bay	20	6
Port Curtis	8	3
Burnett	7	2
TOTAL	106	20

This represents a return of only 19%.

Results of questions:

1. How long have you been a specimen shell collector?
The average duration as a shell collector by respondents was 18.5 years (Fig.1).

				25 KB		
			20 TSC	25 KB		
		15 TSC	20 TSC	23 KB		
3 TSC	10 BU	14 WSC	20 WSC	23 BU		33 KB
2 ISC	6 WSC	12 CSC	18 WSC	21 PC		31 KB
1-5	6-10	11-15	16-20	21-25	26-30	31-35

Year class

Fig.1 Number of years as shell collectors by respondents from Cairns (CSC), Innisfail (ISC), Townsville (TSC), Whitsunday (WSC), Keppel Bay (KB), Port Curtis (PC) and Burnett (BU) shell groups.

All six respondents from the Keppel Bay Shell Club had been collectors for over 20 years. Only two respondents had been active collectors for less than five years.

2. Are you a member of any other shell collecting club; if Yes, which clubs?
Fifteen of the respondents were members of other shell clubs, including overseas clubs in South Africa, Hawaii, New Zealand and the United States. Ten of the fifteen had membership with the Keppel Bay Shell Club, five with Townsville, Port Curtis and Brisbane MSA Branch clubs, and four with the Whitsunday club.

3. From which sites have you collected over the past 3 years on CLUB collecting trips, and which were the main species collected by you?
See 4.

4. From which sites have you collected over the past 3 years, INDEPENDENT of club collecting trips? Please list shells collected.
The results of questions 3 and 4 have been included in the analysis of collecting returns by permit holders (Section 5).

5. Do you keep a log-book of your collecting activities?
Three respondents keep log-books, two with photographs of shells collected. A fourth collector keeps a regular photographic record.

6. **Please describe your method of collection: reef walking, snorkelling, SCUBA, "other".**
All respondents listed reef walking as the major method of collection; two listed snorkelling, one SCUBA, and one had used a small hand dredge in the past.

7. **What tools do you use?**
Tools used by respondents include: bucket, knife, gloves, probe, rake, wire, small hook, kitchen tongs, pronged garden cultivator, collecting bag or pouch, small specimen vials, and shoes with tin inserts. Some collectors opt to minimise equipment in order to achieve mobility, thus maximising valuable collecting time. A few prefer to take a camera to record field observations.

8. **Have you noticed any change in abundance of shells over the past 3 years on sites visited by you? Please describe changes.**
Most respondents replied "no change" to this question, three of whom stated that any observed changes in shell populations are considered a natural phenomenon. Two respondents had observed a decrease in abundance of shells. Decreases in shell at Tryon Island and Keppel Bay Islands were attributed to shell collectors and tourists, based on 20 years of observation. Decreases noted on Feather Reef and Mourilyan Harbour, near Innisfail, were attributed respectively to cyclone damage and harbour dredging and developments.

9. **In your opinion which are the most important collecting sites (give reasons)?**
The results of this question are treated in Section 4.

10. **Do you specialize in any particular groups of shells? Please specify.**
Nine do not specialize and collect all shell groups, Australian and worldwide. Specialization in the following groups was noted by the remaining eleven collectors:

Cypraeidae	(3)
Muricidae	(3)
Volutidae	(2)
Olividae	(2)
Conidae	(1)
Cymatiidae	(1)
Strombidae	(1)
Mitridae	(1)
Nassariidae	(1)
Pectinidae	(1)
Terrestrial	(1)
Freshwater	(1)
Mangrove	(1)

11. **Are you conducting any research related to your shell collecting activities? Please describe.**
Three respondents conduct informal research into shells (taxonomy, distribution, life-history, behaviour) as part of their collecting activies. Two others collect regularly for the Australian Museum and one for overseas taxonomists.

12-17. **"Exchange Section"**
Results are discussed in Section 6.

18. **What species are most commonly requested for exchange interstate and overseas?**
Four respondents said that they did not exchange shells; sixteen exchange interstate and overseas. Shell groups declared by respondents as commonly requested for exchange are as follows (records in brackets):

Interstate		Overseas	
Pectinidae	(4)	Volutidae	(7)
Volutidae	(3)	Cypraeidae	(5)
Cypraeidae	(3)	Muricidae	(5)
Muricidae	(3)	Conidae	(4)
Conidae	(3)	Pectinidae	(2)
Olividae	(1)	Mitridae	(1)
Turridae	(1)	Zoila spp. from WA	(1)
Bivalves	(1)		
General	(1)		
Endemics	(1)		

19. **Has the zoning of the Marine Park affected your collecting activities? If Yes, in what way?**
Thirteen respondents felt that their collecting activites had been affected by the Marine Park zoning; three anticipated some effect in the reply "not yet". Affects listed are (records in brackets):

. Loss of good/accessible collecting sites, leading to increased pressure on remaining sites. (5)

. Put off by paperwork; permit bother has stopped overseas visitors. (2)

. The early bag limit prevented collection of shells for exchange. (1)

. Loss of coastal shelling sites means loss of potential monitoring sites by collectors. (2)

20. **Do any other activities interfere with your shell collecting (eg. tourism, coral collecting.)?**
Twelve respondents made comments in response to this question. The principal effect felt were:

. Tourists: anticipated visitors to Wilson Island (Capricornia) and regular visitors to coastal sites of Dingo Beach, Stanage Bay and Clairview. (5)

. Coral collectors who destroy the reef. (1)

. Trawlers working close inshore. (2)

. Coastal developers, building harbour walls and dredging.

21. **Do you practice any deliberate conservation methods?**
All respondents affirmed their practice of conservation methods consistent with the "Collecting Code" recognized by shell clubs, which all club members are expected to adhere to:

. Collect only for your own use and limited exchange.

. Do not collect damaged and marked shells.

. Do not collect juvenile shells.

. Do not collect shells on eggs.

. Do not damage coral in the search for shells.

. Return all overturned rocks to their original position.

22. **Do you have any recommendations to make concerning your shell collecting activites?**

Recommendations listed include:

. More education is needed for all visitors to the Great Barrier Reef.

. All shell collectors should be licenced, with a fee.

. All shell collectors should require a collecting permit.

. Club membership should be compulsory for all shell collectors.

. GBRMPA should provide feed-back on data collected.

. Established shell collectors should be allowed special permits to collect in Marine Park Zones.

. Reefs should be closed on a rotational basis (eg. 3 years).

. Dredging with a small hand dredge should be allowed in selected lagoons.

. Permits should be issued regionally, especially for overseas visitors.

3.1.1.4 Survey Summary

In a total membership (1987-8) of 612 in the eleven clubs at least 148 may be considered locally active members (Table 1). The Rockhampton based Keppel Bay Shell Club, which has its own club hut at Yeppoon, has the largest membership of 300, only 30 of whom are currently active collectors. A large component is made up of members from other clubs in Queensland, interstate and overseas. The Port Curtis (Gladstone) and Burnett River (Bundaberg) Shell Discussion Groups are closely linked with the Keppel Bay Club. All eight members from Gladstone and 13 from Bundaberg are active collectors, regularly involved in activities of the Keppel Bay Shell Club.

Further north, the Whitsunday Shell Club (Mackay) has a current membership of 22, 15 of whom are regularly involved in collecting. This club has links with the Keppel Bay club to the south and Proserpine and Townsville Shell Clubs to the north. The total membership of 105 for the Townsville club includes an active group of 29, the remaining membership including collectors from adjacent clubs (43), overseas members (14) and 9 club/museum memberships. The 76 members of the Cairns Shell Club is made up of at least eight locally active collectors and a large component of members from other clubs and overseas.

The Bowen based Port Dennison Shell Club, with a membership of 16, most of whom are active, is largely independent of activities of the other North Queensland clubs.

The only shell clubs to show any growth since 1981 are Cairns and Townsville, increasing their membership by 15% in the five year period prior to 1986. During 1987 the Townsville club was active in enlisting new members reslulting in an increase of over 90% from the 1986 membership of 56. The Whitsunday club has halved in size in the past six years. The Keppel Bay Shell club has remained relatively stable in the same time period, though members express concern at the lack of young collectors. Most active collectors of Queensland shell clubs would have membership with the Keppel Bay Shell Club, which celebrated twenty-five years of establishment in 1987.

TABLE 1: QUEENSLAND SHELL CLUBS, AS AT MARCH 1988

CLUB	ADDRESS	MEMBERS (1988) Total	Active	MEETING (monthly)	LOCATION	NEWSLETTER
Malacological Society of Australia, Brisbane Branch	Queensland Museum, Qld. Cultural Centre, P.O.Box 300, South Brisbane, 4101	75		Last Tuesday 7.30 pm.	Qld. Museum	Australian Shell News, (MSA Newsletter)
Burnett Shell Discussion Group Bundaberg	c/- Mrs Bev Heidke, Heidke's Road, M.S. 108, Bundaberg, 4670	13	13	Last Friday 7.30 pm.	Private homes	
Cairns Shell Club	c/- The Secretary, P.O.Box 1735, Cairns, 4870	76	8	2nd Friday 8.00 pm	Cns. Education Centre	Cairns Shell News
Innisfail Shell Club	c/- The Secretary, P.O.Box 286, Innisfail, 4860	16	16	3rd Monday 8.00 pm	Innisfail High School	
Keppel Bay Shell Club Rockhampton	c/- The Secretary, P.O.Box 5166, North Rockhampton, 4701	300	30	4th Friday 8.00 pm	Club Hall Yeppoon	Keppel Bay Tidings
Port Curtis Shell Discussion Group Gladstone	c/- Mr Noel Trevor, 76 Wyndham Avenue, Boyne Island, Via Gladstone, 4680	8	8		Private homes	
Port Denison Shell Club, Bowen	c/- The Secretary, P.O.Box 300, Bowen, 4805	16	16			
Proserpine Shell Club	c/- The Secretary, P.O.Box 324, Proserpine, 4800	46	5	2nd Tuesday	Private homes	Proserpine Shell News
ownsville Shell Club	c/- The Secretary, P.O.Box 41 Hermit Park, Townsville, 4812	105	29	1st Wednesday 8.00 pm	Currajong State School	Townsville Shell Club Tidewatch
Whitsunday Shell Club, Mackay	c/- The Secretary, P.O.Box 1227, Mackay, 4740	22	15	1st Monday 8.00 pm	Leisure Centre	Whitsunday Shell Club Newsletter

Active specimen shell collectors include both men and women in approximately equal ratios. The activity appeals to husband/wife teams, many of whom are in the 40-60 year age category. The activity requires a great deal of commitment; the collection, cleaning, labelling and processing of shells demands time and energy, such that couples often opt to share the hobby. The paucity of young club members, in the under-30s age group, is a point of concern for some of the older shell clubs. This may be indicative of a lack of interest in club membership by collectors in this age group or, more likely, a real lack of younger serious collectors.

On the whole shell collectors are reluctant to disclose information on collecting sites and numbers of species collected. Results of questions 3 and 4 were not very informative because few collectors had a reliable record of their collecting activities for previous years. Log-books are seen to be unnecessary by the majority of club members, though official club trips are usually summarized in an article for the club newsletter. The process of cleaning, collecting labelling and storing of material is time-consuming in itself. The label assigned to each shell with date, site and identification data is considered adequate and many collectors encountered have an impressive memory for details associated with the collection of certain specimens. Long-term shell collectors represent a largely untapped source of information on molluscs: distribution, abundance behaviour and breeding, most of it unwritten. Whilst few are involved in formal research the combined interests of some of the more experienced club members are of great value.

Shell collectors are also reluctant to accept any responsibility for an observed decrease in shell populations. It is true that natural fluctuations in shell distribution are often hard to explain and predict. Memebers of the Keppel Bay Shell Club who have collected on Wilson and Tryon Island for over 20 years are unable to detect cycles in occurrence of cowries. The "natural fluctuation" argument is not under dispute but it has been used in cases where a long-term monitoring study may indicate a real decrease due to shell collection.

The exchange of shells, within and between Queensland clubs, interstate and overseas, represents a significant means by which collectors can access shells beyond their own collecting reach. Approximately 80% of club collectors exchange shells at some stage. The most popular shells requested by overseas collectors are the endemic volutes (Volutidae) cowries (Cypraeidae) and murex (Muricidae). Australia is home to over 30% of the worlds Volutidae, a group which includes numerous local colour forms. Cones (Conidae) and pectens (Pectinidae) also rank as important shells for overseas exchange. The same groups are commonly requested for interstate exchange.

Many shell collectors see tourists as affecting their own activities and are quick to point out the injustice, in their opinion, of banning shell collecting on a reef such as Michaelmas Cay, whilst permitting 100 tourists a day to trample the reef flats. There is a wide belief amongst shellers that the general public visiting the reef "en-masse" is ignorant of reef behaviour and that management plans should give high priority to the education of tourists and tour operators.

The objective of the shell club collecting code is to ensure the continuation of breeding populations of molluscs in the understanding that, provided all damaged shells, juveniles and those on eggs remain in the population replenishment will occur. A general rule is used for juvenile/adult distinction: a shell with a well-developed lip or teeth on the aperture (cowries) is considered mature. Those with thin lips are regarded as juveniles. Where a mature shell of some species has neither of these characteristics the assessment of maturity is based on size and weight of the shell, although a less reliable indicator.

Collecting techniques and equipment used by club collectors will be discussed in section 4. Section 5 will analyse collection data from this questionnaire and QNPWS permit returns, 1984-1987.

3.1.1.5 Survey Critique

The objectives of the **club** questionnaire were acheived. As the completion of the questionnaire was vested with the club secretary questions were not considered personal and the response was good, from all but the Port Denison Club at Bowen.

The response to the **individual** questionnaire, by contrast, was disappointing. Whilst a degree of hostility was expected, in the light of the history of shell collecting management by GBRMPA, it was hoped that personal introduction and discussion prior to disribution would counteract this. The limited success of this survey can be attributed to a number of factors:

. **Hostility** by some collectors to the GBRMPA as a result of restrictions placed on their activity with the zoning of the Marine Park. The feeling was strong in a small number of shell club members, some of whom encouraged others to respond in the same way. A repeated comment was "If we give you information you will only use it against us". Hence the reluctance to declare favoured collecting sites in the fear that these areas would be closed to collecting in the future. The competitive nature of shell collecting, promoted largely through the shell shows, gives rise to a degree of possessiveness over special collecting sites, on a group and individual scale. A shell club may wish to protect its local collecting sites from exploitation by outsiders and individual members may wish to conceal the discovery of a source of an uncommon species.
The propensity for specimen shell collectors to take live shells is regarded unfavourably by a large percentage of the general community and collectors are aware of this. As a consequence many feel the need to defend their reputation and thus inclined to underdeclare numbers of shells collected, even in areas where no restrictions apply. The "conservation" aspect of club collecting is frequently stressed.

. **Timing.** The survey was conducted early in the study to allow maximum time for retrieval. However, the response rate may have been higher had more time been allowed to restore shell collectors' confidence in the GBRMPA prior to questionnaire distribution. During the latter stages of the two-year study shell club members appeared less threatened and were more prepared to cooperate as a better understanding was achieved between them and the Authority.
A further disadvantage of timing was the coincidence of two additional studies into shell collecting, that titled "The Seashell Trade in Australia", conducted by the Council of the Malacological Society of Australia for the Australian National Parks and Wildlife Service, and an "Economic Study of Shell

Collecting" being undertaken by Ms.Kylie Herbert, an honours student at Griffith University in Brisbane.

. **Exchange Section.** The inclusion of this section in the questionnaire under discussion, on behalf of Ms.Herbert, produced a negative response from all participants. Financial questions were considered an invasion of privacy, a prime reason for refusal to respond in many cases desite being given the option to omit the section. A higher response rate may have been expected had this section not been included in the questionnaire.

. **Log books.** After early discussions with members of Townsville and Cairns shell clubs the investigator was lead to believe that most shell collectors maintained a log book or collection record. The majority of respondents, however, admitted to keeping no formal record, thus making data retrieval for previous years a difficult task.

More positively, the response rate represents 19% of those distributed, or 13% of the active shell club population in Queensland. The information, therefore, can be used as a framework to be supplemented with information gained through personal interview, group discussion and attendance of meetings and collecting trips.

3.1.2 Shell Club Meetings

All shell clubs hold regular monthly evening meetings at a local hall or private home. Meetings are conducted on a semi-formal basis and minutes recorded on each occasion. The meetings by shell discussion groups are generally less formal. Matters discussed include correspondence, shell shows, fund-raising activites and collecting trips. The programme may include a guest speaker, slide show or small displays produced by members. A major activity conducted by all shell clubs is that of fund raising by sale of raffle tickets for shell prizes. An additional activity popular with the more northern clubs of Townsville and Cairns is the "Sell, Swap and Buy" gathering, usually held over a weekend on two or more occasions a year, which attracts club members wishing to exchange or buy and sell shells from fellow members. Collectors travel between Townsville and Cairns to attend these events.

3.1.3 Shell shows

Three of the Queensland clubs have annual shell shows which are significant events in the club calendars and provide an opportunity for members to produce competitive and educational displays. The Keppel Bay Shell Show, held traditionally on a weekend in July, attracts attention from interstate and overseas. Collectors from New Zealand and the United States are known to coincide their annual shelling trip to Australia with this event. The Keppel Bay Shell Club hall provides a venue for extensive displays within and dealers stalls without. Shell show visitors take advantage of the opportunity to exchange and sell specimens amongst themselves.

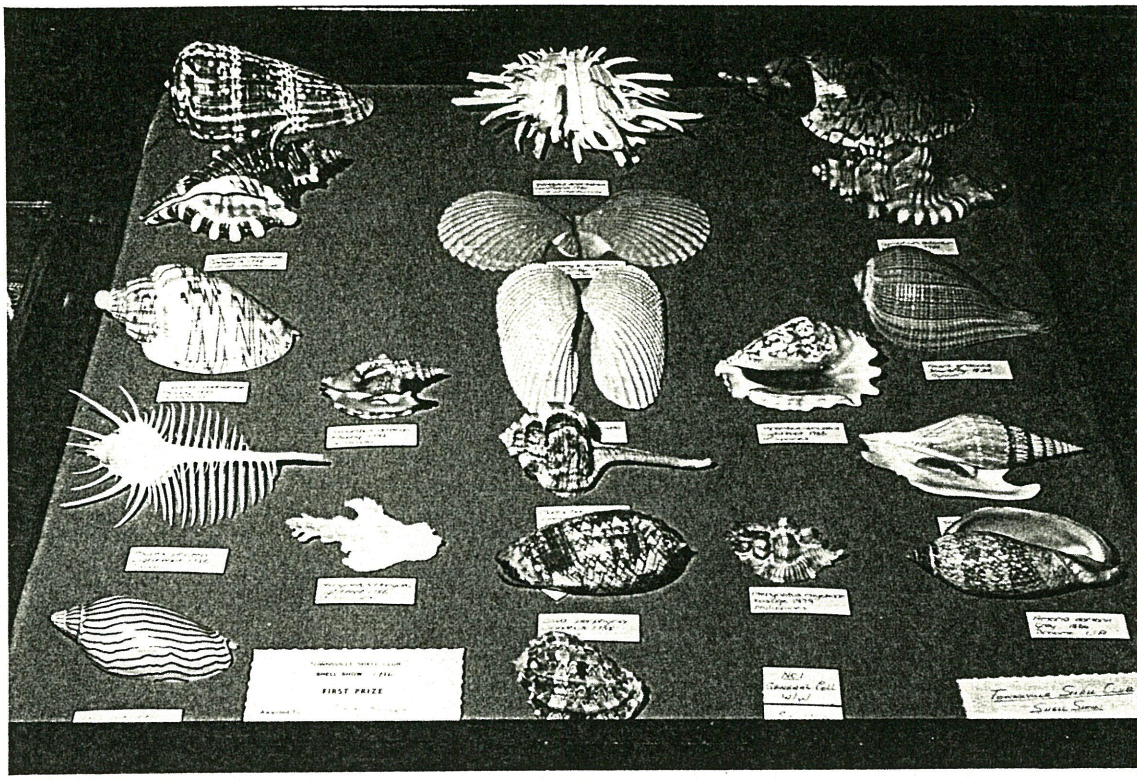
The Proserpine Shell Show, a smaller, one-day event, in which shell displays are secured behind a wire netting "fence", is patronized largely by Proserpine, Townsville and Whitsunday Club members.

The Townsville Shell Show, held annually in August or September, features competitive and educational displays, comparable with those of the Keppel Bay show.

PLATE 1: SHELL DISPLAYS AT TOWNSVILLE SHELL SHOW, 1987

A. A competitive display of general worldwide shells, awarded the prize for the Best Overall Display.

B. An educational display of cone shells.



A

Cone shells are capable of delivering a venomous sting via a harpoon like dart. They should not be handled.
CONE SHELLS
Conus marmoreus In situ
Conus marmoreus
Conus textile
Conus terebra in situ
Conus textile with egg capsules
DISPLAY

B

Displays are categorized, usually on the basis of families. Those most popularly displayed are: Conidae, Cypraeidae, Fasciolidae, Muricidae, Mitridae, Olividae, Volutidae, Strombiidae and Pectinidae. Additional categories include land snails, local shells, trawled shells, variations within a species, shells of one colour, personal favourites, "odd bods", and educational displays. The categories vary from year to year. The Keppel Bay Shell Club also encourages entries in photographic and shell art sections. Categories for the 1987 shell shows totalled 24 at Keppel Bay, 24 at Townsville and 17 at Proserpine. Prizes, usually small trophies, shells or gift items, are awarded to first and second places in each category. A "shell of the show" is selected from all shells displayed at Keppel Bay and Townsville whereas, at Proserpine, shells are entered specifically for this category.

Shells are displayed in rectangular glass-topped wooden trays, approximately 50 x 80 cms, with identification and locality data on accompanying labels. Displays are judged by a panel of invited judges, usually prominent collectors from other clubs, and assessed on the following categories:

	Keppel Bay Shell Club	Townsville Shell Club	
		1987	1988
. quality of specimens	40%	80%	60%
. presentation	20%		30%
. accuracy of labelling	20%	20%	10%
. variety of species	20%		

The shell shows, therefore, are largely competitive, with an educational element which some club members would like to see emphasized. Shells displayed may include self-collected material and that aquired by purchase and exchange. Names which recur amongst prize winners are often those of long-term collectors and those with the largest and most valuable collections. It is not unheard of for the more competitive members to purchase shells specifically to complete a display tray. The competitive element appears to be strongest amongst northern club members (Cairns and Townsville), in contrast to the more academic and educational approach of members of the Keppel Bay and Brisbane clubs, several of whom have had a long affiliation with the Queensland Museum.

3.1.4 Club newsletters

Newsletters are produced on a bi-monthly basis, for circulation to members and interested parties, by the following clubs:

Keppel Bay Shell Club, "Keppel Bay Tidings":
An eight-page high-quality newsletter featuring articles on past meetings, collecting trips, species descriptions, book reviews, historic information and general news; well illustrated with black and white photographs.

Proserpine Shell Club:
A foolscap sheet, photocopied; 2-4 pages containing details of meetings, collecting trips and local news.

Townsville Shell Club, "Tidewatch"
A small booklet with colour photo frontispiece; 18-20 pages with information on club activities, descriptions of local shell finds (including trawled shells), a "forum" column in which

controversial issues (including GBRMPA policy on shell collecting) have been discussed. The balance of articles are chatty contributions from members, based on their shelling experiences.

Cairns Shell Club:
A photocopied foolscap size with colour photo frontispiece, illustrating shells described in the feature article. Other articles include news of meetings, shelling and club visitors.

Whitsunday Shell Club:
Foolscap size, 1-2 sheets; covering club activities and members' news.

Malacological Society of Australia: Australian Shell News.
A high quality magazine of 10 pages, covering shell descriptions, literature reviews, and Society news.

3.2 Casual Collectors

This category includes the beachwalker, reef visitor, tourist, local resident, diver and sailor. The casual collector may be a resort visitor, an island camper or a charter boat passenger who is attracted to visible shells, often the more showy or colourful specimens, dead or alive. The majority of casual collecting occurs on beaches and reef flats adjacent to tourist destinations, at accessible coastal sites and on reefs with sheltered anchorages frequented by dive boats and bareboat charters. A large component of collectors in this category would be from interstate and overseas, in search of souvenirs from their visit to the Great Barrier Reef. The size of the Great Barrier Reef Marine Park, the diversity of recreational user groups and large number of access and destination points present difficulties in an assessment of casual shell collecting on the Great Barrier Reef. Every user of the Marine Park, be it resident or tourist, is a potential for this collector category, an activity which is often unpremeditated.

3.2.1 Whitsunday Visitor Activity Survey

For the purposes of narrowing the field of research the Whitsunday Island Group was selected as the sample area in which to base a study of visitor activities. The survey was designed to seek information on shell collecting by different tourist groups.

3.2.1.1 Survey Objectives

The object of the survey was to ascertain the level of shell collecting by a sample of tourists in the Whitsunday Islands and the relative importance of the activities undertaken by resort guests, bareboat charter passengers and campers. Additional information sought from shell collectors identified in the survey was the source of shells collected and the purpose of the collection. Opinions were also requested on the adequacy of activity information available to Whitsunday visitors.

3.2.1.2 Survey Methodology

For the purposes of this survey two simple questionnaires, designed to be answered with minimal effort, were designed:

. a general activity questionnaire in which questions on shell collecting were masked amongst questions on other

activities likely to be undertaken by each of the target groups (resort visitors, bareboat charter passengers and campers);

. a more specific questionaire on shell collecting aimed at determining the level of collecting of dead and live material, and the purpose of collecting by all groups.

The object of developing two questionnaires was to counter the effect of reluctance to supply information on collecting activities often experienced with people subject to direct questions and to compare the responses.

A letter of introduction was sent to the managers of three popular Whitsunday resorts, Daydream Island, South Molle, Whitsunday "100", the two major bareboat charter companies, Whitsunday Rent-A-Yacht and the Australian Bareboat Company, and the Disrict Ranger of the Conway office of the Queensland National Parks and Wildlife Service responsible for overseeing camping in the Whitsundays. This was followed up by a personal visit to all five individuals who agreed to participate in the circulation and retrieval of questionnaires. A small pilot distribution was undertaken prior to Easter 1987 to assess the relative values of the two questionnaires and sample periods were selected to commence with the busy Easter period in April, 1987, followed by two separate weeks in May and June, to coincide with the low Spring tides.

At the resorts, questionnaire distribution and retrieval was vested with the management; papers were placed in guests rooms with a covering note and collected at the end of their stay. Explanatory notes were also posted on resort notice boards.

Questionnaires lodged with the two bareboat charter companies were placed on board the vessels with other information supplied to passengers, and completed papers were retrieved by the management on conclusion of the charter.

Campers were interviewed by National Parks personnel during routine field checks at island camp sites.

The numbers of questionnaires sent out to each distributor is listed in Table 2. A total of 510 was sent to resorts and bareboat charter companies though it is unlikely that all were used due to opposing commitments of the managers and lack of participants.

3.2.1.3 Survey Results

The response to the pilot distribution indicated that there were no advantages to using a questionnaire without inclusion of specific questions on shell collecting. The two questionaires were combined, therefore in subsequent survey periods.

The results of the survey, listed in Table 2 , are illustrated in Figures 2 and 3. Returns were received from South Molle Resort (64 respondents) from sample periods of Easter, May and June and from Daydream resort (52 respondents) from distribution during Easter and in May. None of the 50 questionnaires deposited at Whitsunday "100" resort were returned due to an apparent closure at short notice for renovations.

One bareboat charter company returned questionnaires from 46 respondents collected during the Easter period; the second company reported that all questionnaires were ignored by passengers.

TABLE 2: WHITSUNDAY VISITOR ACTIVITY SURVEY

QUESTIONAIRE RETURNS

	Questionaires	April	May	June	Shell collectors
BAREBOAT	Nos. sent	50	50	-	
WRAY	Returned	18	-	-	Total- 13 12 minor act. 1 major act.
	Respondents	46	-	-	
	Nos. sent	25	25	-	
ABC	Returned	-	-	-	
RESORTS	Nos. sent	60	50	50	
SOUTH MOLLE	Returned	22	9	13	Total- 9 9 minor act.
	Respondents	31	16	21	
	Nos. sent	50	50	50	
DAYDREAM	Returned	14	15	-	Total- 16 5 minor act. 11 major act.
	Respondents	30	26	-	
WHITSUNDAY "100"	Nos. sent	50	-	-	
	Returned	-	-	-	
CAMPERS	Returned	6	5	4	10 minor act.

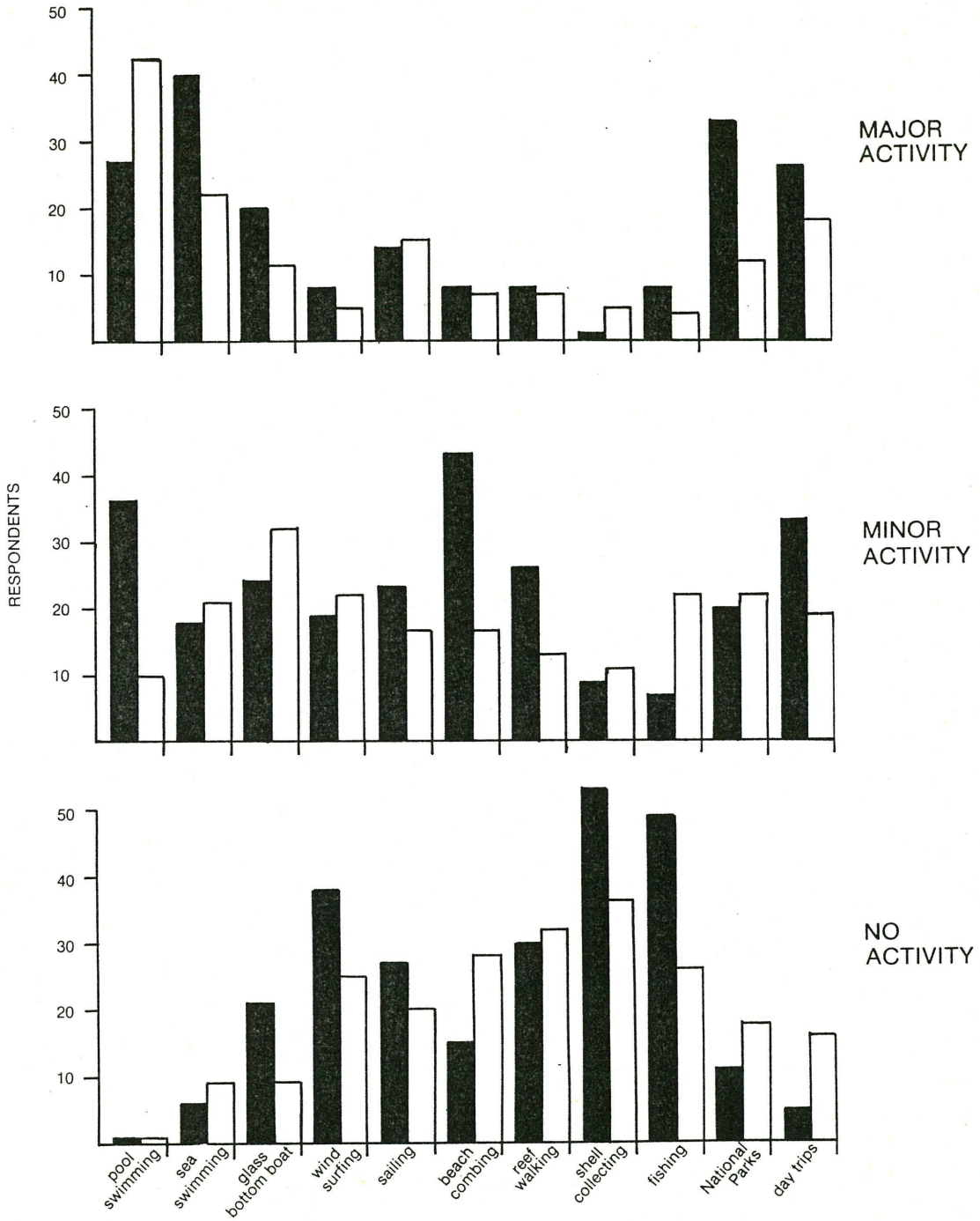


FIG.2 VISITOR ACTIVITIES AT SOUTH MOLLE RESORT (■-64 RESPONDENTS) AND DAYDREAM RESORT (□-52 RESPONDENTS) SURVEYED IN APRIL-JUNE, 1987.

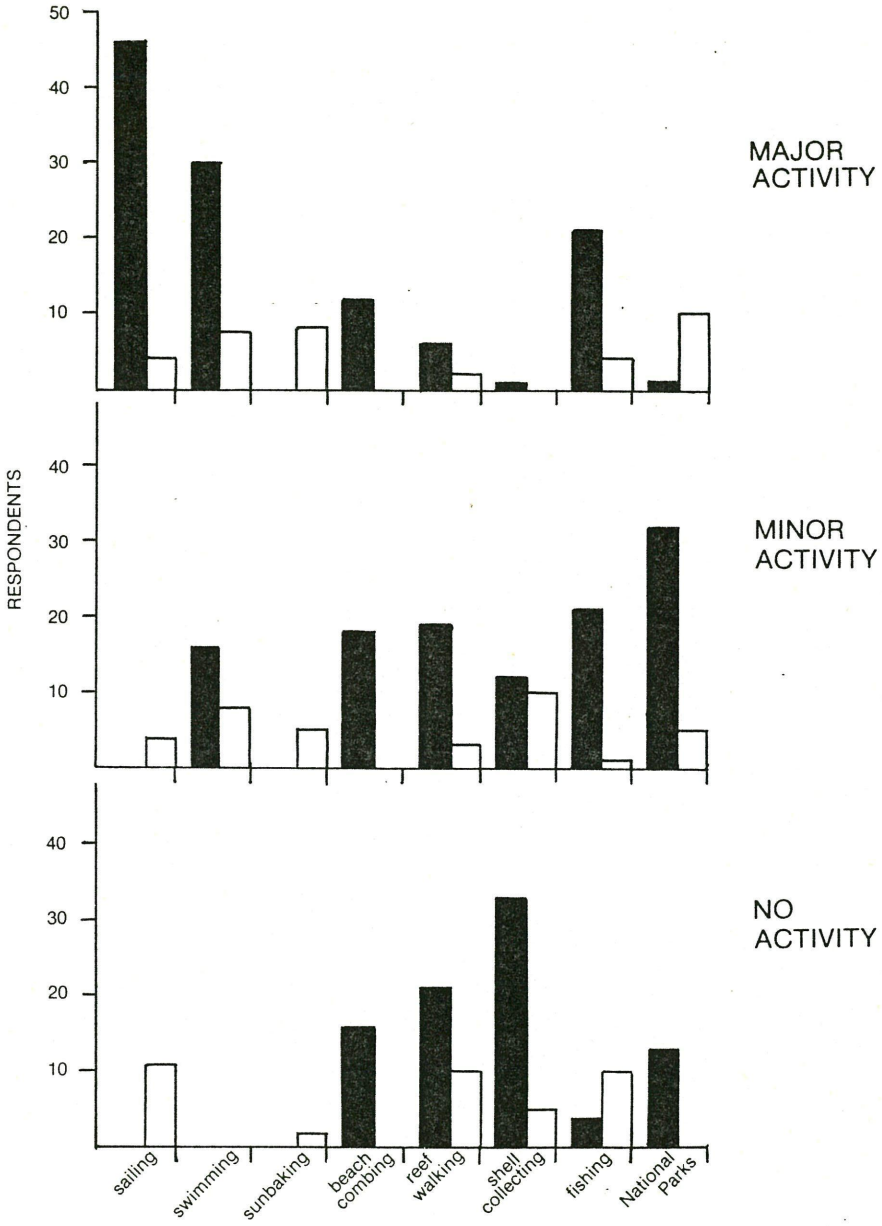


FIG.3 ACTIVITIES UNDERTAKEN BY BAREBOAT PASSENGERS (■-46 RESPONDENTS) AND CAMPERS (□-15 RESPONDENTS) IN THE WHITSUNDAYS, SURVEYED IN APRIL-JULY, 1987.

Fifteen campers were interviewed by National Park rangers, at Stonehaven Beach, Henning Island and Conway National Park during April, May and July.

The number of returns received totals 91 (17.8% of those sent out). In many cases a single questionaire was completed by a couple or group bringing the total respondents to 185, including the 15 responses from campers.

The results show an overall consistency in activities undertaken by visitors to both resorts. Principal activities indulged by these visitors are pool and sea swimming, coral viewing from glass-bottom boats, walking in the National Parks, and day-trips from the resort. Shell collecting was described as a "major activity" by six of the 116 resort respondents, one from South Molle and five from Daydream. Four of these (a group from New South Wales) had collected live shells (2-10) amongst dead shells; the remainder collected dead beach specimens only (maximum 30). All shells collected were for private use. For 20 respondents (nine from South Molle, 11 from Daydream) the activity was classified as "minor". Dead shells only were collected, numbers ranging from seven to 50 specimens, none of which were identified. Shell collectors came from New South Wales (12), Queensland (6), Victoria (3), ACT (3) and England (2). Eighty-nine resort respondents did not collect any shells during their visit to the Whitsundays.

All 46 bareboat respondents listed sailing, not unexpectedly, as their major activity, with fishing and swimming also popular. Shell collecting was desribed as a "major activity" by one passenger from Canberra who gave no numbers for shells collected for personal use at Cid Harbour, Butterfly Bay and Blue Pearl Bay. Twelve respondents who referred to their shell collection of dead shells as a "minor activity" were from Queensland (6), New South Wales (4) and England (2).

Activities favoured by campers, mostly from overseas, were walking in the National Parks, swimming and sunbaking. Shell collecting constituted a minor activity of ten of the fifteen respondents. All collected dead shells (maximum of 100, others- "cup full", 12 and "a few") for private use.

3.2.1.4 Survey Summary

Of the 185 respondents participating in this survey seven (3.8%) regarded shell collecting as a major activity, 42 (22.7%) considered their collecting a minor activity and 136 (73.5%) did not collect shells. Five collectors (2.7% of the total) in the "major activity" group, a bareboat charter passenger and four visitors to daydream resort had collected live shells (2-10 shells) whilst the remainder of the collectors concentrated on dead shells, mostly beach specimens in numbers ranging from two to 100, most records being under 30 shells. All collected for personal use and the lack of identification of shells suggests that they were taken by visitors in search of souvenirs rather than by serious specimen shell collectors. The group with the highest number of collectors, all participating in a "minor activity" was the campers, half of whom were from overseas. Campers represent a largely unsupervised group whose activities are generally confined to the locality or island of the camp site. Many would be "backpackers" who would not be expected to export large numbers of shells from the area.

Likewise, resort visitors select the style of holiday for the relaxation offered and though most resorts are sited in scenic surroundings, the majority of visitors opt for organized or local activities close to the resort. Most island resorts produce a daily "activities guide" for their visitors. This is confirmed by Driml (1987) who quotes statistics from a Queensland Tourist and Travel Corporation survey in 1984/85 in which over 70% of respondents listed swimming/snorkelling and relaxing indoor/outdoor as their major activities.

The majority of potential shell collecting sites of the fringing reefs and barrier reef close to the Whitsundays are inaccessible to a large portion of resort visitors unless on an organized day trip. Tour operators taking tourists by boat and sea-plane to Langford and Hardy reefs claim to emphasise the fragile nature of the reef and do their best to ensure that no material is removed. A number of such tour operators were questioned on the information supplied to visitors and all felt the need for more useful information, on basic reef biology and tourist behaviour, which they could impart. In many cases the tour leaders are boat skippers or hostesses with skills that do not include reef knowledge.

Bareboat charter passengers have frequently been cited as excessive shell collectors. The survey did not confirm this; it indicated that the prime motive for bareboat charter was sightseeing, sailing, swimming and fishing.

No attempt was made to survey private boat users. A concurrent study of the recreational usage of private boats in the Witsunday Islands being undertaken by Honours student (Ms Wendy Goodburn, University of Sydney), investigated the types of activites undertaken at anchorage locations. Only 16.7% of the sample undertook foreshore activities, listed as "barbecues, visiting a beach, camping, **shell collecting** and exploring caves". Though numbers do not refer specifically to shell collecting the investigator considers that it is not a major activity of private boat users.

3.2.1.5 Survey Critique

On the whole this survey provided some worthwhile information given its limitations and in spite of the low response. By enlisting the help of people on the spot, the investigator with time limitations forfeited a more personal interest in the survey. It is unlikely that pressure was put on people to participate, particularly amongst bareboat charter passengers, many of whom are on holiday to escape paperwork.

Respondents did not appear reluctant to answer questions on shell collecting. Only 2.7% of respondents reported collecting live shells, the remaining respondents who collected dead shells as a minor activity represent 22.7% of the sample. The number of visitors to Whitsunday Island resorts in 1984 was estimated as 54,924, with 9,940 estimated bareboat charter passengers and 10,784 campers (Management Establishment Task Force Report to National Parks, 1985). The sample of 185 visitors in these categories is considered representative of the total estimated and may therefore be taken as an indication that shell collecting forms a minor component of the activities undertaken by visitors to the Whitsunday Islands. An important consideration, however, in relating this sample to the remainder of the Great Barrier Reef, is the relative quality and accessibility of shell collecting sites to resort visitors and campers. The activities

of visitors to islands in the Marine Park are governed by the facilities offered and the mobility of the visitors. A resort with ready access to extensive fringing reef is more likely to support shell collectors than one with no reef. The Whitsunday Islands, continental in their origin, feature smaller areas of reef than the island cays of the Capricorn Group. Heron Island, surrounded by extensive reef, supports a large resort and staff. Likewise, Tryon and North-West Islands are popular camping destinations. The accessible reefs on these islands, particularly at Heron Island, are now considered depleted of shells as a result of overcollection by tourists and shell collectors (Domm 1977).

Historically the early inhabitants of some Barrier Reef Islands were keen shell collectors. The remains of a large shell collection remains on display at South Molle Island and anecdotal reports of extensive collection by "locals" at Heron Island indicate that shells were more readily available than they are today at these localities.

Today reports are still received of resort guests who leave decomposing shells in their rooms though these were unconfirmed in interviews with three different house staff at Heron Island Resort in late 1987. Two staff confirmed sighting small pieces of live-taken coral but live shells had not been seen in possession of visitors. The resort conducts supervised instructive reef walks, the dive staff discourage removal of any material and the presence of a staffed National Parks Interpretive Centre serve to enforce the correct behaviour in the immediate area of the resort, zoned as Marine National Park "A" and "B".

Objections have been mooted, by members of the Brisbane Branch of the Malacological Society of Australia, and research scientists using the Heron Island Research Station, that the sale of highly-priced specimen shells at the resort shop encourages visitors to collect their own. It would be naive to assume that no shells are collected but extensive measures have been taken to control the activity as much as possible at this location.

3.3 Commercial and "quasi-commercial" Collectors

This category includes retailers who collect shells for sale or manufacture into shell products and souvenirs, and trochus fishermen. A short-term survey of the shell trade in Australia (Willan, 1986) found that the percentage of business derived from the sale of Australian shells ranged from 1% in Queensland to 100% in Western Australia. Queensland dealers interviewed by McGinnity (1985) revealed that the majority of shells in stock were imported from the Philippines, India and New Guinea. At the time of writing a single commercial collecting licence is on issue to a shell dealer/ trawlerman operating in Central Queensland. The "quasi-commercial" collectors include a small number of visitors from New South Wales and Victoria who visit the northern beaches for several months of each year to coincide with the low tides, during which shells are collected for resale on return to the south to offset holiday costs. A few shell club members would also qualify for this category; those who buy or "obtain" shells from trawlers for resale and exchange amongst other collectors, and those who accumulate large numbers of self-collected shells for sale to dealers and other collectors. No commercial shell collecting licences are currently on issue to any such collectors.

3.4 Trawler Operations

Molluscs are a small and regular component of the by-catch in the prawn fishing industry which is confined to the General Use "A" zones of the Marine Park and does not impinge on the reef proper. Prawn trawling, using otter trawls, is the most important fishery in Queensland. Traditionally, one or two nets were used but there is an increasing trend towards the use of three or four nets, resulting in greater efficiency and a decrease in the amount of benthic by-catch obtained.

Shell catches are highly variable. On the whole only a few interesting shells are obtained in each trawl. The quantity and quality of shell is governed by factors such as the fishing gear, the area being worked and the season.

The scallop fishery, which targets the mollusc Amusium balloti, is based in southern Queensland. Trawlers working in inshore waters with gear designed to fish the benthos are more likely to collect specimen shells than the prawn trawlers, although the shells are potentially less interesting than the deep water species.

It is recognized that trawlers represent a source of shells to collectors, otherwise unobtainable by collectors. Although it is illegal for fishermen to retain shell for commercial purposes the limited amount of material channelled to collectors and museums over the past 20 years has largely been ignored. At present, however, with the increasing interest of collectors in trawled shell, the entry into new deep-water trawling grounds and the competitive nature of the fishing industry more trawlermen, particularly in southern Queensland, are making a habit of retaining shells for sale to collectors and dealers. Fishermen are becoming more aware of the value of shell specimens, largely as a result of promotion by dealers and collectors themselves.

The principal sources of trawled shells are boats in the ports of Townsville, Yeppoon, Gladstone, Bundaberg, Hervey Bay and Mooloolaba. In most cases shells are collected direct from trawlers by a few collectors and dealers or manufacturers at each port, some of whom have a standing arrangement with trawlers, others of whom visit the wharfs at regular intervals "on spec", approaching boats as they unload their catch and asking if any shells have been retained.

In Townsville three members of the Shell Club have an arrangement with at least three trawlers to purchase all shell caught in the trawls. Material brought up in deep water trawling trials off the shelf east of Townsville have produced some new and interesting material. One trawler, in particular is responsible for bringing in deep water material from depths of 80-100 fathoms off Townsville. This vessel has an arrangement with a shell collector who cleans all the material and ensures that the skipper has some good shell specimens for his own collection in return for the remains of the catch. It is believed that some money also passes hands when the shells are particularly interesting. In this case the shell collector is assured a unique collection and the surplus shell obtained gives this person a trading advantage over other collectors, the material being distributed by means of sale and exchange at the popular shell club "Sell, Swap and Buy" events (2-3 times a year at Townsville).

Amongst the Townsville-based fishermen shell collecting appears to be confined to small numbers of boats. Of fifteen skippe
be confined to small numbers of boats. Of fifteen skippers interviewed four admitted to supplying shell collectors regularly, one for payment, one other for shell-cleaning returns. The majority disclaimed any interest in shells on the grounds that they were too much trouble, smelly and not worth the effort involved. In these cases most shells collected were thrown overboard. Most trawlermen admitted to having been approached for shell by collectors at some stage. Of the small percentage (<5%) of shells retained by such trawlers (often by the deckhand or cook), for personal use only, the popular shells are the large bailers and trumpet shells, commonly used as plant containers. At the time of interview few Townsville trawlermen were aware of the relative values of shells. More recently, however, a local shell club member has reportedly distributed requests for shells, with a price list, amongst the fleet, which may well encourage further shell retention.

Bundaberg is the major source of trawled shells for shell collectors, due principally to the fact that 12-15 of the 50 boats operating from the port are involved in trawling outside the Swain Reefs and the outer edge of the Capricorn/ Bunker group, in depths of 150-220 metres. Working in new grounds, the shell material brought up has aroused great interest amongst shell collectors and shell values are high accordingly. Of the remaining trawlers working out of Bundaberg approximately 50% are believed to retain limited amounts of shells for purchase by local collectors and dealers.

The ports of Gladstone, Hervey Bay, Tin Can Bay and Mooloolaba are additional sources of shells. Small numbers of Hervey Bay boats supply individual collectors in Bundaberg and Townsville (the latter in payment for marine engineering services), a dealer in Townsville, and manufacturers in Hervey Bay and Mudgeeraba.

3.5 Researchers

Only three scientists are currently conducting research on molluscs on the Great Barrier Reef which involves active field collection. In each case the research targets a specified species and all collection information is recored systematically.

3.6 Aboriginal and Islander Groups

Coastal populations of Aborigines have, in the past, relied heavily upon molluscs as a food source and as materials for artifacts. The shell middens of the north and north east coast of Queensland provide a record of species and numbers of shells gathered locally for food (Meehan 1982) whilst museum collections document those used as containers, body ornaments, spears, scrapers and rattles (Schall 1985).

Today the coastal Aboriginal populations are drastically reduced. With an estimated population of 100 adults north of Cape Melville at the communities of Yarabah, Hopevale, Lockhart (Chase 1978), and other communities of Wujal Wujal (Bloomfield) and Palm Island the pressures on shells of the coastal and offshore reefs would be correspondingly reduced. In the post-contact period shell artifacts have been succeeded by modern alternatives. An Independence Day ceremony at Daru in the Torres Straits in 1986 saw natives dressed in PVC tubing arm bands and plastic

breastplates (David Lawrence, pers. comm.). Likewise the dietary emphasis on shellfish has reduced with the influence of white man's food. A comprehensive account of shellfish gathering by Aboriginal peoples in Arnhem Land is given by Meehan (1982) who details shell species and volumes gathered during 1972 and 1973. Shell gathering is largely the work of women and children who concentrate on easily obtainable shell fish on accessible beach and reef flats.

4. COLLECTING TECHNIQUES AND TARGET SPECIES

Collecting sites favoured by **specimen shell collectors** are coastal reefs and accessible inshore reefs. In addition, several shell clubs organize at least one club trip per annum to more distant reef locations, hiring a boat for one to four-day periods. Collecting is highly seasonal, the "shelling season", usually May to September, includes the monthly low tides. For three to four days each month the low tides result in up to three hours of intertidal and sub-littoral exposure during the daytime, allowing ready reef access by walking and wading. Committed shell collectors will plan their holidays and activities around these dates in order to take advantage of every opportunity to pursue the hobby and will focus on specific sites known to be productive, sometimes travelling considerable distances. A limited amount of night shelling occurs at the summer low tides. In all cases shell collecting would be the prime objective of a reef visit by such people.

4.1 Shell collecting sites: field trips 1984-87

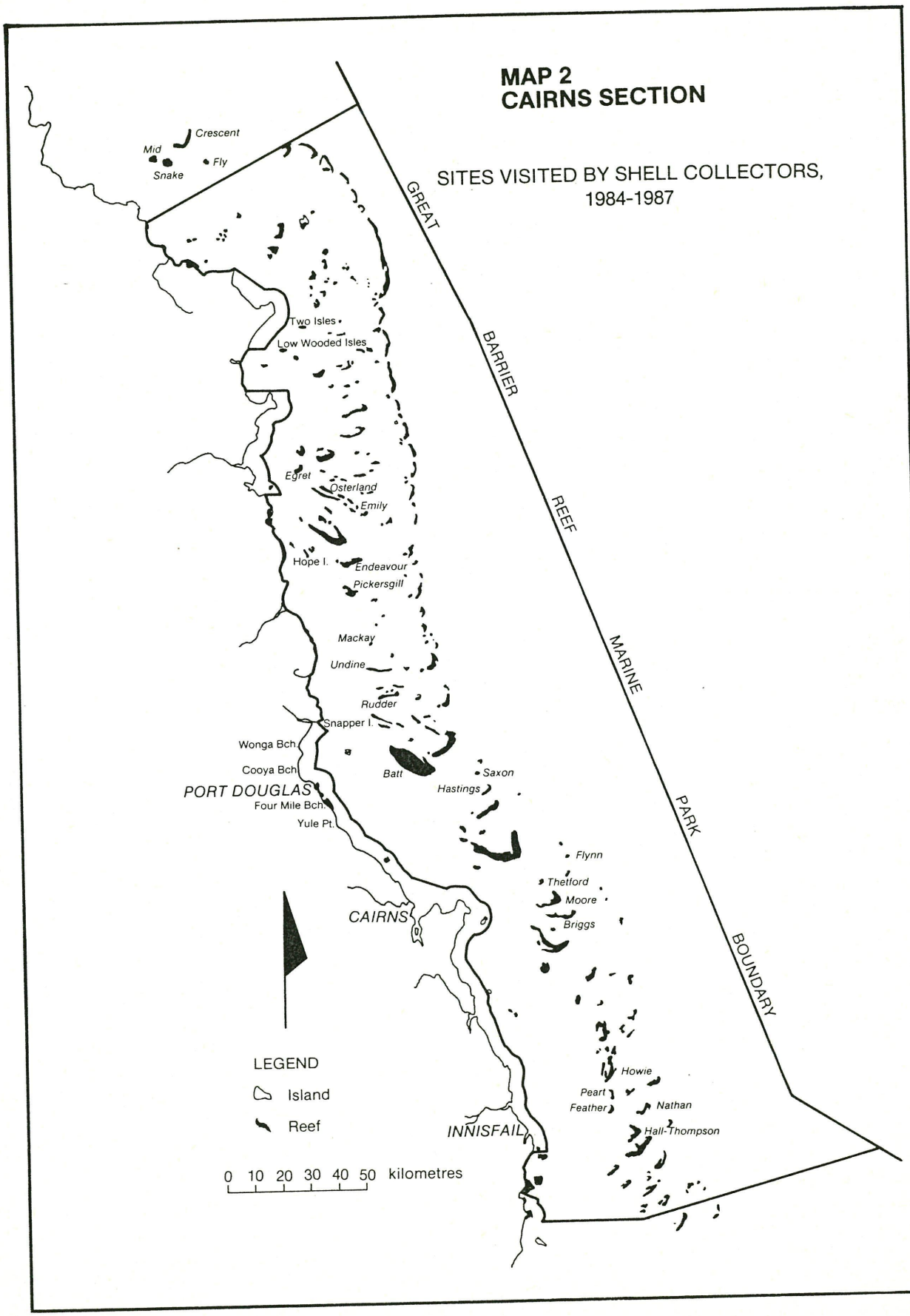
Collecting trips conducted by Queensland shell clubs averaged one 2-3 day trip per annum, on a charter vessel, carrying 8-13 collectors. A single charter vessel, the 14.6m MV Aurora, operated by Northern Coastal Charters and based in Port Douglas, offers regular shelling trips during the collecting season. The boat caters for up to 12 passengers on day trips and 10 on extended trips. Members of the Cairns shell club make regular use of this service. On occasions the boat has been booked by the club for an official club outing.

The number of recorded group shell collecting trips for 1984-1987 are summarized in Table 3 in which the reefs are listed north to south. It is noteworthy that this record, for the Cairns and Capricornia Sections, is post-zoning, such that some preferred sites in both sections are no longer open to shell collecting. For example: Upolo Cay, Michaelmas Cay and Low Isles in the Cairns Section, and Heron, Wreck and One Tree Islands in the Capricornia Section.

The most extensively collected area on record is the Cairns Section (Map 2), largely due to the location of the Charter vessel, MV Aurora, operated by Northern Coastal Charters and used by club members from Cairns and Townsville, plus interstate and overseas visitors, and local non-club collectors. During 1984 and 1985 most of the Aurora trips were single day trips at the cost of $25-30 per day, focussing on the most accessible reefs, Rudder, Undine, Mackay and Batt. Cairns club members ventured further north, to Evening, Pickersgill, Endeavour and Hope Island Reefs on a 4-day trip (cost, $180 per head)in September 1984.

TABLE 3: NUMBER OF RECORDED SHELL COLLECTING TRIPS ON THE GREAT BARRIER REEF, 1984-87.

		1984												1985												1986												1987													
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
Mid	14066																																											1								North	
Crescent	14082																																										1								FAR NORTHERN	
Snake	14087																																										1								SECTION	
Fly	14109																																									1									
Two Isles	15002																																										1									
Low Wooded Isles	15003																																		1																
Egret	15013																																										1									
Osterland	15078																																											1								
Emily	15082																																									1									
East Hope Island	15065								1																						2	1										2		1							
Endeavour	15089																														1	2												1							
Pickersgill	15093								1																						1	2										1									
Evening	15095								1																																											
Snapper Island	16006																																										1									
Mackay	16015		1	1	1		1								1	1															1	1	2	1	1							2	1	1							CAIRNS
Undine	16020		1	2	1	1	1								1	1															1	1	3	3								1	1								SECTION
Rudder	16023			3	2	2	1								1	2			2												1	2	2	2	1							1		1							
Batt	16029		1	2	1																																					1		1							
Saxon	16032																																																		
Hastings	16057																																										1								
Flynn	16065																								1		1	1	2	1										1			1	1	1	1						
Thetford	16068																														1											2	1	1							
Moore	16071																														1																			
Briggs	16074						1																																												
Howie	17018																														1																			
Peart	17024				1														1																																
Feather	17034				1											1	1	1														1	1	1								1								
Nathan	17035					1													1																																
Hall-Thompson	17037					1																																					1								
Otter	18018						1																																												
Barnett Patches	18019																		1																																
Little Trunk	18026						1												1														1																		
Kelso	18030						1																																												
Lodestone	18078																		1																																
Darley	19043						1																																												
Gould	19072																																1																		
Hook	19136																		1																																
Langford	20019																		1															1																	
Stevens	20294						1																																												
Wigton Island	20262						1																																												
Calder Island	20289																		1	1																																
Scawfell Island	20290																			1																																
Double Island	21034																														1											1									
Tryon Island	23046																				1											2	2	1	1									1							
North West I.	23049						1												1																																
Masthead Island	23069										1																																								
Boult	23079																																											1								
Hoskins	23080														1																												1								
Lady Musgrave I.	23082														1																1			1																South


MAP 2
CAIRNS SECTION
SITES VISITED BY SHELL COLLECTORS,
1984-1987
GREAT
BARRIER
REEF
MARINE
PARK
BOUNDARY
Crescent
Mid
Fly
Snake
Two Isles
Low Wooded Isles
Egret
Osterland
Emily
Hope I.
Endeavour
Pickersgill
Mackay
Undine
Rudder
Snapper I.
Wonga Bch
Cooya Bch
PORT DOUGLAS
Four Mile Bch
Yule Pt.
Batt
Saxon
Hastings
Flynn
Thetford
Moore
Briggs
CAIRNS
Howie
Peart
Feather
Nathan
Hall-Thompson
INNISFAIL
LEGEND
Island
Reef
0 10 20 30 40 50 kilometres

Rudder reef was shelled on at least eight occasions by groups of 8-12 people in 1984, and at least five times in 1985.

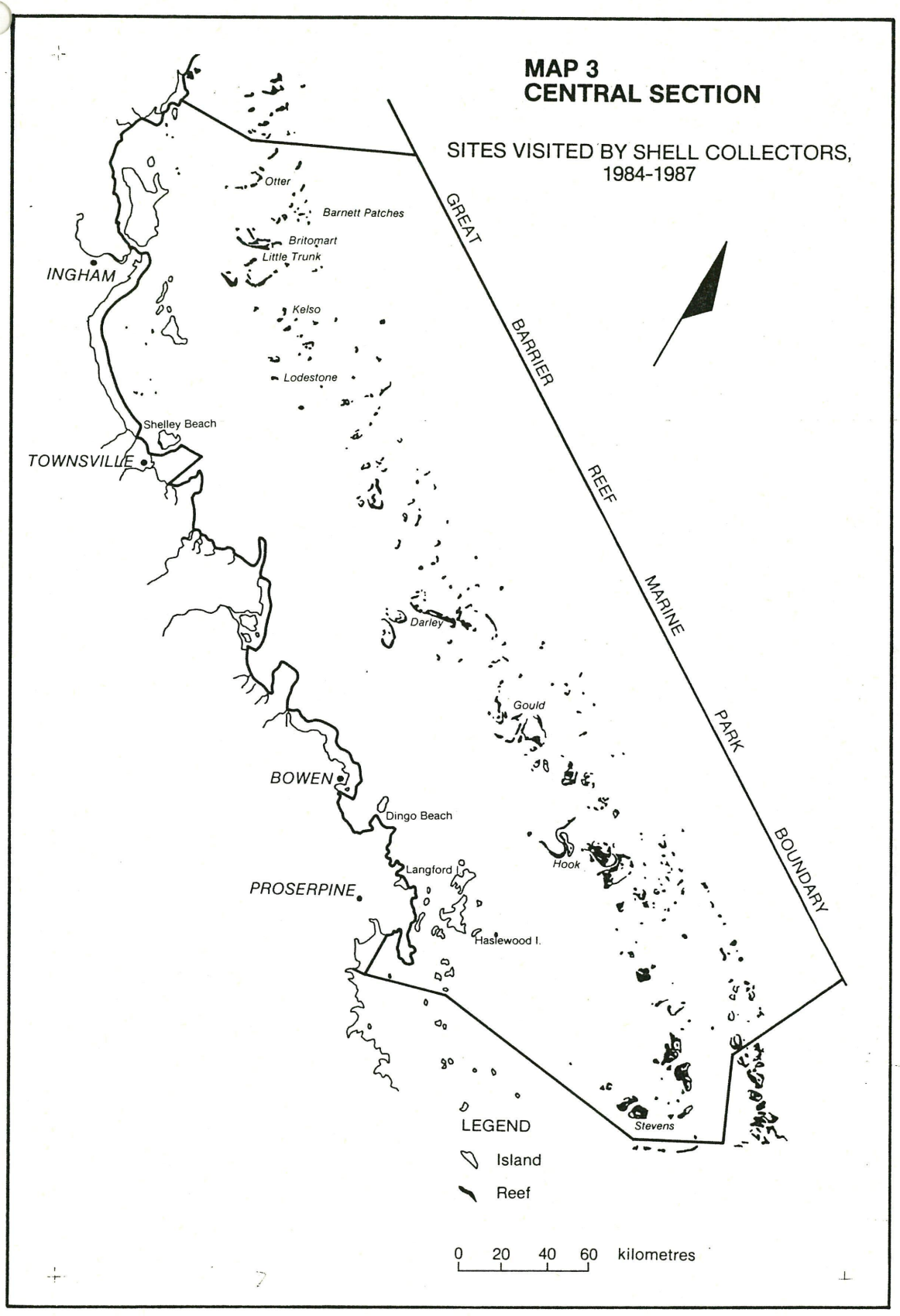
In 1986 Northern Coastal Charters ran regular day-trips to Rudder, Undine and Mackay Reefs, and two 3-day trips to take in Pickersgill and Endeavour Reefs and Hope Island, which was used as a camping base. Again, in 1986 recorded trips to Rudder and Undine Reefs totalled eight each, with six trips to Mackay Reef. In 1987 the charter operators, conscious of the pressures of frequent visits to nearby reefs, and motivated by the economies of extended trips, concentrated on 4-day trips for 12 people (cost, $220 per head), using Hope Island as a base camp. Two such trips were able to take in more northerly reefs, including Pickersgill, Endeavour, Emily and Osterland. The June charter, a private 7-day booking by six members of Cairns and Whitsunday shell clubs, extended their collecting into the Far Northern Section, on Mid, Crescent, Snake and Fly Reefs. The reefs of Two Isles and Snapper Island, and Egret Reef in the Cairns Section, were shelled also. Day trips in 1987 took shellers to Rudder and Batt Reefs, on two occasions each. On several occasions scheduled trips were cancelled on account of bad weather or insufficient bookings. The most productive reefs during this period were Osterland, Endeavour, Snake, Undine and Rudder Reefs. Collecting data is analysed in Section 5.2.

An additional trip to Hastings Reef, made by 14 members of the Cairns and Townsville shell clubs, chartered the Cairns-based vessel, Nance 'E' (cost $35 per head). In July 1987 a group of eight American divers chartered the Bali Hai II from Cairns to collect shells extensively on reefs north of Cairns, including Ribbon Nos. 3, 8, and 10, Pearl, Boulder, Two-Isles and Pickersgill, over a ten day period.

Coastal sites frequented regularly in the Cairns locality, by Cairns and Townsville club members, overseas visitors, tourists and locals are Wonga Beach, Cooya Beach (Mossman), Four-Mile Beach (Alexander Reef, Port Douglas), and Yule Point. Yorkeys Knob and the offshore Double Island are additional sites favoured by local shellers. A visit to Four-Mile Beach on two consecutive low tides in June, 1987 saw two active collectors on the reef flat on both days in a total of five people the first day and 14 the second. Wonga and Cooya Beaches were visited by four collectors each on the second day. At Wonga one couple were able to reach outer areas of exposed reef with a small dingy.

Reefs in the southern extreme of the Cairns Section and the Central Section (Map 3), generally further offshore than those to the north, have been used less extensively by members of the Innisfail and Towsville clubs. The Innisfail club plans day-trips annually to Feather, Nathan and Peart Reefs for 10-12 people (average cost, $30), though the lack of numbers in recent years has lead to frequent cancellations. Four such trips are recorded for 1984 and 1985, two for 1986 and none for 1987, though a collection return for 1987 indicated that at least one collector visited Feather Reef. Briggs, Hall-Thompson and Otter Reefs were visited also in 1984. The reefs off Innisfail were severely damaged by Cyclone Winifred in February 1986, resulting in poor shelling (ie. depleted mollusc populations) on Feather Reef in June and July of the same year.

Coastal collecting sites frequented by Innisfail club members are those of King Reef off Kurrimine Beach, and Clump Point. Both these sites suffered badly in Cyclone Winifred.


MAP 3
CENTRAL SECTION
SITES VISITED BY SHELL COLLECTORS,
1984-1987
GREAT
BARRIER
REEF
MARINE
PARK
BOUNDARY
Otter
Barnett Patches
Britomart
Little Trunk
INGHAM
Kelso
Lodestone
Shelley Beach
TOWNSVILLE
Darley
Gould
BOWEN
Dingo Beach
Langford
Hook
PROSERPINE
Haslewood I.
Stevens
LEGEND
Island
Reef
0 20 40 60 kilometres

The Townsville shell club plans a single 2 or 3-day trip annually, relying on the availability of local charter vessels and timed to coincide with the annual shell show. Thirteen collectors, the majority from Townsville, others from Mackay, Canberra and New Zealand, spent two days visiting Little Trunk and Kelso Reefs in 1984 (cost, $150); fourteen people shelled on Barnett Patches, Lodestone and Little Trunk Reefs in 1985 (cost, $140); and fourteen shellers spent two days at Little Trunk Reef in 1986 (cost, $140). The 19.5m vessel "Divemaster" was chartered for the trips in 1985 and 1986. The 3-day trip planned for three days in August 1987 on board the "Hero" was cancelled at short notice due to bad weather. Little Trunk Reef and Barnett Patches were to have been visited. Little Trunk Reef has therefore been a popular target site for this group, collecting being concentrated on a small, productive area which includes the sand cay on the southern point. Collecting can no longer take place on Barnett Patches, now zoned as Marine Park "A".

The Palm Island group is also a popular venue for local shell collectors with their own boats. Coastal sites frequented in the Townsville locality, mainly by local collectors, are Shelly Beach, Rowes Bay and Kissing Point. The zoning of Shelly Beach as Marine Park "A" saw the closure of this site to collecting after July 1987.

Additional collecting on nearby reefs is undertaken on a small scale by members of a Townsville diving club, the North Queensland Underwater Explorers Club. Approximately six members of the 50-strong club are keen shell collectors. The club trips average one weekend every two to three months. Popular destinations are the Palm Islands, Havanna Island and local reefs, Broadhurst, Davies, Chicken and Bowl, and Myrmidon further offshore. Davies and Myrmidon are now closed to shell collecting. A two-week trip by this club in October 1987 on board the "Takaroa", took divers to the outer reefs of Abington, Diamond Islet, Lihou, Willis Islet, Herald and Holmes, resulting in opportunistic shelling by most of the 12 participants and more serious collecting by four members. Three other diving clubs in Townsville are known to discourage the collection of live shell whilst on reef trips.

The Port Dennison shell club at Bowen advertised monthly reef trips during the shelling season though no record of the trips has been obtained. Gould and Darley Reefs were visited in mid 1984, and Hook Reef in 1985. Other popular collecting areas by members of this club in the past are Darley, Fairy, Seagull, Net, and Langford Reefs, Border Island, Butterfly and Mackerel Bays on Hook Island, and Haslewood Island. With the declaration of the Central Section of the Marine Park Hook, Langford and Haslewood Islands are zoned as Marine National Park "A" and Butterfly Bay as Marine National Park "B", therefore restricting shell collecting at these sites. The coastal sites frequented by Bowen shell collectors are Brisk Bay, Dalrymple Point and Dingo Beach.

The Proserpine Shell Club favours nearby coastal sites, a number of the members preferring to avoid the discomfort of boat trips. Dingo Beach, north of Proserpine, being an accessible area of local reef has attracted collectors from Queensland and interstate for over 30 years. Hideaway Bay, just to the north has recently become a popular alternative site. It is most likely that these sites, particularly Dingo Beach, were visited by collectors on every day-time low tide and many of the summer night low tides. Counts of shell collectors on the site were

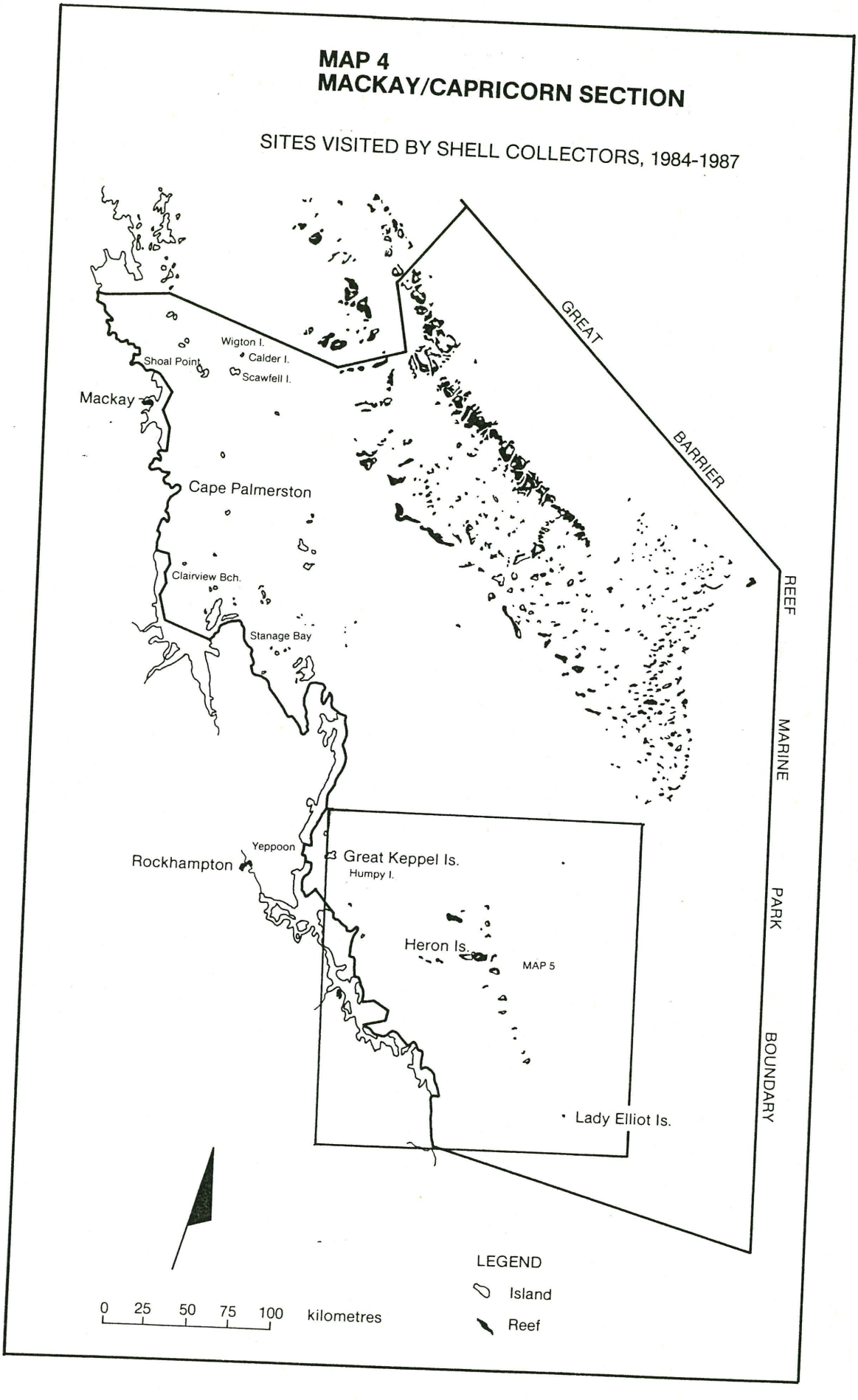
made on single days in May (16), June (25), July (18) and August (36) indicating regular heavy pressure on the area. Eight of the collectors counted in July and August were campers from interstate who were resident in caravans close to the beach for at least three months of the winter period, the prime objective being shell collection. Shell collectors from this area with their own boats have in the past collected around Gloucester Island, which is now zoned as Marine National Park "A".

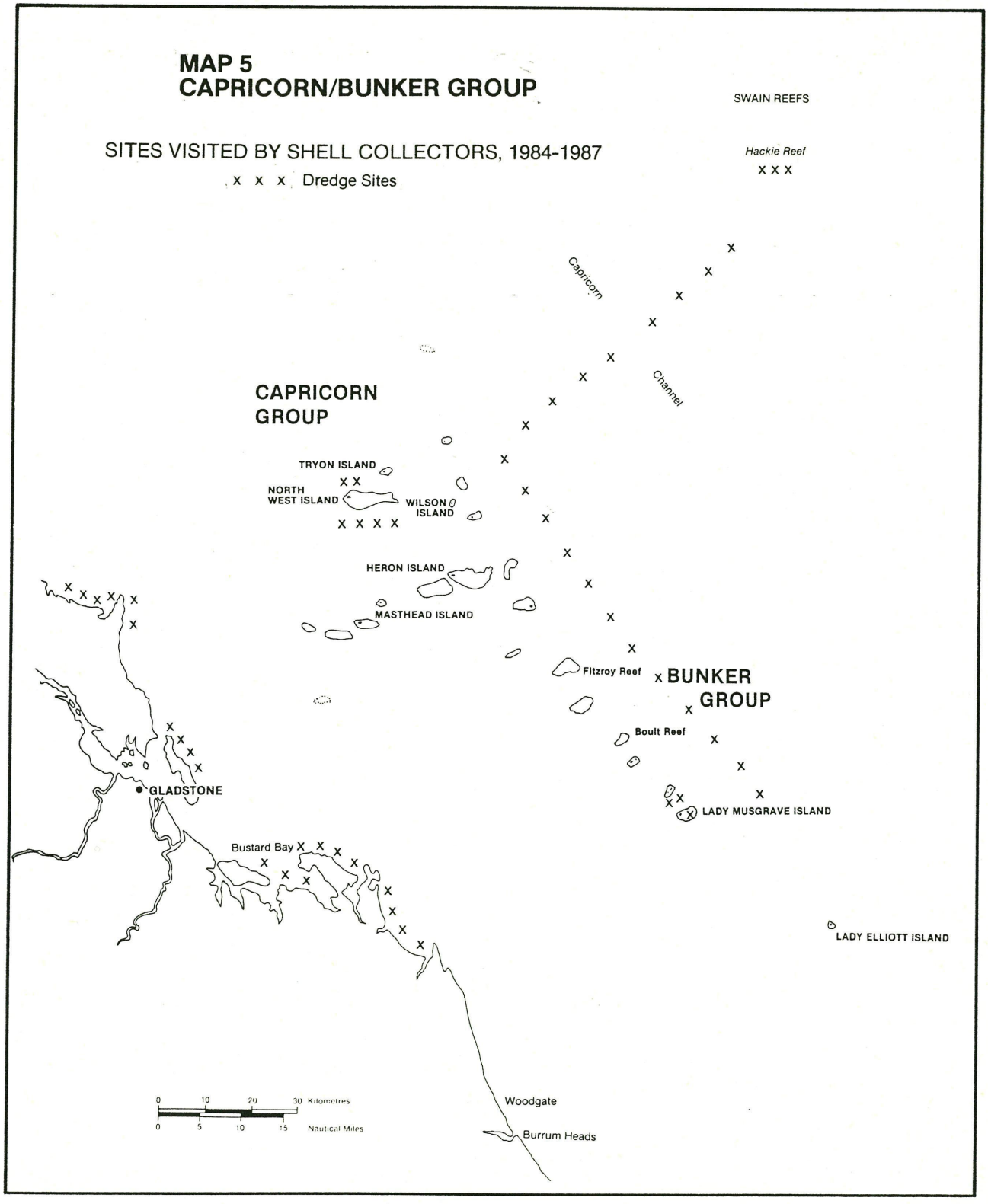
The Whitsunday shell club, based in Mackay, has run regular day trips to offshore islands during the shelling season, for groups of 10-20 shellers, using local charter vessels. A single trip in 1984 took 10 collectors to Wigden Island reef edge; three trips in 1985 involved ten club members at Calder Island and Stevens Reef, fourteen collectors at Langford Island (reef and sand bank) and 20 at Scawfell Island (reef and sand bars). Langford Island was visited again in 1986. Coastal collecting at Dingo Beach, Shoal Point and Clairview is an important activity of Whitsunday club members independent of organized club trips. Armstrong Beach, Seaforth and Shute Harbour are additional collecting sites.

Shoal Point and Clairview (Map 4) are also visited regularly by members of Keppel Bay, Port Curtis and Burnett shell groups. These club members tend to collect more independently than those from the northern clubs. Several collectors have their own vessels or good contacts with local trawlers with whom thay may arrange an occasional trip. The Keppel Bay shell club organizes an annual social outing/collecting trip to a local coastal collecting site, timed to coincide with the shell show. The same club, 25 years old in 1987, has had a long association with local trawlermen who have nurtured an interest in deep trawled shell (Section 3.4). During the 1960s and 1970s a number of expeditions were mounted to offshore Chesterfield and Saumarez Reefs in search of live specimens of Volutidae. More recently members of the Port Curtis and Burnett shell groups have pursued individual interests in the same volutes, with private expeditions to offshore reefs and those in the Swains group. The strong commitment to shell collecting by such people is evident in the personal costs involved. At least three members of each club have collected in recent years within the Capricorn/Bunker Group, the Swain Reefs and inshore (Map 5) using small dredges towed by their own boats.

The Keppel Islands and adjacent islands, offshore from Yeppoon, have been popular with shell collectors for many years. Humpy and Middle Islands are a source of melanistic and rostrate cowries which, though "freaks" in nature, are popular with shell collectors and hold their value accordingly. The proposed zoning for the western beaches of Great Keppel Island, expected to be effective in mid 1988, is Marine National Park "A", with Middle Island zoned as Marine National Park "B".

Traditional shell collecting sites in the Capricornia group are the camping islands, North West, Tryon and Wilson. Species records on these sites for the past 20 years have been made available by shell club members. From these island bases shell collectors had ready boat access to Bloomfield and Wreck Reefs. Masthead Island, the most accessible of the Capricorn Group, and the lagoon of Lady Musgrave Island are popular sites. Both islands are accessible by tourist boats operating out of Gladstone and are visited by large numbers of people annually. A new day-cruise, also operating out of Gladstone has the capacity to take large numbers of snorkellers and beach walkers to North


MAP 4
MACKAY/CAPRICORN SECTION
SITES VISITED BY SHELL COLLECTORS, 1984-1987
GREAT
BARRIER
REEF
MARINE
PARK
BOUNDARY
Wigton I.
Calder I.
Shoal Point
Scawfell I.
Mackay
Cape Palmerston
Clairview Bch.
Stanage Bay
Yeppoon
Rockhampton
Great Keppel Is.
Humpy I.
Heron Is.
MAP 5
Lady Elliot Is.
LEGEND
Island
Reef
0 25 50 75 100 kilometres


MAP 5
CAPRICORN/BUNKER GROUP
SITES VISITED BY SHELL COLLECTORS, 1984-1987
x x x Dredge Sites
SWAIN REEFS
Hackie Reef
x x x
Capricorn
Channel
CAPRICORN GROUP
TRYON ISLAND
NORTH WEST ISLAND
WILSON ISLAND
HERON ISLAND
MASTHEAD ISLAND
Fitzroy Reef
BUNKER GROUP
Boult Reef
LADY MUSGRAVE ISLAND
LADY ELLIOTT ISLAND
GLADSTONE
Bustard Bay
Woodgate
Burrum Heads
0 10 20 30 Kilometres
0 5 10 15 Nautical Miles

West Island, whilst plans are underway to take groups of up to 50 people to a barbecue site on Wilson Island on a regular basis.

Shell collecting has been restricted on the reefs of Heron Island and Wistari Reefs since their establishment as a Marine Park in 1975. The Capricornia Section was first zoned in 1981, with shell collecting restricted at Heron Island and Wistari Reefs (Marine National Park "A"), Llewllyn Reef (MNP "B"), One Tree Island (Scientific Research Zone) and Wreck Island (Preservation Zone). The introduction of the Southern Section zoning plan in mid 1988, which includes the Capricornia Section and the original Capricorn Section, as yet unmanaged, will see shell collectors affected by the "split zoning" of Tryon, North West, Masthead and Lady Musgrave Islands though most admit that favourite collecting sites are not included in the proposed Marine National Park "B" zones on each island. The greatest area of concern to collectors from the Port Curtis shell discussion group is the loss of Wilson Island as a camping site, and therefore a collecting site, through the leasing of the western portion of the island by the Queensland Government to the "P & O" company who own Heron Island Resort. The island itself, as a State National Park, is out of the hands of the GBRMPA.

4.2 Collecting Techniques

Most shell collecting undertaken in the Marine Park is intertidal and involves reef walking at periods of extreme low tide. Subtidal collecting by divers, although believed to occur less frequently, has involved the collection of considerable numbers of shells, particularly by overseas visitors (see section 5.1). Collecting by trawling and dredging occurs on a smaller scale.

Beach and reef walkers attempt to minimise equipment to allow mobility. Good reef walking shoes, a canvas bag or bucket (some use a glass-bottomed bucket for shallow water viewing), gloves, and probes (tongs, knife, fork) are considered essential items.

Coastal shelling involves considerable rock-turning and sand-probing in the intertidal zone. An experienced collector will upturn rocks and examine the undersurface, the crevices within the rocks and the substrate beneath the rock, using a gloved hand and a probing tool. The club collecting code insists that all upturned rocks are returned to their original position with extreme care in order to preserve the variety of animals found in this habitat. Numerous records of unreturned rocks have been received from upset shellers expressing concern that they will be blamed for the irresposible behaviour of ignorant or uncaring public.

Sand shelling is the least energetic type although collectors may be required to walk considerable distances to reach a productive sand bar (eg. Shelly Beach, Townsville). The richest rewards found on the low tide when bumps, cracks and trails in the sand provide clues to the presence of olives (Olividae), moon shells (Naticidae), strombs (Strombidae) and different bivalves. At the turn of the tide many buried shells become active and emerge suddenly from the sand, described as "popping" by collectors. Experienced shell collectors will avoid trampling the sand before the tide turns.

PLATE 2: COLLECTING TECHNIQUES AT DINGO BEACH

A. Collectors in search of Cypraea stolida f.brevidentata wade on a falling tide to maximise search time.

B. Rocks are lifted and returned on the exposed reef flat.

A

B

PLATE 3: COLLECTION OF SAND SHELLS

A. Sand shells are detected on the bars at Rudder Reef at the turn of the tide.

B. Sand shells collected include *Terebra* species and the volute, *Cymbiola rutila*.

A

B

Reef collecting occurs most commonly during the limited periods of extreme low tides during the winter months, when walkers can reach the exposed reef flats and sand bars for approximately three hours. This involves boat transport and wading amongst submerged coral in order to reach the reef on a falling tide. The glass-bottom bucket may be used whilst wading. A typical reef flat is divided into back reef/lagoon area with scattered bommies, soft corals and sand patches; a reef top with cemented coral slabs, coral rubble and small areas of living coral; and the seaward edge or rim of the fore reef characterised by live corals whose morphology can withstand the force of the waves. Some reefs support a sand cay, formed by the accumulation of coral and shell sand in the protected back reef zone. Each zone of the reef has its characteristic faunal assemblages which most shell collectors will be familiar with. When collecting on a reef with a coral cay this area is usually the last to be exploited. All shellers in a group will converge on the sand as the tide rises resulting in high pressure on a small area for a short period of time.

Sublittoral collecting, below the low tide level, is undertaken to a minor degree by reef walkers, wading with glass-bottom buckets. Snorkellers and SCUBA divers are able to explore deeper waters; SCUBA divers having the advantage of prolonged search periods and access to greater depths, submerged caves and recesses. Collecting techniques underwater are much the same as those on exposed reefs. Night diving is considered to be the most productive as many molluscs are active night feeders. Some spectacular finds of live volutes, Amoria canaliculata and Cymbiolacca thatcheri have been made by night divers on the outer Saumarez reefs (Byrne 1971, Weston 1978). Likewise, the Capricorn/Bunker islands have attracted divers in search of sand-dwelling volutes. There are very few divers at present among shell club members in Queensland.

Benthic collecting, the collection of shells from the sea floor, involves trawling and dredging. The majority of shells obtained in trawls in the Marine Park (with the exception of the commercially trawled scallops) represent by-catch of the prawn fishery. Shells are most likely to be taken in a beam trawl when the leading edge of the net is dragging on the sea floor, scooping up animals from the substrate. It is advantageous when targetting prawns to avoid catching the benthos and the added danger of snagging the nets on large objects motivates trawlermen to adjust their nets to fish as cleanly as possible. Several boats have modified their gear to use four nets instead of the traditional two, which also results in cleaner fishing. Of the small amount of shell material taken by trawlers operating out of Townsville (5-20 shells per one hour trawl) less than 5% is retained. The deep water trawlers from Bundaberg (12-15 of the total fleet of approximately 50), responding to the demands of the local shell collectors, are more inclined to retain all shells taken.

Dredging for shells has been a popular practice with collectors and trawlermen in the Yeppoon, Bundaberg and Gladstone area, resulting in some exciting finds from the Swain/Pompey reefs and the Chesterfield reefs in the Coral Sea. In the past a collector/dealer from Mossman dredged extensively amongst the reefs north of Cairns. A dredge is a small net attached to a square or rectangular frame, with a spiked lower edge designed to dig into the surface of the sea floor. Dredges are most effective when towed behind a boat over a sandy or muddy

substrate. Tows are usually of 10-20 minute duration, dependent on the catches. Occasionally a trawler will tow a dredge at the same time as a beam trawl in order to assess the benthos. Two known commercial shell collectors, one no longer operational, collecting from the southern and northern regions of the Marine Park, obtained most of their material with dredges towed by a trawler or small vessel. Small dredges have also been used by at least six shell club members in the Central Section, around the Palm Islands and Gloucester Island, and more extensively in the Southern Section, in the Swains, Capricorn Channel, Caricorn Islands and along the coast. The Port Curtis Shell Discussion Group has recently made an application to QNPWS and Qld DPI Fisheries Management to dredge within prescribed lagoons in the Capricorn Group, Fitzroy and Lady Musgrave in particular. It is anticipated that the application will be approved for use of the dredge, to conform to specifications in the Fisheries Act, by nominated club members on club outings, with the usual proviso of regular collection returns.

4.3 Processing Shells

The collection of a live shell necessitates removal of the soft body, cleaning the shell and labelling before it is to be included in a collection.

Various cleaning methods are used, depending on the type of shell and personal preferences. The simplest, and most unpleasant method is the rotting of the animal over a period of time. Shells are wrapped in tissue and enclosed in an airtight container and left for up to two weeks, after which the decomposed body is removed from the shell with tweezers, probes and a fine jet of water. Some collectors use a 50:50 mixture of methylated spirits and seawater to preserves shells after collection and remove the dead animal at a later date. The empty shell is then placed in a 50% bleach solution to remove the periostracum (eg. Conidae, Cymatiidae) and encrusting growths. Heavy encrustations are removed by scraping and picking with fine tools. Naturally glossy shells such as the Cypraeidae and the Olividae are not treated with bleach as it affects the shine.

Other cleaning methods include freezing, boiling, and microwave treatment. Fresh shells may be frozen and the body removed by the above method after slow thawing. Boiling of gastropods is less popular than in the past as it may cause crazing of the shells, though it is still used for easily removal of the flesh of bivalves. The microwaving technique is only successful on certain molluscs which separate from their shells during processing .

The cleaned and dried shells may be gently buffed or lightly oiled prior to cataloguing and inclusion into the collection. Details recorded on the labels include: identification and authority, date of collection, location and habitat.

4.4 Shell collections

The interest in shells, for many shell club members, originated with beach collections during childhood. With a growing interest collectors develop preferences for particular shell families and become more selective of quality shells. Some prefer to specialize in Australian representatives of chosen groups whilst a more extensive collection will include worldwide material

obtained through purchase and exchange. The questionaire response (3.1.1.3) indicated that more than half the participants chose to specialize in shells of the groups Cypraeidae, Fasciolariidae, Volutidae and Olividae, all of which are well represented on the Great Barrier Reef.

The limits of a collection are set by individual preferences, finances, access to shells, and time and space afforded by the collector.

Specimen shells are usually stored in taxonomic groups, in large shallow drawers and glass cabinets out of direct sunlight. The purists are particular in their choice of timber for storage cabinets as the natural acids in some materials are said to damage shells. Shells are best kept in conditions as dry and stable as possible to avoid the development of "Bynes' Disease", believed to be caused by a fungus which produces a dull bloom on shells, particularly cowies, and can spread rapidly through a collection.

Long-term and serious specimen shell collectors allocate a room, garage space or under-house area, the "Shell Room", to their hobby. A typical shell room would be lined with drawers and storage cabinets, with a work surface for shell processing, a small library of reference books, shell displays and shell artifacts indicative of the strong interest in conchology. The short-term collector or one with space limitations may choose to store the collection in small plastic bags, shoe-boxes and cartons. There are some extensive and impressive collections amongst Queensland shell collectors which include self-collected shells and material obtained through exchange and purchase. Those who have built up these collections have developed a considerable fund of knowledge, largely through their own collecting experiences, reading, and exchange of information through shell club activities.

A number of private collections accumulated by trawlermen and divers have also been viewed. On the whole these are restricted to self-collected shells, mostly showy specimens which are displayed in glass cabinets and shelves, the majority unlabelled.

5. RECREATIONAL SHELL COLLECTING PERMITS

The numbers of recreational shell collecting permits issued prior to February 1988 are summarized in Table 4.

In the total 469 permits issued since their introduction in 1982, shell collecting was covered by 319 (68.0%) in the Cairns Section, 200 (42.6%) in the Capricornia Section and 20 (4.3%) in the Far Northern Section.

Permits were initially issued for each trip for periods of one week to one month. In the 1984-85 period, and in subsequent years, permits were issued for the duration of a calender year. A permit may cover an individual, family or group. There is a tendency now for some families to apply for separate permits to cover each individual, to allow greater freedom of collecting. Approximately 1,300 people have been covered by all permits issued to date, many of these being repeat issues from year to year. Most of the group issues were made to schools, divers and "Adventure Holiday" groups camping on the Capricorn Island. The

TABLE 4 : RECREATIONAL SHELL COLLECTING PERMITS ISSUED 1981-88

YEAR	TOTAL	CAP	CNS	CNS/FN	CNS/CP	CNS/CP/FN	FN
1981-82	9	9	-	-	-	-	-
1982-83	10	10	-	-	-	-	-
1983-84	42	18	23	-	1	-	-
1984-85	71	30	31	-	10	-	-
1985-86	126	48	71	-	5	1	1
1986-87	99	13	64	7	7	7	-
1987-88	112	20	58	13	10	11	-
TOTAL	469	148	247	20	33	19	1

(CAP=CAPRICORNIA; CNS=CAIRNS; FN=FAR NORTHERN)

largest group catered for was that of 42 campers on North West Island, in the Capricorn Group. A summary of of 54 such permits issued to 465 campers between 1984 and 1986 is as follows:

	North West I.	Masthead I.	Lady Musgrave I.	Tryon I.
Permits	27	6	13	8
Nos.	252	23	115	75

The potential impact of shell collectors on the reefs surrounding the islands where camping is permitted is higher than on less accessible reefs. The camping numbers are limited by Queensland National Parks and Wildlife, to 150 on North West Island, 30 on Tryon Island, 50 on Lady Musgrave and, on Masthead Island, 30 during the bird breeding season between 1st October and 1st March, and 60 for the remainder of the year. Campers at these localities are largely unsupervised though the QNPWS Marine Park Rangers based at Heron Island maintain regular inspections.

The percentage of male versus female permit nominees is 62.2% and 37.8%, indicating that a greater number of men is involved.

5.1 Permit Returns, 1984-February 1988

Collecting returns were received from 91 permittees between 1984 and February 1988, representing a 19.4% compliance with permit requirements. Some returns include data for more than one date or locality, bringing the total actual returns to 221. Twelve returns are excluded from the analysis: two stated that no collecting had taken place in the permit period, the remaining 10 lacked sufficient detail. One significant return is also excluded from the data summary as collection data for at least eight different sites were amalgamated. Since it records the collection of large numbers of shells by a group of divers on reefs north of Cairns it will be considered separately.

Shell club members submitted 89.5% of the returns:

Cairns	144
Keppel Bay	13
Townsville	12
Innisfail	7
Brisbane	5
Port Curtis	3
Bundaberg	2
Whitsunday	1

The remainder record collecting by a dive club, Prodive (13), and 19 non-club members, two from overseas.

Collection localities in the Cairns, Central and Capricornia Sections, referred to in the returns are listed in Table 5, with the number of collection records.

The low number recorded for the Central Section is explained by the lack of permit requirement in this section prior to the declaration of the zoning plan in July 1987. The revised structure of the shell collecting permits in this section (no permits required for collection of less than five shells. per

TABLE 5: SHELL COLLECTING LOCALITIES, AND NUMBERS OF RECORDS, 1984-87

CAIRNS SECTION		CENTRAL SECTION		CAPRICORNIA SECTION	
Rudder	32	Dingo Beach	2	Tryon Island	8
Undine	26	Otter	1	North West I.	6
Flynn	20	Little Trunk	1	Masthead I.	5
Mackay	12	Kelso	1	Lady Musgrave I.	5
Hastings	11			Double Island	2
Pickersgill	10			Hoskins	2
Snapper I.	9			Scawfell	1
Endeavour	8			Half Moon Bay	1
Feather	7			Wilson Island	1
Thetford	6			Boult	1
Emily	5			Fitzroy	1
Batt	5			Lady Elliot I.	1
Osterland	4				
Yule Point	4				
King	2				
3 Wooded Is.	1				
Saxon	1				
Moore	1				
Briggs	1				
Hope Is.	1				
Nathan	1				
Hall-Thompson	1				

Summary:
Cairns Section: 168 collecting records over 22 sites.
Central Section: 5 records over 4 sites.
Capricornia Section: 34 records over 12 sites.

species) will result in the retrieval of only limited data in the future.

The data records the collection of 327 different species and subspecies, representing 56 different families. A total of 9304 live shells were removed on 209 occasions, on trips to 38 different sites in the Great Barrier Reef Marine Park. In some cases the collection of dead shells is also recorded, but the low numbers have not been included in this analysis. The additional record from a group of eight visiting divers from the USA who collected at more than six sites in the northern region of the Cairns Section, lists the removal of 3205 shells (325 species), 25% of all collection records.

In summary: the permit returns record the collection of over 12,000 live shells from reefs of the Great Barrier Reef Marine Park since 1984, undertaken by 19.4% of all permit holders. The collection figures will be treated as an underestimate of the collecting by all respondents, the tendency being to moderate the numbers declared. The data does not include all collecting undertaken in the Central Section during this period. The majority of respondents are members of Queensland shell clubs; the data therefore excludes any record of shells collected by casual and commercial collectors and those taken by persons failing to fulfill the conditions of their permit.

5.2 Collection data

The 40 mollusc species most commonly collected by the permit respondents are listed in Table 6. The data are summarized for all sections, and broken down into lists for each of the Cairns, Central and Capricornia Sections.

The results indicate that the most important self-collected shells are in the families Cypraeidae and Conidae, with the Strombidae and Olividae as popular groups. Other families represented at high levels are the Ovulidae, Mitridae, Terebridae, Vasidae, and Ceriithidae.

The species composition of shells collected in each section is largely a function of availability. This, to a degree, governs the interests of shell collectors at each locality. Particularly significant is the prominence of the family Cypraeidae, the cowries, in Capricornia collected shells. Twenty-two of the 40 species listed are from this family. The principal collecting sites from which these were recorded are the camping islands of Tryon, North West, Masthead and Lady Musgrave, the reefs of which are noted for their diverse Cypraeid fauna. At least 76 different species of Cypraea have been recorded from the Great Barrier Reef Marine Park, 51 of which are known to have occurred in the Capricornia Section. Several species are found regularly as melanistic and rostrate forms in this area which is an added attraction to collectors.

Listed in the three separate sections are 83 different species, of which 76 are molluscs having an Indo-Pacific distribution, and considered common species on the Great Barrier Reef (Wilson and Gillett 1974, Burgess 1985). The remaining 7 (underlined) are uncommon or are endemic to East Australia. A "Rarity Rating", on a scale of 1-20 (the rarest), has been developed for Cypraea species by Burgess (1985), described further in Section 6.2.4.

TABLE 6: MOST HEAVILY COLLECTED MOLLUSC SPECIES ON THE GREAT BARRIER REEF, RECORDED BY PERMIT HOLDERS, 1984-87.

	ALL SECTIONS	Total	CAIRNS SECTION	Total	CENTRAL SECTION	Total	CAPRICORNIA SECTON	
1.	Lambis lambis LINN.	496	Lambis lambis LINN.	473	Strombus luhuanus LINN.	19	Cypraea arabica LINN.	152
2.	Cypraea annulus LINN.	300	Conus marmoreus LINN.	282	Terebra chlorata LAMARCK	18	Cypraea annulus LINN.	119
3.	Cypraea arabica LINN.	299	Strombus luhuanus LINN.	201	Conus flavidus LAMARCK	12	Cypraea moneta LINN.	65
4.	Conus marmoreus LINN.	291	Oliva miniacea RODING	200	Conus litteratus LINN.	12	Conus ebraeus LINN.	51
5.	Strombus luhuanus LINN.	220	Cypraea annulus LINN.	180	Cerithium nodulosum BRUG.	11	Cypraea erosa LINN.	51
6.	Oliva miniacea RODING	210	Conus litteratus LINN.	177	Cypraea moneta LINN.	10	Cypraea cribraria LINN.	45
7.	Conus litteratus LINN.	191	Oliva tessellata LAMARCK	159	Cypraea stolida LINN.	10	Cypraea felina GMELIN.	43
8.	Cypraea vitellus LINN.	160	Cypraea arabica LINN.	142	Oliva miniacea RODING	10	Strombus aratrum RODING	40
9.	Oliva tessellata LAM.	159	Ovula ovum GMELIN	121	Cypraea caurica LINN.	9	Cypraea vitellus LINN.	38
10.	Cypraea moneta LINN.	156	Vasum turbinellum LINN.	113	Cypraea lynx LINN.	8	Cypraea tigris LINN.	36
11.	Cypraea erosa LINN.	139	Mitra mitra LINN.	111	Conus marmoreus LINN.	8	Cypraea errones LINN.	30
12.	Conus textile LINN.	130	Cypraea vitellus LINN.	106	Conus textile LINN.	7	Cypraea caurica LINN.	28
13.	Cypraea lynx LINN.	124	Cypraea lynx LINN.	106	Cypraea cribraria LINN.	7	Conus catus HWASS	25
14.	Ovula ovum GMELIN	123	Conus textile LYNN.	102	Cypraea erosa LINN.	7	Conus textile LINN.	20
15.	Mitra mitra LINN.	122	Conus arenatus HWASS	101	Conus leopardus LINN.	7	Oliva oliva LINN.	20
16.	Vasum turbinellum LINN.	121	Terebra maculata LINN.	94	Conus miliaris HWASS	7	Cymbiolacca pulchra SOW.	17
17.	Conus ebraeus LINN.	120	Conus flavidus LAMARCK	91	Conus virgo LINN.	7	Lambis lambis LINN.	17
18.	Conus flavidus LAMARCK	117	Cypraea erosa LINN.	81	Turbo chrysostoma LINN.	7	Cypraea asellus LINN.	16
19.	Conus arenatus HWASS	108	Cerithium fasciatum BRUG.	80	Cypraea vitellus LINN.	6	Cypraea carneola LINN.	16
20.	Cypraea tigris LINN.	104	Cypraea moneta LINN.	80	Drupina grossularia RODING	6	Cypraea hammondae IREDALE	16
21.	Terebra maculata LINN.	97	Cypraea isabella LINN.	79	Lambis lambis LINN.	6	Cypraea melwardi IREDALE	16
22.	Cypraea isabella LINN.	93	Turbo chrysostoma LINN.	79	Trochus maculatus LINN.	6	Conus miliaris HWASS	15
23.	Conus leopardus RODING	88	Conus leopardus RODING	78	Turbo argyrostomus LINN.	5	Cypraea staphylaea LINN.	15
24.	Cypraea caurica LINN.	87	Trivirostra oryza LAM.	73	Cypraea arabica LINN.	5	Cypraea clandestina LINN.	14
25.	Turbo chrysostoma LINN.	86	Calpurnus verrucosus LINN.	71	Cypraea felina GMELIN	5	Conus coronatus GMELIN	14
26.	Cypraea errones LINN.	83	Conus miles LINN.	69	Cypraea gracilis GASKOIN	5	Conus flavidus LAMARCK	14
27.	Cerithium fasciatum BRU.	80	Conus ebraeus LINN.	68	Cypraea isabella LINN.	5	Cypraea eglantina DUCLOS	10
28.	Cerithium nodulosum BRU.	80	Cypraea tigris LINN.	65	Conus omaria HWASS	5	Cypraea lynx LINN.	10
29.	Terebra chlorata LAM.	76	Cerithium nodulosum BRUG.	63	Conus planorbis BORN	5	Cypraea isabella LINN.	9
30.	Trivirostra oryza LAM.	76	Conus virgo LINN.	60	Oliva annulata GMELIN	5	Cypraea kieneri HIDALGO	8
31.	Conus miles LINN.	75	Terebra chlorata LAMARCK	56	Trochus niloticus LINN.	5	Conus virgo LINN.	8
32.	Calpurnus verrucosus L.	74	Conus quercinus LIGHTFOOT	55	Conus arenatus HWASS	4	Haliotis asinina LINN.	8
33.	Conus lividus HWASS	67	Conus capitaneus LINN.	54	Cypraea asellus LINN.	4	Lambis truncata KIENER	8
34.	Cypraea cribraria LINN.	66	Terebra dimidiata LINN.	53	Conus aulicus LINN.	4	Pyrene testudinaria LINK	8
35.	Conus capitaneus LINN.	62	Cyp.caputserpentis LINN.	51	Cypraea eglantina DUCLOS	4	Rhino. brettinghami CERN.	8
36.	Cyp.caputserpentis LINN.	60	Cypraea caurica LINN.	50	Conus glans HWASS	4	Rhinoclavis asper LINN.	7
37.	Cypraea carneola LINN.	56	Conus striatus LINN.	49	Conus miles LINN.	4	Conus capitaneus LINN.	7
38.	Terebra dimidiata LINN.	56	Conus eburneus HWASS	48	Conus vitulinus HWASS	4	Cyp.caputserpentis LINN.	7
39.	Cypraea felina GMELIN	55	Trochus niloticus LINN.	47	Lambis truncata KIENER	4	Conus frigidus REEVE	7
40.	Strombus aratrum RODING	52	Vasum ceramicum LINN.	40	Lambis chiragra LINN.	4	Cypraea minoridens MELVILL	7

PLATE 4: MOST HEAVILY COLLECTED SHELLS ON THE GREAT BARRIER REEF PART A.

1. Conus textile Linnaeus, 1758; Indo-Pacific.
2. Conus litteratus Linnaeus, 1758; Indo-Pacific.
3. Conus marmoreus Linnaeus, 1758; Indo-Pacific.
4. Mitra mitra (Linnaeus, 1758); Indo-Pacific.
5. Lambis lambis (Linnaeus, 1758); Indo-Pacific.
6. Oliva miniacea (Roding, 1798); ;Tropical Indo-Pacific.
7. Conus flavidus Lamarck, 1810; Tropical Indo-Pacific.
8. Conus ebraeus Linnaeus, 1758; Indo-Pacific.
9. Vasum turbinellum (Linnaeus, 1758); Tropical Indo-Pacific
10. Strombus luhuanus (Linnaeus, 1758); Western Pacific

Scale = 5cm

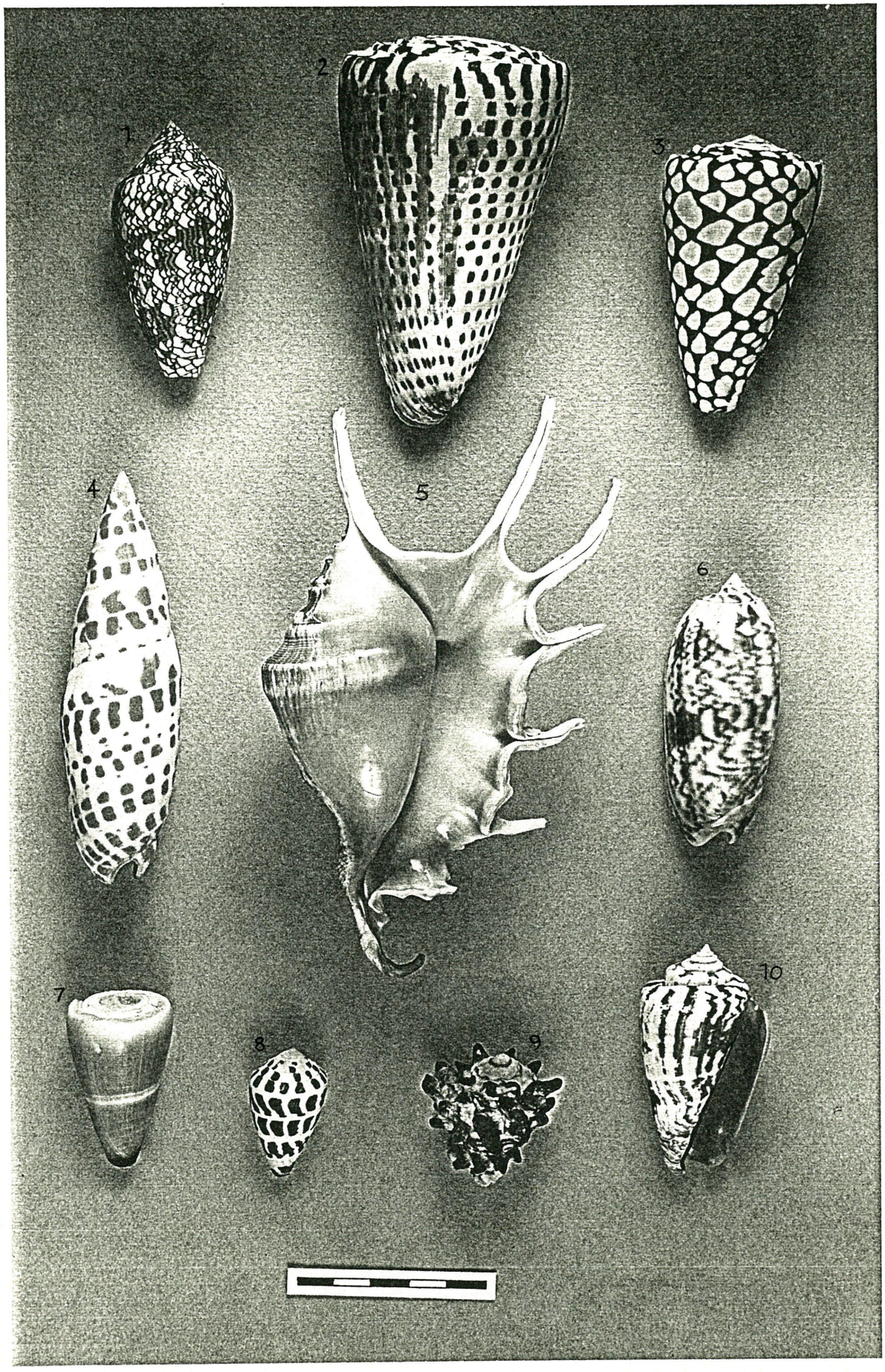

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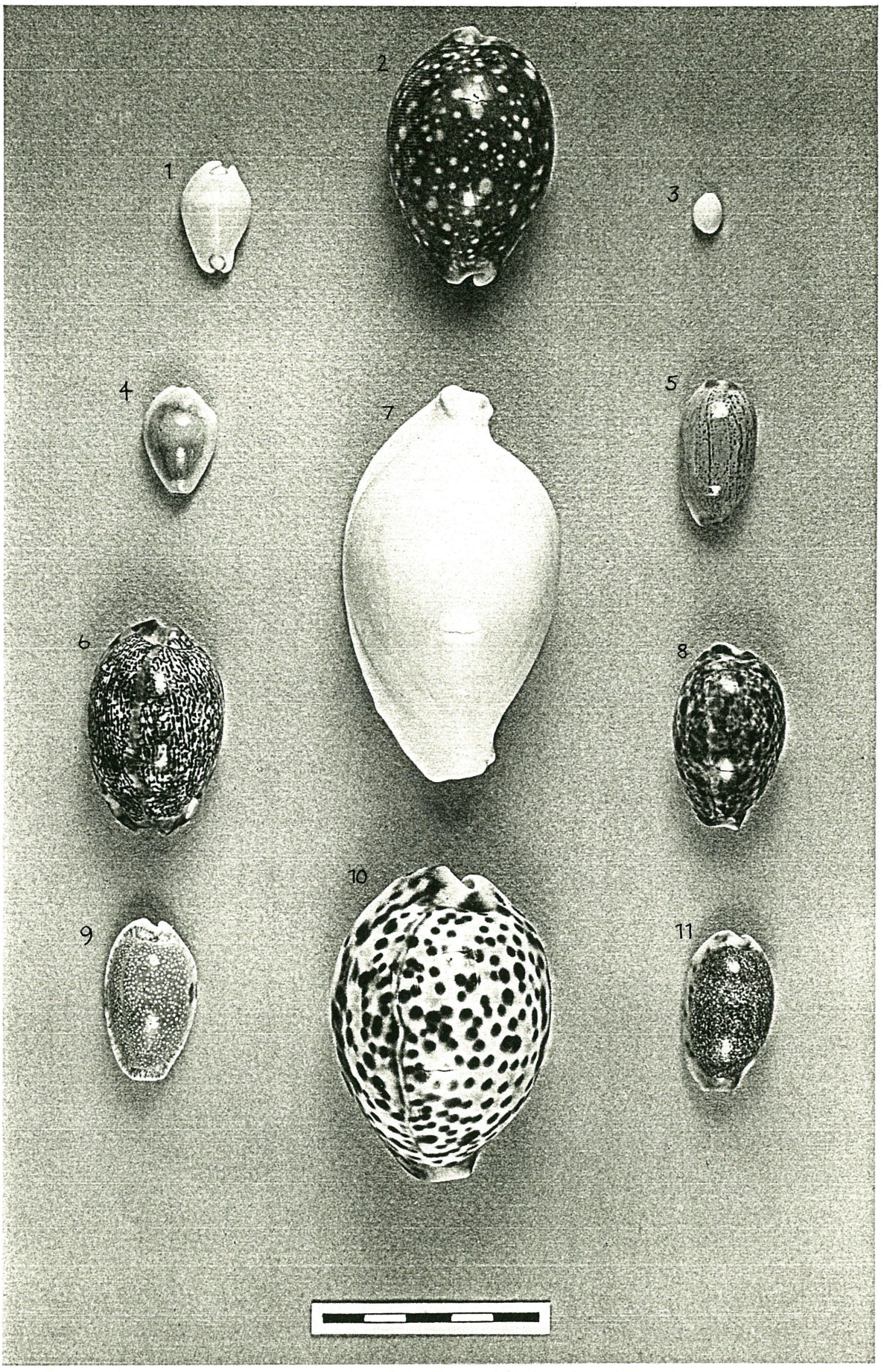
PLATE 5: MOST HEAVILY COLLECTED SHELLS ON THE GREAT BARRIER REEF, PART B.

1. *Calpurnus verrucosus* (Linnaeus, 1758); Indo-Pacific.
2. *Cypraea vitellus* Linnaeus, 1758; Indo-Pacific.
3. *Trivrostra oryza* Lamarck, 1810; Indo-Pacific.
4. *Cypraea moneta* Linnaeus, 1758; Indo-Pacific.
5. *Cypraea isabella* Linnaeus, 1758; Indo-Pacific.
6. *Cypraea arabica* Linnaeus, 1758; Indo-Pacific.
7. *Ovula ovum* (Linnaeus, 1758); Indo-Pacific.
8. *Cypraea lynx* Linnaeus, 1758; Indo-Pacific.
9. *Cypraea erosa* Linnaeus, 1758; Indo-Pacific.
10. *Cypraea tigris* Linnaeus, 1758; Indo-Pacific.
11. *Cypraea caurica* Linnaeus, 1758; Indo-Pacific.

Scale = 5cm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The ratings ( ) are given below:

CYPRAEIDAE	Cypraea cribraria Linnaeus, 1758 (10)
	Cypraea melwardi Iredale, 1930 (>10)
	Cypraea hammondae Iredale, 1939 (10)
	Cypraea minoridens Melvill 1901 (10)
	Cypraea stolida Linnaeus, 1758 (10)
CONIDAE	Conus omaria Hwass 1792
VOLUTIDAE	Cymbiolacca pulchra (Sowerby, 1825)

The only volute represented on these lists is Cymbiolacca pulchra, an endemic shell restricted to Central and Southern Queensland, which occurs in a number of local forms around the Capricorn Islands, all much sought-after by collectors who would need to snorkel, dive or dredge the obtain them. Though not included in the three lists two additional volutes, also endemic to Queensland, have been collected on exposed reefs in the Cairns and Central Sections. Twenty seven specimens of Cymbiola rutila (Broderip, 1826) and 23 Amoria maculata (Swainson, 1822) have been taken.

One endemic cowrie is included in the Capricornia list: Cypraea cribraria melwardi Iredale, 1930, confined to Queesland, is regarded as an uncommon subspecies or white form of Cypraea cribraria Linnaeus, 1758, an Indo-Pacific shell. C.cribraria, though more common in occurrence, is no less popular with collectors.

The remaining four species of Cypraeidae and single cone species are described as "uncommon" by Wilson and Gillett 1982, and rated as 10 and >10 by Burgess, 1985.

For all seven species, their uncommon status and endemicity make them popular targets for collectors and numbers recorded as collected here may be taken as an indication of the total numbers observed by the collectors involved.

5.3 Collection versus availability

The records of numbers of shells collected is only meaningful when related to the estimated availability of the shells at the collection site. Collection figures are also related to the number of collectors present and their level of experience.

Three reef collecting trips were made with club members from Cairns and Townsville, non-club members and overseas visitors, in 1986 and 1987, in which rough estimates of shell collection versus abundance were made. A further 3-day trip destined for reefs off Townsville, on which more detailed abundance estimates were to be made, was cancelled at short notice due to bad weather.

Summary of trip details:

Date	Destination	Shellers	Spp. collected	Total shells
24/May/86	Inner Rudder Reef	12	67	190
15/Aug/86	Little Trunk Reef	12	82	250
07/Sep/87	Inner Rudder Reef	8	39	153

The destinations, the western extreme of Inner Rudder reef and the southern extreme of Little Trunk reef, both with a small sand cay, have been identified as productive sites on previous collecting trips. Rudder reef has the highest record of collecting trips in the period of 1984-87.

In May 1986, 12 shellers, most of whom were experienced, worked within an estimated area of 1.5 km (reef top, fore-reef, back-reef, sand cay), 8% of the total reef, in 3.5 hours. Of the 67 species taken the Conidae (15) and Cypraeidae (8) were the most popular groups. On the second trip to Inner Rudder (September, 1987) the eight collectors which included three club members and two overseas visitors, was relatively inexperienced. On this occasion the 39 species (153 shells) collected included four Cypraeidae (4), Conidae (4), Strombidae (5) and Volutidae (1). The trip to Little Trunk reef in August, 1986, was conducted by a group of 11 experienced and one inexperienced collectors. In an estimated area of 1.75 m (6.5% of the total reef), covered in three hours, 82 species (250 shells), including Cypraeidae (21), Conidae (20), Strombidae (6), Trochidae (5), Fasciolariidae (5), Terebridae (3), and Volutidae (1) were collected.

On each occasion the shellers were dropped off in the back-reef area on a falling tide as the reef top was emerging. Most collectors were inclined to make their way slowly towards the reef crest, returning to the sand bar or cay at the turn of the tide. During most of the collecting period shellers were widely dispersed. However, there is a tendency to converge on the restricted area of sand during the latter stages such that sand shells (Olividae, Terebridae, Ceriithidae and Volutidae) are heavily exploited.

The most heavily collected shells on the first trip to Rudder were the spider shell Lambis lambis (17), the cerith Rhinoclavis fasciatus (10) and the cone Conus marmoreus (9). Estimates of the numbers of C.marmoreus and L.lambis on the reef top were one per eight square metres. Extending the estimates to an area of 1000m of reef top covered one can extrapolate that less than 13.6% of the population of L.lambis, and <8% of the population of C.marmoreus was removed from the area sampled. Both species are popular with collectors and tourists and can be readily exchanged, hence the tendency to take surplus specimens. In contrast, shells such as the cerithiid, Rhinoclavis asper, and the turban shell, Turbo chrysostomus, which may be present in similar numbers, attract less attention.

The greatest impact is felt on shells which are popular as a result of their rarity. For example, the only Volutidae available on the reef tops of the northern reefs are Aulicina rutila, Amoria maculata and Melo amphora. On the trip to Rudder in May, 1986, three A.rutila (two dead) and six A.maculata (five dead) were collected. At the same site in September, 1987 three A.rutila (one dead) were taken. At Little Trunk reef, in August 1986, five A.rutila (two dead), two A.maculata and one M.amphora were taken. The demand for these species is such that the numbers of shells collected, including dead specimens, represents all of those sighted during the three trips (with the exception of one A.rutila observed laying eggs which was not disturbed). Similarly, the numbers of Cypraea cribraria (5), C.stolida (5), C.felina (5), C.isabella (5), C.talpa (3), C.punctata (3), C.brevidentata (1) and C.quadrimaculata (1) represented all specimens of these species seen at Little Trunk reef. The numbers of Conus species, C.textile (4), C.aulicus

(4), C.imperialis (3), and C.striatus (1) would also be indicative of the totals of the species encountered on Little Bank reef.

These figures give an indication that the availability of some species at each collecting site is such that all specimens of the species sighted will be taken. The demand of shells is directly related to their availability at each site. The impact of collecting upon a given population will be greater on the less common species since a higher percentage of the total will be removed. The sites most susceptable to overcollection are those where collecting will be concentrated on a confined area, in which the area searched represents a high percentage of the total ground area.

6. IMPACT OF SHELL COLLECTING

Catterall and Poiner (1986) isolated a number of important ethnographic (related to exploitation technique) and biological determinants of the consequenses of the effects of human gathering on marine mollusc species. Their work was based on traditional techniques employed by Australian Aborigines and the natives of Papua New Guinea. The same parameters can be applied in an assessment of the potential impact of specimen shell collecting on the Great Barrier Reef.

6.1 Ethnographic factors:

6.1.1 Collector numbers

The group size on an organized collecting trip is limited by the capacity of the boat used to transport collectors to the reef site. On average, 12 people will collect over an estimated area of 1.5 square kilometres of exposed reef in a period of 3 hours. For six months of the year, during a 3 to 5-day period the northern reefs are accessible to reef walkers. Additional to the tidal limitations are those imposed by the cost of boat hire and poor weather.

The same limitations are less likely to apply to accessible island and coastal sites with camping facilities, where large numbers of people can reach the exposed reef flats at every opportunity, day or night. The impact of collecting will be greatest at these areas, for example, North-West, Tryon, Lady Musgrave and Masthead Islands, and coastal sites of Four-Mile, Kurrimine, Dingo and Clairview Beaches.

6.1.2 Techniques employed

Most collecting is done by hand or using a small digging tool, which has a minimal effect on the habitat, provided upturned rocks are returned with care. Dredging and trawling are less selective processes and are more likely to cause habitat disturbance, to the detriment of the fauna. There is no shortage of anecdotal evidence from trawlermen and shell collectors of the detrimental impact of trawling on offshore mollusc populations. The decline of the scallop fishery in southern Queensland is an example of depletion of mollusc populations through overfishing and disturbance of the benthos.

6.1.3 Size-selectiveness

Continual removal of immature and sub-adult shells before they have contributed reproductively will lead to depletion of the resource. The decline of both the scallop and trochus fisheries has been attributed in part to this factor (Nash 1985, Dredge 1987) and management proposals for the fisheries place emphasis on the need for revised minimum size limits (Nash 1985, Harper 1988). Recreational shell collectors are aware of the need to leave juvenile shells though the criteria used to identify adults of different species may not be reliable. The general rules of thickened lips, well-developed apertural teeth or spines, and thickened shells are based on fragmented biological information, seemingly overgeneralised for all species.

6.1.4 Commercial and private collection

The scale of collection varies according to the individual interests of the collectors, the size of their collection and the level of exchange and resale intended. Collectors become more selective with the development of their collections. Many collectors will admit to excessive collecting in previous years. The higher levels of collecting, likely to have the greatest impact on shell populations, are undertaken by collectors with commercial intent. Most club collectors take a few extra shells with a view to exchange material; a small number of club members regularly collect excessively to supplement low incomes; others have exploited shells encountered in large aggregations by collecting excessive numbers; interstate visitors (at least six couples per season at Dingo Beach) gather large numbers of shells to sell on return to the southern states to offset holiday costs; two known dealers, only one of whom has a current commercial collecting licence, collect with a dredge and SCUBA gear around the Capricornia Islands and at Dingo Beach. The collection by groups of overseas visitors, observed and recorded at reefs north of Cairns is on a considerably larger scale than that of local collectors. These collectors seek to maximise the returns from a rare collecting opportunity. The collecting, therefore, of those with commercial intent, and that of groups of non-local collectors is potentially more detrimental than that of the conservative club collector and the casual collector.

6.1.5 Natural history knowledge

Very few epifaunal shells on an exposed reef flat are protected from an experienced collector with the intention of finding as much as possible. Collectors with a good knowledge of the natural history of the shells sought, and familiarity with the area under scrutiny will have an advantage over the inexperienced or casual collector. The committed collector, therefore, could have a greater impact on the populations of rare or well concealed shells than the casual collector or one new to shell collecting.

6.2 Biological factors

6.2.1 Natural history

Major aspects of the life history of an organism include the growth rate, age and size at maturity, sexual differences, reproduction, longevity and larval duration. Each mollusc species possesses unique features, though those of the same

family group often have much in common. The knowledge of the life history of the shells found on the Great Barrier Reef is fragmentary and includes reproductive studies on Hawaiian Cypraeidae and Conidae (Ostergaard 1950), ecological studies on the red-lipped stromb, Strombus luhuanus, (Catterall and Poiner 1984, 1987, Ritchie 1986), growth studies of Heron Island Conidae and Cypraeidae (Frank 1969) and detailed studies of the commercial species, Trochus niloticus (Nash 1985, Honma 1987), the tridacnid clams, summarised in Munro and Nash, 1986.

It has generally been considered that reproductive and growth rates increase with temperature increase and that tropical species are short-lived compared with temperate species (Frank, 1969). However, findings on the growth and reproduction of Heron Island gastropods, lead Frank to postulate that turnover rates on a coral reef are low and longevity high. Gastropods with determinate growth cease growing once they are reproductively mature and maximum size is reached. Subsequent growth is then confined to thickening of the shell or the lip (Strombiidae, Olividae) , and/or development of the apertural teeth (Cypraeidae). As juveniles some of these shells are quite distinct from the adult; for example the Cypraeidae and Olividae have a thin-shelled "bulla" stage and the stromb, Lambis lambis, is without its distinctive spines. Once the gonads of a mollusc are mature the shell is capable of reproducing. Other groups have continuous growth and may gradually increase in size all their life. Shells of the families Muricidae and Cymatiidae, which grow continuously are believed to increase in size in a series of growth periods which give the shells their distinctive appearance of a series of ridges and spines, evidence of earlier thickened lips. The maturity of such shells, when found during the growth stage with a fragile lip, will therefore be hard to determine using the collectors' criteria. It cannot be assumed, therefore, that a small muricid or cymatid is mature on the basis of its thickened lip.

Shell collectors assess that collection of a shell with mature features, irrespective of its size, is "moral" since the shell has had an opportunity to contribute to the next generation. An important ommission from this line of thought is the significance of the contribution. The fecundity of a mollusc is unlikely to be at its maximum in the first years of maturation; the reproductive contribution would therefore be insignificant. Such reasoning is the basis for increasing the size limit on the trochus shell, Trochus niloticus, as proposed by Nash (1985) after studying the relative fecundity of mature animals of increasing size. Shell collectors should set size limits above the size at first maturity, where known, to ensure that an adequate proportion of those remaining have active gonads. The fecundity at first maturity is low and increases in subsequent years. To a degree this is considered by rejection of shells with scars and breakages, but the collection of unconfirmed "dwarf forms" should be discouraged.

Reef gastropods may not mature as early as expected by some shell collectors who assume that recruitment occurs annually and maturation takes place within the first year. It has been inferred by those with this belief that, provided there are sufficient shells remaining at a site to breed during the summer months when collecting pressures are low, there will be ample material for collection during the following winter. The common and heavily collected stromb, Strombus luhuanus does not mature until its second year (18-24 months) (Ritchie 1986). The same

time period could be inferred for a second stromb, Strombus campbelli, commonly collected in a similar environment at Dingo Beach. Over the past two years collectors have observed and collected greater numbers of small adult S.campbelli at this site, referring to them as a "dwarf form" and thus increasing their desirability. A more acceptable explanation is that these are "sub adults", more apparent due to the removal of a large percentage of the adult population, which have not yet reached their peak breeding potential.

Reproduction in molluscs takes a variety of forms. Some marine molluscs occur as separate sexes which release eggs or sperm directly into the water for external fertilization. In such species fecundity is high (ie. large numbers of eggs are produced) and adults often congregate to breed. The successfully fertilized eggs develop into a free-swimming larvae which spend a period of time in the plankton before settling and developing into a benthic juvenile. This form of reproduction occurs in abalones (eg. Haliotis asinina) and limpets.

Many gastropod species are seasonal in their reproduction, as are other reef organisms, responding to temperature increase and day-length as triggers to the development and release of eggs and sperm. The development of more than one brood per season (iteroparity) is favoured under conditions where spawning success is highly variable and has been observed in Conus flavidus (Frank 1969) and Trochus niloticus (Nash 1985).

The popularly collected mollusc families, most of which reproduce by internal fertilization, display a variety of mechanisms: the Cypraeidae lay circular or oblong egg masses in crevices, under rocks and empty bivalve shells. Each egg mass consists of several hundred capsules which, themselves, house hundreds of eggs. Ostergaard (1950) counted 100 capsules, each with 200 eggs, laid by Cypraea caputserpentis a small cowrie found on the exposed reef edge. Other figures include: Cypraea carneola (1000 eggs), C.isabella (1500 eggs), and C.helvola (1000) eggs. Eggs were observed to hatch as free-swimming veliger larvae within three to fourteen days, during which the females of some species brood the eggs. The veliger period is believed to be no more than a few days (Wilson and Gillett, 1974).

Members of the Conidae vary in their breeding habits. Eggs are laid in flask-shaped capsules, in lower numbers than the Cypraeidae. Ostergaard (1950) counted 34 egg cases, each with 50 eggs, in an egg-mass laid by Conus omaria. Ostergaard suggested that this species, a popular shell for collectors on the Barrier Reef, develops juveniles directly from the egg, foregoing the ability to disperse as larvae.

The shells of the family Volutidae are all believed to reproduce by direct development. Eggs are laid by the female in cylindrical egg masses. For example, the bailer shell, Melo amphora, which is collected on inshore reefs and offshore by trawlers, produces an angular egg case in which juveniles develop from the eggs in individual capsules. The females are believed to protect the egg masses during the laying period which may take several days (Wilson and Gillett, 1974). The end result of reproduction by direct development is the restricted distribution of distinct populations of volutes, due to the lack of larval dispersal. Some species become highly polytypic (a number of distinctive populations of one species), such as the Queensland Cymbiolacca pulchra species complex of which the Heron Island Volute is one form, C.pulchra f.woolacottae. These distinct

forms have become a target for shell collectors who seek representatives from different areas. As such the Queensland Volutidae would be the most vulnerable family and the most likely to feel any impact of collection. To a degree they are protected from extreme collection by their sub-tidal distribution, but some collectors will go to great expense and lengths to find and exploit known populations of volutes, the surplus collection of which ensures a supply of material for exchange.

The stombs lay coiled gelatinous egg-masses which contain thousands of tiny eggs. Some species are known to aggregate during mating, eg.Strombus luhuanus, (Catterall and Poiner, 1973), a habit which would make them potentially vulnerable to overcollection during this period.

Sexual dimorphism of molluscs, where present, is, in most cases, unlikely to be detectable in the field. The only occasions where males are likely to be taken selectively are when egg-laying females are left.

6.2.2 Distribution

Marine molluscs show a high degree of habitat specificity which is related to their individual preferences for food and shelter, and their relative tolerance to exposure, wave action and depth. The major environments encountered in the marine park are rocky shores, sandy shores, mangroves, fringing reefs (coastal and island) offshore reefs and deep water all of which support characteristic fauna. A typical reef and shoreline is zoned as a result of the gradient of physical conditions; each zone may be subdivided into micro habitats. In the Great Barrier Reef Marine Park an additional north/south gradation is superimposed by the changes in water temperature with latitude. With experience shell collectors become familiar with the distribution of preferred shells and will often travel considerable distances to a site in search of specific shells.

The habitat specificity and the depth range of a species are likely to affect its resilience to overcollection. A shell with a high degree of specificity eg. the Ovulidae, the small cowries allied with soft corals, can be sought by locating the hosts. Intertidal, sand-dwelling shells are similarly accessible despite their burrowing habits. If the distribution of such shells extends to sub-tidal waters, less accessible to the majority of collectors, a depleted intertidal population may be replenished through recruitment from greater depths. A subtidal existence, therefore, may protect a population of shells from the detrimental impact of overcollection. Shell collectors have used this argument in defence of heavy intertidal collecting at Dingo Beach where the small cowrie Cypraea stolida f.brevidentata is subjected to heavy collecting pressures, year after year. No specimens of this shell, once found, would be left to breed and the area is so well-searched that the remnant populations at the close of the shelling season would be minimal. Dingo Beach is one of the few areas where collecting occurs during the summer night-time low tides. Collectors argue that C.brevidentata will still be found the next year, but anecdotal evidence from numerous sources indicate that all shells at Dingo Beach have become depleted through years of collecting. The effort now required to find one C.brevidentata is such that only the hardy who are prepared to wade in knee-deep water are likely to be lucky. If the benthic stages of species with partially subtidal distribution are mobile, then migration of reproductive individuals into the intertidal area may occur. The presence of

subtidal reserves, therefore, may protect the species as a whole (though, again, Dingo Beach is exploited by collectors using SCUBA and Hookah equipment) but collection pressures at some sites may be so high that local populations will continue to decline whilst such collecting continues. Restricted populations of some mollusc species may be a product of local physical conditions (eg.currents). In cannot be assumed, in such cases, that replenishment will occur from outside sources.

6.2.3 Camouflage and refuge behaviour

Many molluscs are well camouflaged against their background as a result of cryptic colouration and encrusting growths, eg.*Lambis lambis*, most *Conus* species, the Muricidae. These shells may be protected from observation by casual collectors unfamiliar with their morphology, but camouflage affords little protection from collectors with experience. Likewise, the tendency of some shells to burrow or hide in crevices protects them from casual collectors and less so from serious collectors. Nonetheless populations of buried shells are potentially better protected from extreme depletion of reproductive individuals than more visible shells (Catteral and Poiner, 1987).

6.2.4 Rarity

The rarity of a species is an estimate of its availability to the average collector at the present time. An assessment of rarity must take into account the estimated populations of a given shell on both local and broad scales. Burgess (1985) has developed a Rarity Estimation Table (Table 7) based on the known worldwide distributions of 202 *Cypraea* species. In a scale of 1-20, 20 represents a unique specimen and one, many millions. Shells estimated at more than 2,000 on record fall into the scale of 10 and below. All the heavily collected species of *Cypraea* from the Great Barrier Reef Marine Park (Table 5) are rated as 10 and below, though the form *C.cribraria melwardi*, not recognized as a distinct species by Burgess, would deserve a higher rating. The only cowrie recorded with a range restricted to North East Australia is *C.xanthodon*, rated as 10.

The rarest Cypraeidae collected in East Australia are those taken by trawlers, such as (rating):

Cypraea porteri Cate, 1966 (19)
Cypraea langfordi f.*moretonensis* Schilder, 1965 (16)
Cypraea musumea Kuroda and Habe, 1961 (16)
Cypraea hirasei Roberts, 1913 (15)
Cypraea guttata Gmelin, 1791 (13)
Cypraea martini Schepman, 1907 (13)
Cypraea hungerfordi f.*coucomi* Schilder, 1965 (11)
Cypraea hesitata f.*beddomei* Schilder, 1930 (11)

A rare shell may be so as a function of limited distribution and population size, as far as can be known, or because only a few have been found. Many of the prized rarities of earlier days are now plentiful and values have dropped accordingly. The famous "Precious Wentletrap", *Epitonium scalare* Linnaeus, which is trawled in low numbers off the Queensland coast, peaked in value in the 18th Century at 200 ducats (Dance, 1987) and would now only be worth $7.50 on the Australian market. Likewise a specimen of the "Glory of the Sea" cone, *Conus gloriamaris*, from the Solomon Islands fetched US$2,000 in 1963; now less rare, a good specimen may be purchased for $120 from an Australian dealer. The value of a shell is based on popularity of the species or group to collectors as well as rarity. A general

TABLE 7: RARITY ESTIMATION TABLE (AFTER BURGESS, 1985)

20	Unique- only one known specimen
19	10 or less
18	10-20
17	20-40
16	40-60
15	60-100
14	100-300
13	300-500
12	500-1000
11	1000-2000
10	When estimating rarity in the range
9	of 10-4, we must consider restricted
8	area or inaccessibility. These rarity
7	estimations cannot be exact.
6	
5	
4	
3	A few million
2	Several million
1	Many millions

Note: though a shell may be very common where found, where its true rarity may be (1), if its distribution worldwide is very restricted the availability to collectors as a whole must decide its rarity rating.

indication of the relative rarities of shells at present may be found in a dealer's price list.

As trawlers and divers are penetrating deeper waters and unexploited reefs the rarity of certain species of shells is decreasing. Nonetheless, the demand of rare shells is such that they will hold their value whilst supplies are limited. The deep water trawling off the south Queensland coast, around the Swain Reefs and the Capricorn Channel has extended the known distributions of cowries such as Cypraea porteri and C.hesitata, C.langfordi moretonensis, the cones Conus duplicatus and C.teremachi, and the volutes Cymbiolacca intruderi and Amoria canaliculata.

The rarer a shell the more sought-after it will be by collectors and the greater the effort put into finding it. Trawlermen and shell collectors have mounted major expeditions to the Swains and reefs in the Coral Sea in search of rare volutes, using dredges and SCUBA. The known distribution of deep-water material, resulting from some such expeditions in the Mackay/Capricorn Section is indicated in Map 6, produced with the assistance of members of the Burnett and Port Curtis Shell Discussion Groups.

In conclusion, with techniques and transport available to the committed collectors and commercial exploiters the rare shells are no longer protected by virtue of their former unavailability.

6.3 Impact summary

Evidence of the impact of shell collecting on the Great Barrier Reef is largely anecdotal; a number of popular coastal and island sites are reported to have been "shelled out" by excessive collecting in the past. Today tourist pressures on such sites are on the increase. Depletion of shell resources can occur through overcollection and through habitat disturbance. Often the causes are confused and specimen shell collectors have been blamed for damage caused by others, by natural causes (storms and cyclones) and by man-made changes (sewerage outfalls, crop spray runoff). More serious than the threat to individual species is the threat to accessible coastal and reef sites subject to heavy tourist pressure, causing habitat damage. Often rocks are left unturned, corals are crushed and live shells and other organisms are removed unwittingly by visitors who are unfamiliar with the environment.

The greatest detriment has occurred at sites where tourist pressures have been combined with shell collecting, seen at Low Isles, Four-Mile Beach, Kurrimine Beach, Dingo Beach, Langford Island, Keppel Islands, Heron Island, Masthead Island, North West Island, Tryon Island and Lady Musgrave Island. The influence of shell collectors is greatest at Dingo Beach where the prime motive of most visitors is that of collecting.

To date there is little evidence of any immediate threat to mollusc species in the Great Barrier Reef Marine Park as a result of shell collecting. However, the rarity, the resultant demand by collectors, and the biological attributes of some species render them potentially threatened. The most vulnerable species are those which reproduce by direct development, such as the family Volutidae, well-represented in Queensland waters. Also vulnerable are other endemic species with restricted distribution

which are accessible to reef walkers, such as Cypraea xanthodon, C.stolida f.brevidentata, and C.cribraria f.melwardi.

7. SPECIMEN SHELL TRADE

The Australian shell trade and the economics of the Great Barrier Reef Region shell trade have been the subjects of recent short-term studies by Herbert (1986) and that compiled by Willan (1986). McGinnity (1986) investigated the activities of 32 Queensland establishments dealing in shells as part of a broader study on coral collecting on the Great Barrier Reef.

7.1 The Australian shell trade

The Malacological Society of Australia study, was commissioned by Australian National Parks and Wildlife Service in the wake of reports of significant depletion of local mollusc populations being exploited for the specimen shell trade. The study sought information on the major families involved in the Australian shell trade, domestic and export and aimed at identifying groups of shells vulnerable to overcollection, and developing management recommendations on the basis of the findings. The survey was conducted in two sections: 1) A questionaire survey of 40 dealers in five Australian states, 18 of whom responded.
2) A survey of 18 organizations related to molluscs (shell clubs, marine research groups and museums), conducted by postal questionaire.

Through the survey ascertained that 10 dealers, mostly from Western Australia, had over 50% of their business in Australian marine shells; the other eight dealt in 20% or less (Willan 1986). Amongst the 30 most commonly sold listed the following occur in Queensland :

CYPRAEIDAE:	Cypraea hesitata
	Cypraea cribraria
VOLUTIDAE	Cymbiolista hunteri
	Cymbiolacca pulchra
	Amoria canaliculata
	Melo amphora
	Melo umbilicata
MELONGENIDAE	Syrinx aruanus
TONNIDAE	Tonna cerevisina
SPONDYLIDAE	Spondylus wrightianus

The most common families sold are the Cypraeidae, Volutidae, Conidae and Muricidae, prices ranging from $0.20 to $4,000 per specimen.

Willan estimated the Australian shell trade to be worth $2.5 million, $2.0 million of which comes from the specimen shell trade through dealers, and $0.5 million from the ornamental shell trade. Over 90% of the Australian species sold are endemic.

The majority of endemic shells sold have been live collected by people other than the dealers. Shells are graded on standards defined by the Hawaiian Malacological Society; the International Grading Standards: gem, fine, good and fair. Prices vary

according to their rarity and grade. Dealers admit to selling shells of all grades.

The second section of the Willan study requested comment from six Queensland shell clubs, and from branches of the Malacological Society of Australia, and from other societies from four other states, on shells potentially threatened by the specimen and ornamental shell trade, and collection for culinary purposes. The only Queensland shell considered potentially threatened by the groups is Melo amphora which is taken regularly by trawlers, particularly in southern Queensland, and incorporated into artifacts such as lamp-shades and fruit bowls. In summary of the questionaire findings the report gives a more extensive list of Australian marine molluscs potentially vulnerable to exploitation from the shell trade which includes the following species occurring in Queensland:

STROMBIDAE:	Lambis lambis Linnaeus, 1758
	Strombus thersites Swainson, 1823
	Strombus luhuanus Linnaeus, 1758
CYPRAEIDAE:	Cypraea hungerfordi f.coucomi Schilder, 1965 End.
	Cypraea langfordi f.moretonensis Schilder,1965 End.
	Cypraea hirasei f.queenslandica Schilder, 1965 End.
	Cypraea subviridis Reeve, 1835
	Cypraea xanthodon Sowerby, 1822 End.
	Cypraea walkeri Sowerby, 1852
	Cypraea pyriformis Gray, 1824
	Cypraea martini Schepman, 1907
	Cypraea musumea Kuroda and Habe, 1961
	Cypraea guttata Gmelin, 1791
	Cypraea cribraria f.melwardi Iredale, 1930 End.
	Cypraea stolida Linnaeus, 1758
	Cypraea stolida f.brevidentata Sowerby, 1870 End.
CASSIDAE	Cassis cornuta Linnaeus, 1758
	Cypraeacassis rufa Linnaeus, 1758
CYMATIDAE	Charonia tritonis Linnaeus, 1758
MURICIDAE	Murex macgillivrayi Dohrn, 1862
	Chicoreus axicornis Lamarck, 1822
	Chicoreus cervicornis Lamarck, 1822 End.
	Chicoreus huttoniae Wright, 1879
MELONGENIDAE	Syrinx aruanus (Linnaeus, 1758)
CONIDAE	Conus pergrandis Iredale, 1937
TRIDACNIDAE	Tridacna spp.
VOLUTIDAE	All species Endemic

Estimates made by Willan (1986) that 90% of the Australian species component of the Australian shell trade may be true for the **specimen** shell trade, but doses not include the sale of imported shell (Herbert, 1986). Both Herbert (1986) and McGinnity (1986) recognized that the Australian shell trade hinges on imports, the majority of which originate from the Philippines. Other major sources are Japan, India, Taiwan, the USA and Mexico. The value of imports of unworked shell, pearl shell and coral in 1984-85 and 1985-86 was $488,000 and $619,000 respectively (Australian Bureau of Statistics). Export figures for the same years are $1,578,480 and $1,787,554. Principal consumers of pearl and trochus shell are the USA, Germany, Japan and Italy. Herbert estimated that Willan's figure of $2.5 million represents only a fraction of the total value of the sea shell trade in Australia.

Queensland and New South Wales dominate the import markets; Queensland and Tasmania dominate the export market. The extent of trade **between** states is not identified.

Herbert, in summary of the Australian shell trade, concluded that the most significant features are the level of imports from the Philippines and the small contribution made by local supplies.

7.2 Queensland shell trade

The object of Herbert's study was to understand the economic structure and importance of the trade in shells, souvenir and specimen, which are taken from the Great Barrier Reef. The study was undertaken by questionnaire and interview, with two sections:
1) An analysis of the Queensland shell trade by retail business.
2) An investigation of the economic characteristics of activities of shell club members.

In the first section eight businesses participated; four others refused to co-operate. On the whole shell dealers were reluctant to disclose information on their activities, some of which would also be witheld from taxation authorities.

In an industry which concentrates on the sale of souvenir shells, ornaments, shell jewellery and lamps, dealings in specimen shells are a small component. Eighty-six percent of the material originates from overseas, with only 14% of Australian origin. Local shells enter the market by:

- collection by licenced commercial collectors,
- collection by recreational collectors,
- distribution of trawl by-products and shell from the commercial scallop fishery.

7.2.1 Trade by commercial collectors

At the time of writing only two commercial collector licences are on issue from Queensland DPI and Queensland National Parks and Wildlife Service, one to a shell dealer/trawlerman who has collected shells with a trawl and dredge for several years. The shells are now marketed from an outlet in Townsville. The second commercial licence is on issue to a Whitsunday club member who creates shell jewellery and ornaments, mostly from beach shells, for sale at local markets.

Other dealers known to collect Queensland shells are not in possession of a commercial permit. The price list of a South Australian dealer indicates that he is dependent on the collection of large quantities of any available shells at Dingo Beach for his stock. A Cairns-based dealer who advertises the sale of Queensland shells claims not to have collected since 1983 as it is no longer commercially viable (McGinnity, 1986).

Two Queensland dealers, at the northern and southern extremes of the study area, when questioned on the source of local shells in their stock, confirmed that the material included purchases from trawlermen and casual collectors, locals and interstate visitors. Both dealers had been approached by casual collectors wishing to sell shells, one with large numbers of the stromb, Lambis lambis, collected from northern reefs, the other with two large jars of Cypraea stolida f.brevidentata from the Dingo Beach area. Where L.lambis can be imported for 30-40 cents, retailing at $3.50, the dealer was not interested in paying the $2.50 requested for local material. The shells were subsequently sold by the collectors at a market stall. Likewise, the southern dealer rejected the C.brevidentata on the basis of poor quality, and these shells were taken to Victoria for sale. This is one of several reports

of excessive collection from northern fringing reefs by interstate visitors, often retired couples, who offset the costs of their winter months in the north by the collection and sale of shell on their return. A lady from South Australia, observed filling a bucket with assorted shell at Dingo Beach in 1987, explained that a dealer had recommended the activity as a means of financing her trip. The same dealer is well-known for his own commercial exploitation of Dingo Beach.

7.2.2 Trade by recreational collectors

Included in this category is the trade by shell club members and casual collectors. The second section of the study by Herbert (1986), in its relevance to the current investigation, was conducted in co-operation by both authors. An "Exchange Section" was inserted into the questionnaire developed for shell club members. Respondents were asked what percentage of the shells that they collected were retained for their private collection; they were questioned on the cost of their collecting activites in 1984-86 and the numbers, origin and destination of shells sold in the same period.

Response to the "Exchange Section" of the questionnaire was low (10% of distribution); the reasons have been discussed in Section 3.1.1.3. Nonetheless, in the light of personal interviews with representatives from most of the shell clubs, the results are considered representative of the trading activities of club collectors.

The total costs of their hobby declared by respondents ranged from $40 to $700 and averaged $284 per annum, which is broken down into costs of travel (average $196) and shell purchases (average $88). Only 50% of the respondents revealed their costs. Shells were obtained by personal collection (71%), exchange (15.8%), and purchase (13.2%). Only three respondents stated that they had sold shells, the origin of which was personal collection and trawled shells. These were sold to other collectors, dealers and the public.

Trading of shells by exchange between club members is a significant component of the specimen shells trade. Whilst it is difficult to place a value on this section of the exchange trade it is expected to exceed the trade by sale and purchase through dealers.

The principal venue for exchange of shells are club "Sell Swap and Buy" meetings and the annual shell shows. The Townsville and Cairns Clubs aim at 2-3 such meetings per year, usually conducted over a week-end. Primarily a social function on which members may travel between clubs, surplus material is priced and displayed for exchange or purchase. Exchange values are pegged at roughly two thirds of the dealers' price; values for cash transactions slightly less. A 10% commission contributes to club funds.

The shell shows provide additional opportunities for trade in specimen and souvenir shells. Traditioanally at least one shell dealer has a stall from which a wide range of specimen and souvenir shells may be purchased. Club members also have stalls with surplus material for sale and exchange. In each club there are regular participants in trading activites. Some carry trading material with them which will be displayed to interested parties on request. It is not unusual to find a cluster of people round a small shell display, effecting deals. The network

of collectors within shell clubs is so well-established that individual specialities are known. Most of this trade is unaccountable, with the exception of the official stalls from which the clubs commission 10%. At the Townsville shell show in 1987 the commission of $217.80 represented sales of $2178.00 made by eight members and three dealers, 57% of which was made by one dealer.

Although most active club members will have exchanged at some stage, only a few from each club trade in this way on a regular basis. Surplus material is acquired through the following channels:

1) Self-collected shells surplus to requirement. A few collectors are known to take excess material on a regular basis.

2) Material in a personal collection which has been replaced by better specimens. Shell collections are constantly being modified and upgraded. Shells deteriorate gradually over time, particularly if not maintained in the right conditions, and replacement by improved and more desirable specimens is an ongoing activity which generates surplus material of a less-than-gem grade.

3) Purchase of a large collection with duplicates. A complete collection occasionally comes onto the market and may be broken down into family blocks for easier sale. The purchaser who is interested in only a portion will attempt to recoup costs by exchange and resale of the remainder.

4) Shells acquired from trawlers. The collector who has access to trawled shell, unobtainable by other means, will have an advantage over other collectors and an ensured supply of exchange material. Again, only small numbers of club members are involved, principally from the Townsville, Keppel Bay, Port Curtis and Bundaberg shell groups.

5) Shells aquired by exchange and purchase from overseas collectors and dealers. The few club members who are known to trade regularly have arrangements with overseas collectors and dealers in countries including the USA, Italy, France, England, South Africa, India, Taiwan, New Guinea, New Caledonia, Hawaii and New Zealand. A typical exchange rate would be 6-8 parcels per annum, each containing 10-30 shells. The most popular shells requested from overseas collectors are all Australian endemic shells, in the families Volutidae, Cypraeidae, Muricidae, Conidae and Pectinidae. Collectors have their own overseas correspondents with whom they exchange, sometimes in response to advertisements in shell club newsletters. Parcels are despatched as gift items, souvenirs purchased from a retailer, or museum specimens for research. To date no collectors appear to have struck problems with shell imports and exports; some record parcels having been opened by customs authorities. The following shell clubs have authority to export under the Wildlife Protection Act, 1982: Cairns, Townsville, Proserpine, Whitsunday, Keppel Bay and the Malacological Society of Australia, Brisbane.

The exchange of Australian shells with overseas dealers is a well-established activity conducted at clubs and private homes in the event of visits by the dealers. In 1986 and 1987 dealers from the USA, France and Italy paid visits to the interested shell clubs on the Queensland coast, as part of a more wide-reaching business trip which which would inevitably include dealers in endemic shells in Western Australia. The majority of dealers carry a collection of sought-after overseas shells with them as currency, preferring to deal in shells rather than cash. One dealer from America announced his interest in purchasing shells but his dealings in US dollars and low purchase prices

were not favoured by local club members. Australian shell aquired by dealers during these encounters are often posted out of the country or despatched through a registered Australian dealer, sometimes as "Museum Specimens".

7.2.3 Trade in trawled shells

It is widely known that shells taken by trawlermen, particularly in the ports of Bundaberg, Gladstone, Hervey Bay and Townsville are purchased by collectors and dealers. To date the illegality of this activity has largely been ignored (section 3.4) and the scale of shell retention considered inconsequential.

The only shells retained regularly by trawlermen for their own use are the large Melo amphora and Syrinx aruanus. The latter is frequently smashed by trawlermen as its long siphon snags in the nets. Four small specimen shell collections, compiled by Townsville trawler skippers, have been veiwed; all are unlabelled and displayed in glass cabinets. Most trawler skippers interviewed informally in Townsville argued that they did not have time to handle shells and any retention that occurred on their vessels was initiated by the crew. One skipper insists that his crew only retain quality shells, avoiding wasteful retention of scarred shells. A cook from Cairns-based trawler was observed offering trawled shell to a dealer in Hervey Bay, who was prepared to pay up to $50 for good specimens of the northern volute, Volutoconus bednalli which retails for up to $100.

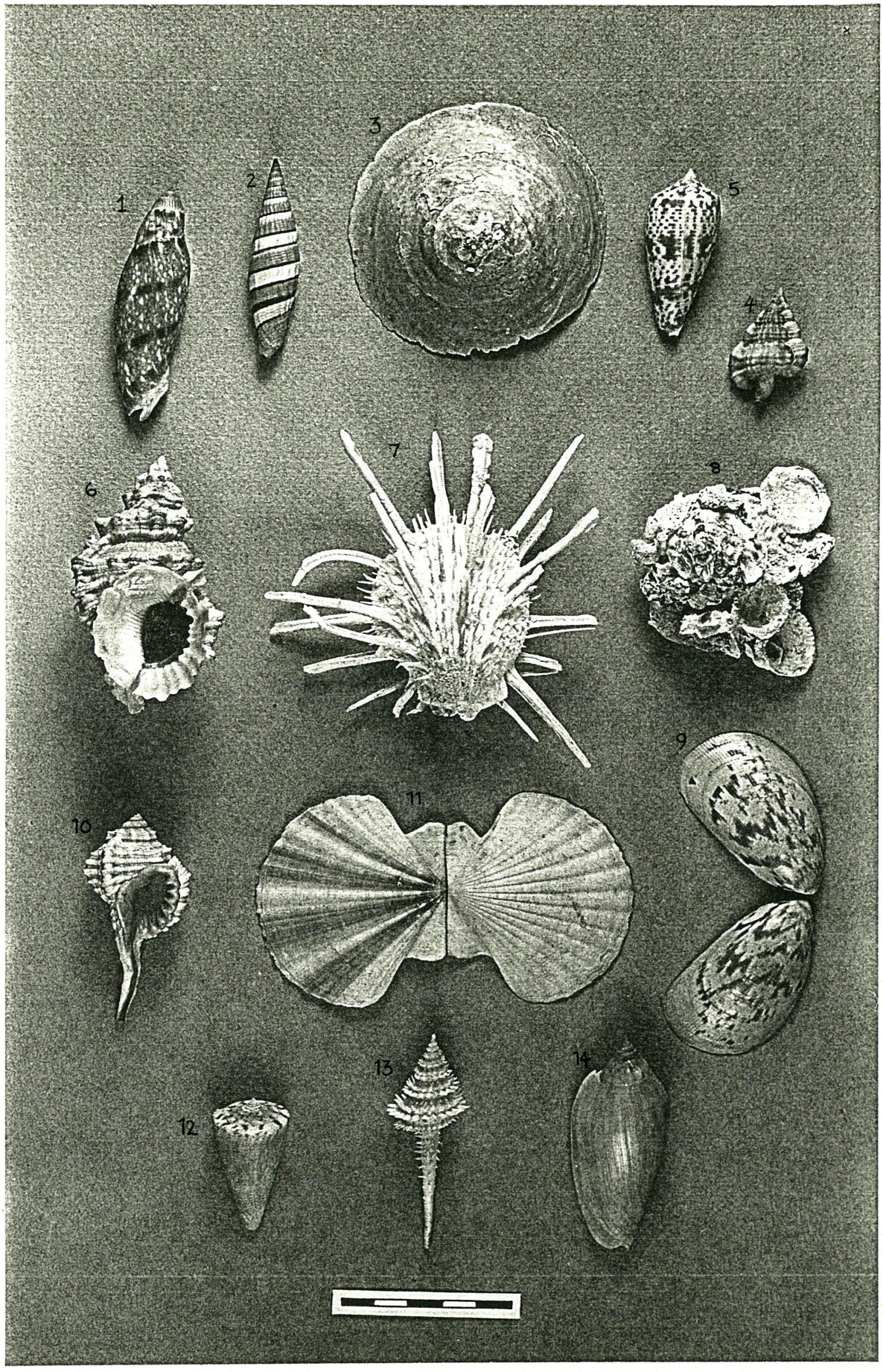
Trading of trawled shell in the Townsville area has, to date, involved at least four club members who have arrangements with two to four skippers apiece, to retain and freeze all shells collected. Other skippers are approached "on spec" by collectors at the wharf. In the past shells were paid for by favours such as engine or refrigerator repairs, or a carton of beer. If cash exchanged hands it would be a token amount of $10-15 for a bucket of mixed shell which would be regarded as beer money for the crew. Today fishermen are more aware of the value of shells. A price list has been circulated amongst Townsville boats, offering cash for named shells, with values up to $200 for southern deep water Cypraeidae and Conidae. The list includes Volutidae, Conidae, Cypraeidae and Muricidae, priced at less than half the recognized retail value. The most highly valued shells from the Townsville trawlers are the cypraeid, Cypraea guttata ($250); the volutes Volutoconus grossi mcmichaeli ($150) which is restricted to the Townsville region, Amoria guttata ($40-$70) and Cymbiolacca craecenta ($70); and the cones Conus lynceus ($20-$30) and Conus neilseni ($15). The catches of shell by trawlers, which are dependent on the season and the area being worked, have been very low in 1987.

At the port of Yeppoon, prior to the zoning of the Marine Park, six of the 30 boats involved in the scallop fishery supplied shells on a regular basis to a local dealer who paid a nominal price per bucket, which contributed to a slipway fund. More recently two scallop boats have been bringing in material on a two to four-week basis, and two deep water trawlers two to three times a year, dependent on the catches. A typical basket of shell from the inshore scallop grounds may contain up to 30 shells, including 10 Spondylus wrightianus, 5 Tonna tetracotula, 3 Melo amphora, 5 Syrinx aruanus, 1 Amoria maculata, Conus leopardus, Strombus campbelli and Tudivasum armigera. Many of these shells are sold as souvenir packages for $5-$15 in groups of 8-16 shells.

PLATE 6: SHELLS TRAWLED OFF TOWNSVILLE

1. Volutoconus grossi f.mcmichaeli Habe and Kosuge 1966; off Townsville.
2. Vexillum taeniatum (Lamarck, 1811); Indo-Pacific.
3. Xenophora indica (Gmelin, 1791); Indo-Pacific.
4. Gyrineum cuspidatum Reeve, 1844; Indo-Pacific.
5. Conus lynceus Sowerby, 1857; Indo-Pacific.
6. Tutufa oyami Habe.
7. Spondylus wrightianus Crosse, 1872; SE Aust-NW Aust, Philippines.
8. Xenophora corrugata (Reeve, 1843); Indo-W.Pacific.
9. Laevicardium attenuatum (Sowerby, 1841); W.Pacific, Japan.
10. Cymatium gutturnium Roding, 1798; Pacific.
11. Annachlamys leopardus (Reeve, 1853); N.Aust.
12. Conus neilseni Marsh 1962; N.Qld, deep water, endemic.
13. Columbarium hystriculum Darragh, 1987; off Townsville, 300 metres.
14. Relegamoria sp. ; off Townsville, 300 metres.

Scale = 5cm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Further south, since 1981, the fleets operating out of Bundaberg and Gladstone have been exploring new deep-sea grounds for the King Prawn. For three years the boats operated in 185-280 metres east of the Capricorn/Bunker Group, and in 1984 operations were moved north east to the shelf waters south and east of the Swain Reefs (Map 6) resulting in some exciting shell finds (Limpus 1986a, 1986b). Amongst the finds of Volutidae, Conidae and Cypraeidae numerous new records have been established, including the occurrence of Cypraea porteri Cate, Conus excelsus Sowerby, and new forms of Nannamoria inopinata Darragh, and N.parabola Garrard. With rarity comes high value: Cypraea porteri now retails at up to $800, Cypraea hirasei queenslandica at $600, Cypraea langfordi moretonensis at $400-$700, and Relegamoria molleri at $200 (Rice, 1987). Trawlermen making these finds are aware of the values and are no longer content to accept a token amount for a bucket of shell. Dealers and collectors now expect to pay approximately 50% of the market price for rare trawled shell specimens. When shells are valued so highly it is often the highest bidder who gets the shell. The collector/dealers who are in a position to pay a good price are in possession of unique collections and have considerable trading power in their stocks of trawled shell. At least three southern collectors in this category could be defined as "collector/dealers" who trade both by exchange, shell for shell, and by cash transactions.

Trawled shell, therefore, is channelled into private and museum collections through a few collectors and dealers who disperse the material within Australia and overseas. It is quite likely that a high percentage of the material is exported in exchange for equally rare overseas material.

The southern trawlers are also a source of material for local manufacturers of shell and coral novelties, shell lamps and ornaments. Details supplied by a Gold Coast based manufacturer are summarized in Table 8. Supplies of trawled shells of the species listed were obtained from 12 trawlers based in Tin Can Bay, one at Tweed Heads, and one in Bundaberg during 1984-86; and from nine Tin Can Bay trawlers in 1987. Other shells used in the process are imported Cypraea tigris, self-collected Strombus luhuanus and Amusium balloti obtained from the scallop processing plant. The manufacturers hold a coral collecting licences. All articles manufactured by this company are sold to a Brisbane wholesaler for distribution to retail outlets throughout Australia.

An additional manufacturer of lamps, fruit bowls, trophies and ornaments, based in Hervey Bay, buys shell regularly from four local trawlers. Shells purchased average $100 worth each month and the content depends on availability. Shells bought include the large volutes Melo amphora, Melo georginae, and Cymbiolena magnifica, plus Syrinx aruanus and Pleuroploca trapezium. A specimen of Melo amphora purchased for $4 may be cut into a fruit bowl, marketing at $10, and the surplus material made into a soap dish ($1) and a mounted trophy ($10-$12). The large Syrinx aruanus are made into lamps ($36) and Pleuroploca trapezium produces a sauce jug, valued at $10. Most of the products are sold at local flea markets and a flower shop. Regular customers from the south, who overwinter at Hervey Bay, take large quantities of the material to sell in the south. The manufacturer also makes an annual trip to Victoria, on which ornaments to the value of approximately $1,500 are sold to cover the cost of the trip.

TABLE 8: SHELLS OBTAINED FROM TRAWLERS BY GOLD-COAST BUSINESS 1984-87

SPECIES	SOURCE	COST	NOS.	VALUE($)
Melo amphora	Tin Can Bay Hervey Bay Bundaberg	<9"= 20c/inch >9"= 35c/inch	2530	5759
Syrinx aruanus	Tin Can Bay	$5-$10 (av.$5)	34	172
Cymbiolena magnifica	Tweed Heads Southport Tin Can Bay	8"= $1.00 9"= $2.00 10"= $3.00	255	520
Cymbiolista hunteri	Tweed Heads Southport	$2.00 each	16	8
Tonna cerevisina	Tweed Heads	*	315	170
Phalium bandatum	Tin Can Bay(80%) Southport (20%)	15c each	*	*
Strombus luhuanus	Airlie Beach	-	800-1,000	
Amusium ballotti	Bundaberg Tin Can Bay proc. plant	*	*	*

(* Information not supplied)

Hervey Bay trawlermen have also been approached by a dealer wishing to purchase fresh frozen Melo amphora for $4 per kilo in order to retail the meat at $28/kilo, a venture which does not appear to have been successful.

It is almost impossible to place a value on the trade in trawled shell since so much of it is conducted through private deals, some of which do not involve cash. Trawlermen and collectors alike are very sensitive to monetary issues, particularly those related to illegal trade. Some Bundaberg skippers who recognize the financial advantages of retaining deep water shell would like to see the trade legalized.

8. SUMMARY

1) Shell collecting in the Great Barrier Reef Marine Park is undertaken by specimen shell collectors, casual collectors, commercial collectors and trawlermen. A total of 596 committed specimen shell collectors have membership with one or more of the 11 Queensland shell clubs and discussion groups. The figure includes at least 150 active collectors, and members from interstate and overseas, many of whom visit Queensland on an annual basis in order to pursue the hobby.

2) Specimen shell collectors have a preference for live, high-quality shells. Principal collector groups are the Cypraeidae, Volutidae, Muricidae, Olividae and Conidae. Club members are expected to conform to the rules of a collecting code.

3) The shell clubs organize monthly meetings; three clubs hold an annual week-end shell show which is open to the public. Other organized club activities include collecting trips (usually one per annum) to reef and coastal sites, Sell Swap and Buy meetings, and fund-raising cent sales and shell auctions. The northern clubs are more involved in these activities than the southern groups.

4) Casual collectors include local beach-walkers, tourists, divers and sailors. A casual collector is generally less discerning than the specimen collector, preferring to collect dead beach shells than live shells. A survey of tourist groups in the Whitsundays identified 26.5% of resort visitors, bareboat charter passengers and campers as casual shell collectors, 23.8% of whom collected dead beach shells. Shell collecting was considered a major activity by 3.8% of those surveyed; 2.7% collected 2-10 live shells. This percentage represents approximately 4072 people collecting between 8143 and 40,720 and live shells from the Whitsundays each year. The activity is concentrated on coastal and island fringing reefs close to resorts and camping sites, and offshore reefs served by tourist boats.

5) Two commercial licences are on issue to collectors in the Marine Park: one to a dealer who collects by dredge and trawl, the other to a collector of beach shells for small-scale manufacture of jewellery. "Quasi-commercial" collecting is also undertaken illegally by an estimated 50 unlicenced locals and interstate visitors who target accessible coastal sites; by small numbers of club members collecting surplus material; and by trawlermen, principally those operating in deep water out of Bundaberg and Gladstone.

6) Most collecting is undertaken on exposed reef flats during periods of extreme low tide. A collecting season is defined by the 3-5 days of Spring tides each month between May and September. Night shelling occurs to a lesser extent on summer low tides. Simple equipment used includes a container (bucket/bag) gloves and a probe or tongs. Small dredges are occasionally towed by boats to access deeper water around the coastlines and in reef lagoons.

7) The most heavy collecting recorded in 1984-87 occurred in the Cairns Section and the Mackay/Capricorn Section. Principal collecting sites were the reefs of Undine, Rudder, Mackay, Endeavour, Pickersgill and Hope Island in the Cairns Section; Little Trunk reef and Dingo Beach in the Central Section; North West, Tryon, and Lady Musgrave Islands in the Capricorn/Bunker Group. Coastal sites of Four-Mile and Wonga Beaches in the Cairns Section, Kurrimine and Dingo Beaches in the Central Section, and Shoal Point and Clairview Beach in the Mackay/Capricorn Section are frequented by shell collectors.

8) A total of 469 Recreational Shell Collecting Permits, covering approximately 1,300 people, was issued by Queensland National Parks and Wildlife Service between their introduction in 1982 and February 1988; 68% allowed collecting in the Cairns Section, 42.6% in the Capricornia Section and 20% in the Far Northern Section. The majority of individual permit holders were shell club members. Most of the group permits were for school, dive and adventure holiday groups, camping on the Capricorn/Bunker islands: North West, Tryon, Masthead and Lady Musgrave.

9) Collection returns were received from 91 (19.4%) permit holders, recording 221 collecting trips. 98.5% of the records were from club members, predominantly collectors in the Cairns locality.

10) The collection data records the taking of 12,509 live shells (327 species, 56 families) on 221 occasions, on trips to 38 different sites in the Marine Park. 25% of the shells were taken by a group of eight overseas divers on a 10-day trip to reefs in the Cairns Section.

11) The most commonly collected shell is the stromb, Lambis lambis, most of which were collected in the Cairns Section. The most popular families were the Cypraeidae, Conidae, Strombidae and Olividae. Collection in the Capricorn/Bunker Islands focused largely on the Cypraeidae. The majority of the 40 most popularly collected species in each section were shells found commonly throughout the Indo-Pacific region. Of the 12 uncommon and endemic shells included in the lists, eight are in the family Cypraeidae.

12) Evidence of the detrimental impact of shell collecting in the Great Barrier Reef Marine Park is largely anecdotal. Reliable reports focus on the coastal sites of Dingo Beach, Four-Mile Beach, Kurrimine Beach, Langford Reef, and Heron, North West, Tryon and Lady Musgrave Islands. Habitat destruction by tourists is seen as much, if not more, to blame for shell depletion in high-pressure areas. The propensity for shell collectors to seek rare shells, particularly some Cypraea species and all Volutidae, makes such shells the most vulnerable to overcollection. Major biological attributes affording a species resilience to overcollection by collectors include early maturation, high fecundity, iteroparity, a free-swimming larval

PLATE 7: EAST AUSTRALIAN VOLUTES (ENDEMIC)

1. Cymbiolacca craecenta McMichael, 1963; Qld.
2. Cymbiola rutila (Broderip, 1826); N.E.Australia.
3. Amoria maculata (Swainson, 1822); Qld.
4. Volutoconus grossi (Iredale, 1927); Qld.
5. Cymbiolacca pulchra (Sowerby, 1825); Qld.
6. Cymbiolacca wisemani (Brazier, 1870); Qld.
7. Cymbiolacca complexa Iredale, 1924; Qld.
8. Cymbiolacca intruderi Poppe, 1986; Qld.
9. Cymbiolacca peristicta McMichael, 1963; N.Qld.
10. Amoria zebra (Leach, 1814; Qld.
11. Amoria canaliculata (McCoy, 1869); Qld.
12. Amoria guttata McMichael, 1964; Qld.

Scale = 5c


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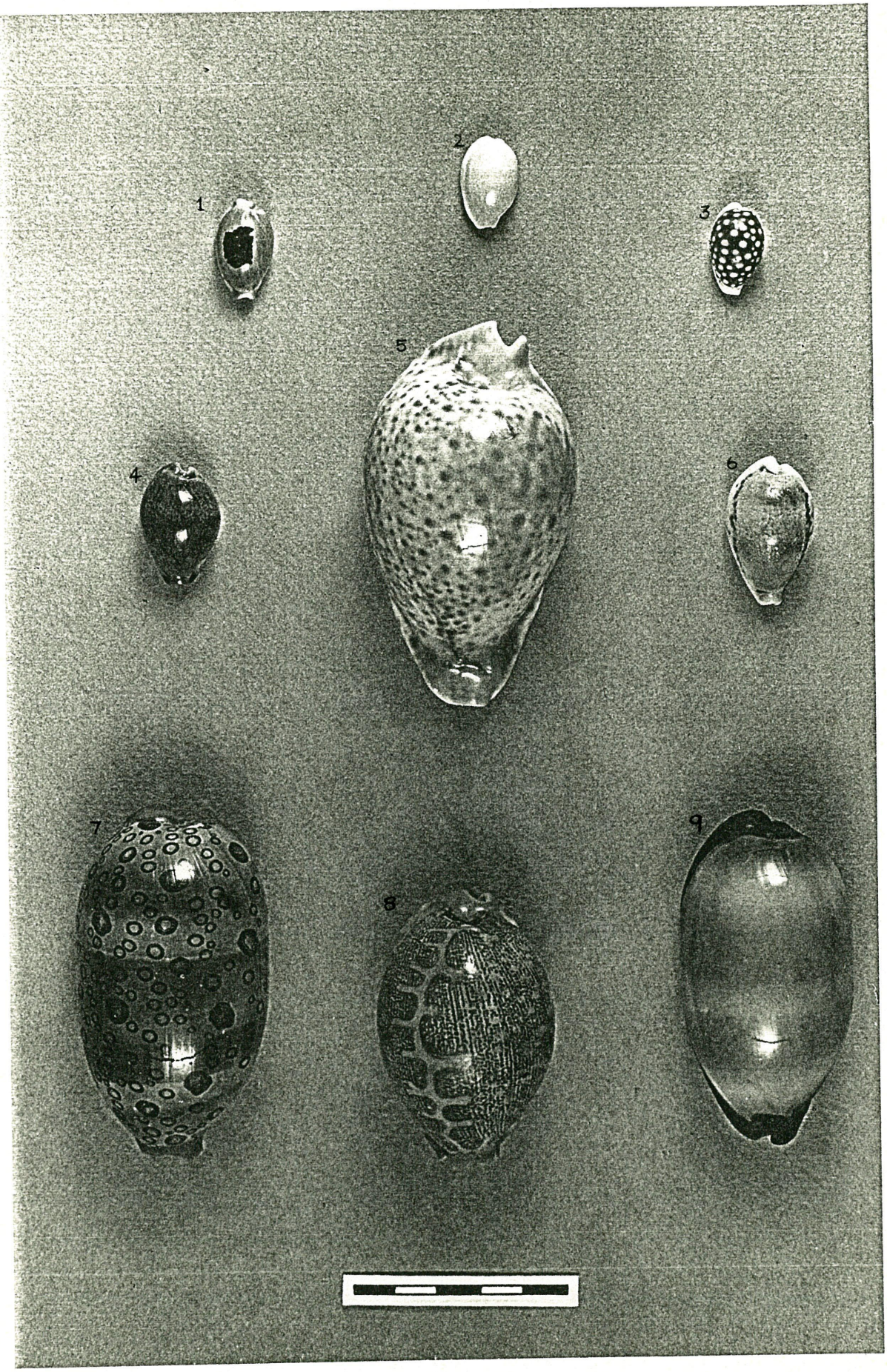
PLATE 8: POPULAR EAST AUSTRALIAN COWRIES

1. *Cypraea stolida* f.*brevidentata* Sowerby 1870; endemic.
2. *Cypraea cribraria* f.*melwardii* Iredale 1930; endemic.
3. *Cypraea cribraria* Linnaeus, 1758; Indo-Pacific.
4. *Cypraea xanthodon* Sowerby, 1832; N.E.Australia, endemic.
5. *Cypraea hesitata* Iredale 1916; SE Australia-S.Qld, endemic.
6. *Cypraea hungerfordi* f.*coucomi* Schilder 1965; S.Queensland, endemic.
7. *Cypraea argus* Linnaeus, 1758; Indian Ocean, S.W.Pacific.
8. *Cypraea mappa* Linnaeus, 1758; Indo-Pacific.
9. *Cypraea talpa* Linnaeus, 1758; Indo-Pacific.

Scale = 5cm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stage, sub-tidal populations and wide distribution. The most vulnerable family, the Volutidae, reproduce by direct development, producing sought-after local forms. Most are sub-tidal and therefore only available to divers and collectors with a dredge or trawl. Any assessment of the resilience of individual species requires more detailed information on the biology than is presently available for most tropical species.

13) The Australian shell trade is made up of trade in Australian endemic specimen shells, estimated at $2.0 million per annum, and a larger component, the ornamental shell trade, based on imports (worth approximately $600,000 a year) from the Philippines, Japan, India, Taiwan, USA and Mexico. Ten of 12 Queensland shell dealers questionned in three concurrent surveys derive 10% and less of their income from the sale of Australian marine shells; the remaining two devote 50% and 70% of their business to the sale of Australian shells. Material is obtained from other dealers by self collection, and by purchase from trawlermen and "quasi-commercial" collectors. A significant portion of the trade lies in the exchange of shells between specimen collectors and dealers, within Australia and overseas, which is unaccountable. Exchange material is derived from surplus shells in private collections, excessive collecting and purchase from dealers and Queensland trawlermen. The most highly priced shells from the Marine Park are found in deep water trawled material from the Mackay/Capricorn Section which are purchased from boat crews at 50% retail value and channelled to Australian and overseas collectors through a few local collector/dealers.

9. MANAGEMENT

The planning and management of a Marine Park on the scale of the Great Barrier Reef Marine Park is a massive undertaking by the Authority which relies heavily upon co-operation of informed users. The concept of a multi-user Marine Park is a recent management strategy which acknowledges and accomodates the incompatability of different activities by the zoning system. A vital stage in the development of the zoning plans for each section is the Public Participation Programme in which users are invited to make representations to the GBRMPA concerning their interests.

9.1 Management of shell collecting

Management strategies applied to shell collectingto date are:
1) Restriction of shell collecting from zones other than General Use zones.
2) The introduction of permits for collecting in General Use zones. Initially permits were issued on a per-trip basis, irrespective of the length of the trip. An arbitrary bag limit specified that no more than two of each species were to be taken in the duration of the permit. In the wake of considerable opposition from the shell clubsthe bag limit was lifted, "limited collecting" defined as "the collection of shells, dead or alive, sufficient only for ones own needs and for limited exchange", and the permits issued for a 12-month period (July to June). No collecting was allowed in the Capricornia, Cairns and Far Northern Sections without such a permit, with the added proviso that permittees were to provide a collection report to QNPWS prior to renewal of the permit. With the declaration of the

Central Section the permit system has undergone further revision. "Limited collecting", redefined in the Regulations "not more than fi[illegible] of any species shall be taken in any 28-day period, or had in possession whilst in the Marine Park", no longer requires a permit. A collecting permit is only required in the Central Section by those intending to collect more than the limit and those collecting for commercial purposes.
At present, therfore, a dichotomous permit system exists within the Marine Park.

9.2 Shell collecting enfringements

To date there have been no prosecutions of shell collecting offenders. In the Capricornia Section, up to 1986, 21 collecting offences (mostly shell collecting) were recorded, principally at Lady Musgrave, Masthead, North West and Heron Islands (Walker, 1986). These were minor enfringements, by people claiming to be unfamiliar with the permit requirement, despite living locally or in Queensland. A lenient approach was taken in 1984-86 to allow the public time to familiarise themselves with the provisions of the zoning plans, and offenders were councilled on the spot by park rangers. Since 1986 enfringements have been dealt with by field counselling and counselling letters. There are no recorded cases of legal action against shell collectors in the QNPWS Enfringement Register, 1987-1988.

9.3 Management review

In its complexity the management of a multi-user Marine Park, particularly at the early stages of development, has associated problems. Principal problems likely to be encountered are misunderstanding by users, and difficulties in enforcement (Saueracker, 1987).

9.3.1 User confusion

A user-based evaluation of the zoning plan and management of the Capricornia Section (ESS, 1987) identified a tendency amongst inexperienced users to assume that restrictions are more severe than they really are, commonly equating the Marine Park with a terrestrial National Park. One of the most pressing of issues raised by the survey concerns public perceptions of what are and are not acceptable levels of resource extraction from the section. A number of groups interviewed expressed strong preferences for reduced levels of extractive activities such as shell collecting and line fishing.

Shell collectors of all categories have been confused by aspects of the zoning structure. Many casual/tourist collectors of small numbers of dead beach shells have been unaware of the permit requirement for this activity. The more experienced specimen collectors, many of whom have participated in the Public Participation Programmes during the development of the zoning plans, are still confused by the multi-user concept. Some find it hard to see justice in a zoning plan which allows 200 tourists daily to trample a reef, or line fishermen to take fish, in areas where shelling by a small group of collectors adhering to a collecting code is not allowed.

Additional confusion has arisen over the respective planning roles of the Federal and State agents. Clubs felt that they were given inadequate opportunity to participate in development of the State zoning plans for the intertidal zone. Collectors are particularly confused by the positioning of boundaries between different zones. For example, at Cape Pallarenda/Shelley Beach, north of Townsville, a non-collecting Marine Park "A" zone separates a General Use zone to the north from the access point at Pallarenda to the south. Effectively shellers are allowed to collect in the General Use zone during periods of tidal exposure, but they are not permitted to be in posssession of shells whilst walking across the Marine Park zone, the only access point. Details such as these are readily picked on by people who perceive their activity to be threatened. Though a minor impracticality in planning it promotes a lack of co-operation amongst critical users.

9.3.2 Difficulties in enforcement

Day to day management of the Marine Park is the responsibility of the regional officers of the Queensland National Parks and Wildlife Service. The vast area is covered by air surveillance and boat patrol. There is a widespread feeling that amongst users that the legal provisions of the zoning plans are not being adequately enforced, that surveillance is inadequate, and that feild officers are disinclined to take action on offenders (ESS, 1987). Shell collectors are aware that there is little likelihood of their being approached in the field with the current policing levels; most of the effort of management is put into high pressure tourist areas, or "key sites".

Policing problems are identified in the dichotomous collecting permit system existing at present. In the Capricornia, Cairns and Far Northern Sections, where a permit is required for limited collecting effective policing requires a personal approach by a ranger with the simple enquiry "Do you have a permit to collect?". By comparison, in the Central Section a ranger must be expected to view, distinguish and count shells of all collectors encountered if the policing is to be given any credence. Though the principal objective of this alternative system is to distinguish excessive collectors from conservative collectors policing must still be regarded as practical if the restrictions are to command respect and co-operation.

9.4 Permits: for and against

The original objectives of the permit system were:
1) to encourage responsible behaviour,
2) to separate potentially conflicting activities,
3) to impose limits on certain activites,
4) to collect data on the activites.

Preliminary assessment of the permit returns in 1986 indicated that the objectives of the permit system were not being realized (Barnett, 1987). The majority of the people applying for collecting permits already saw themselves as responsible reef users; the casual collectors were least likely to be aware of the permit requirements. Estimates of permit non-compliance by two shell clubs, using a randomized response survey technique, indicated that, whilst people were willing to make the initial application, there was a high rate of non-compliance with permit conditions, which lead to underestimation of the quantities of

live shells removed (Chaloupka, 1985). The low number of collection returns received up to 1986 caused the author to question their value as a data source. Two years later, after analysis of the data returned by 19.4% of all permit holders, the achievements of the permit system are more convincing, despite the persistence of some inadequacies.

The advantages of the permit system include the points 1) to 4) raised above. The collection returns have proved to be an invaluable sou the permit system include the points 1) to 4) raised above. The collection returns have proved to be an invaluable source of information notwithstanding the tendency to underdeclare shells collected, and should be retained for this reason alone if monitoring of the activitiy is to continue. Collectors must be trusted to collect responsibly within the permit guidelines and their own collecting code if co-operation is to be achieved. The inadequacies of the permits hinge on unawareness of zoning requirements by casual collectors, perceived futility of a permit for collection of dead shells, lack of respect for the policing, and lack of enforcement of permit requirements.

9.5 Proposals for future management of shell collecting in the Great Barrier Reef Marine Park

In respect of the findings of this report the author proposes that the following recommendations be given consideration:

1) That the collection of the triton shell, Charonia tritonis, the helmet shell, Cassis cornuta, all clams in the family Tridacnidae, shells on eggs and juvenile shells be prohibited.

2) That collection of dead shells be allowed in the General Use zones without a permit. There is little difficulty in distinguishing dead and live-taken material in the field. On-the-spot policing allows little time for live collected shells to be processed before inspection.

3) That permits be retained for limited collecting of live shells (defined as "the taking of not more than five live shells of a species in any 28-day period"), with the proviso that a collection return to a prescribed format (Table 9) is completed adequately before a permit is renewed.

4) That commercial collecting and the dealing of shells be controlled through the issue of commercial collecting permits where the annual income derived from the sale of self-collected shells and shells obtained from trawlers is greater than $1,000; that a charge be made for all commersial collecting permits and the income generated be channelled towards monitoring work.

5) That consideration be given to legalizing the collection of shell by trawlers on a limited licence basis for which a charge is made. The problems associated with the introduction of additional trawler licences has been discussed with J.Beumer (Qld. DPI, Fisheries Management). The major concern is the anticipated flood of applications from trawlermen previously disinterested in shells. This matter requires to be dealt with in the same manner as the retention of other by-catch material such as sea-snakes.

6) That education of the general public be given high priority in the management of all user activities. The public must be well

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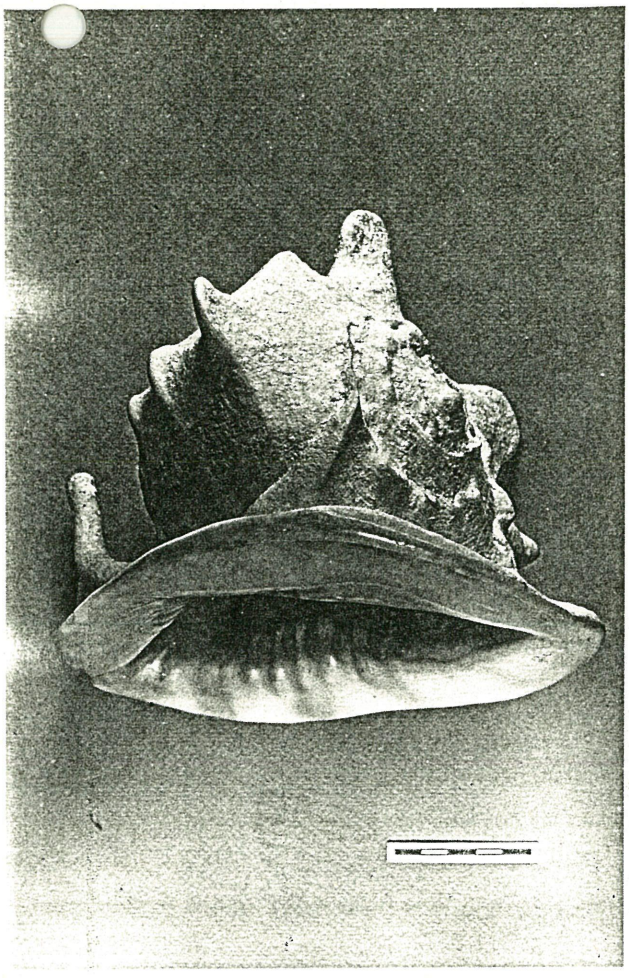
live shells removed (--

PLATE 9: PROTECTED SPECIES ON THE GREAT BARRIER REEF

1. Charonia tritonis (Linnaeus, 1758); Indo-Pacific.
2. Cassis cornuta (Linnaeus, 1758); Indo-Pacific.
3. Hippopus hippopus (Linnaeus, 1758) juvenile; S.W. Pacific

* All Tridacnid clams are protected.

Scale = 5cm



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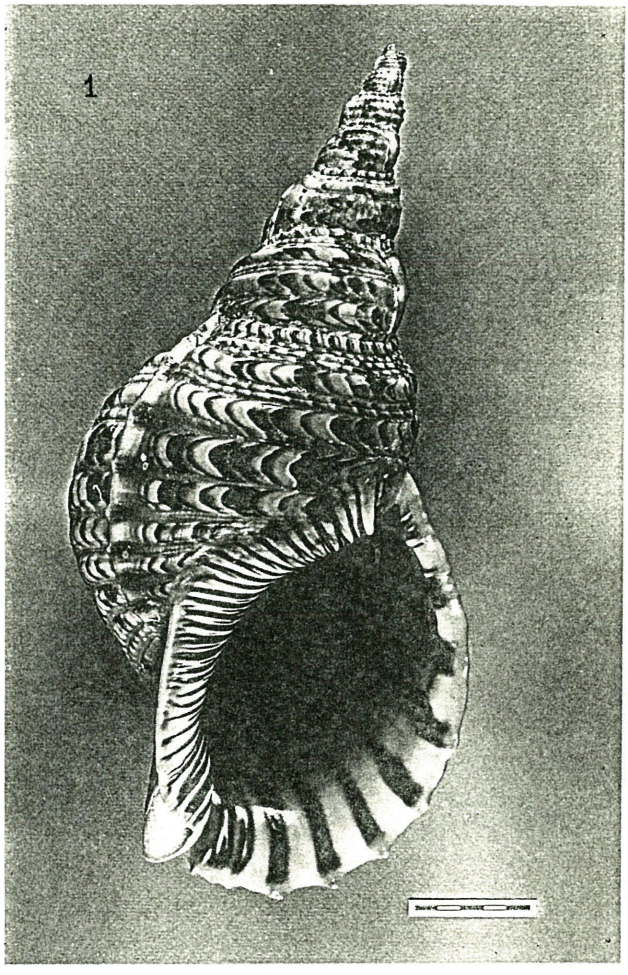

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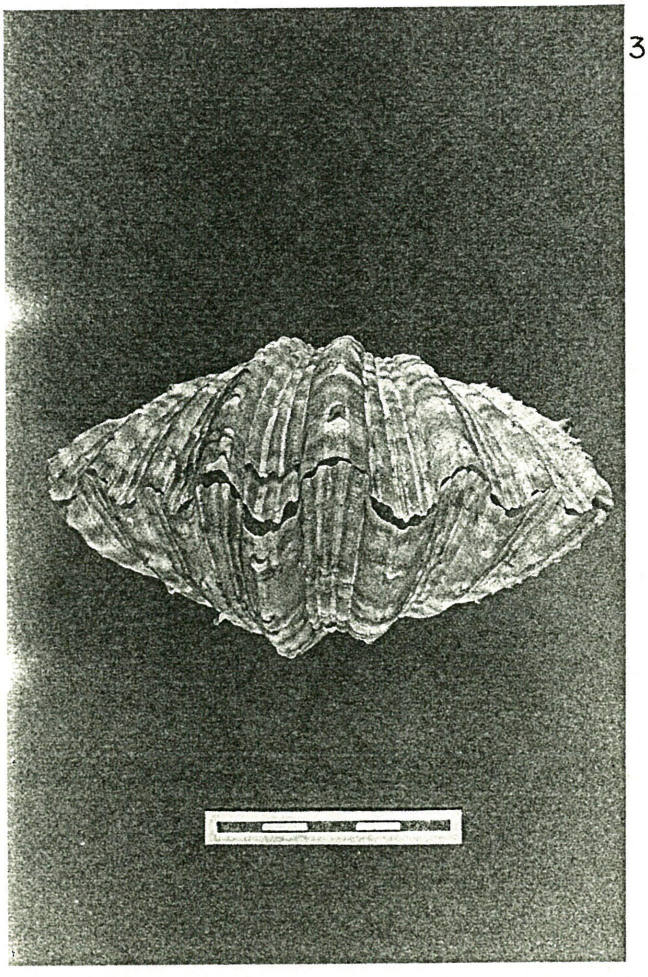

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TABLE 9: PROPOSED FORMAT FOR PERMIT RETURN DATA SHEET

NAME:_____ PERMIT NO._____

SHELL CLUB (if applicable):_____

DATE:_____/_____/_____ COLLECTING SITE:

COLLECTING PERIOD (hours/minutes):_____

COLLECTION DATA:

FAMILY	SPECIES	NOS.TAKEN		NOS.OBSERVED					HABITAT
		alive	dead	<5	5-10	11-30	31-50	51+	*

* HABITAT: eg. reef top, under rock; sand bank; reef front on coral etc.

informed on reef behaviour and collecting regulations, particularly in areas of heavy use. The most effective means of conveying a message is in the use of visual impact material such as posters, supplemented by brochure information supplied to campers with their permits, and made available to resort visitors, day tourists and bareboat charter passengers through the management. The establishment of some basic guidelines to "reef behaviour" by the GBRMPA and QNPWS would be of considerable value to both agencies and to the expanding tourist industry. The leisure businesses dependent on the reef for their livelihood might be approached for financial input to promote the production of education and extension material; or a portion of the income derived from the proposed tourist permit charges allocated towards this area. The extension of Reef Interpretation courses (conducted by Marine Parks staff of QNPWS in the Cairns Section) to other sections , and the further development of the Reef Actvities Manual by GBRMPA should be considered management priorities. Shell club members, many of whom have already adopted an educational role, should be involved with extension activities.

7) That shell collecting infringements no longer be treated lightly and fines imposed on offenders.

8) That a Marine Park officer from each regional office be made responsible for liaising with the local shell clubs. It should be the responsibility of this officer to familiarize him/herself with the current regulations applying to shell collecting and the regional management and user issues affecting collectors. If good communication between GBRMPA and QNPWS at the regional level is assured the regional representatives can effect the liason between the agencies and the users.

9) That the GBRMPA invite shell clubs to appoint a Marine Park representative with whom liaison can be conducted on matters relating to their activity. The opposition experienced with some of the shell clubs has arisen largely through misunderstanding and breakdowns in communication which could have been avoided.

10) That shell clubs be encouraged to participate in monitoring exercises at sites where collecting is conducted on a regular basis. Certain club members have expressed a wish to participate in monitoring exercises provided adequate supervision is offered. Traditionally monitoring programmes lean on the expertise of scientists experienced in the collection and treatment of data. There is a tendency for studies by amateurs to be dismissed as meaningless. The sampling of molluscan populations has inherant problems in the cryptic nature and scattered distribution of shells. A meaningful study demands manpower, repeated access to sample sites and experience in location and identification of shells. Many shell club members are very experienced in collection and identification of molluscs, less so in scientific research. A monitoring policy for shell distribution at selected sites on the Great Barrier Reef should recognize and accomodate the limitations of the more experienced shell collectors. The role of the GBRMPA and QNPWS could be in the provision of assistance in sample design, field supervision, data analysis and production of reports.

The Port Curtis Shell Discussion Group proposed a study of the mollusc populations of the reef of Wilson Island (Capricornia Section) but were unable to overcome the camping restrictions on the island. An attempt to redirect the interests and expertise

towards a study at nearby Tryon Island was rejected leaving the motives of the original proposal in doubt. It is therefore important to establish the basis for studies which involve interest groups.

Monitoring priority should be given to Dingo Beach in the Central Section where shell collectors are active at each low tide during the collecting season (May to September) and on night low tides during the summer months. A stratified sampling procedure would be necessary in the site where different habitats, such as the sand bar, reef rubble zone and fore-reef are well-defined. Suitable sampling times would be over a three to four-day period in May or June, at the beginning of the season, and in September, close the end of the season. The collecting sites are readily accessible from the beach at low water. Additional sites for consideration are Rudder and Undine reefs in the Cairns Section, Clairview Beach in the Mackay/Capricornia Section and Tryon Island in the Capricorn Group. All of these sites have been subjected to regular collecting for several years and site species lists are already available.

11) That park rangers at each regional base should be well-versed in the preferred sites by user groups such as shell collectors. The accessible sites such as Dingo Beach, Kurrimine Beach, Shoal Point and Clairview deserve special attention by those responsible for enforcement. It is recommended that the activities of visitors and campers at Dingo Beach be given particular attention during the coming shell collecting seasons.

12) That consideration be given to future rezoning of Dingo Beach, as Marine National Park "A" zone, on a temporary basis (two years), to allow a suitable period for replenishment of depleted mollusc populations. Such zoning would only be viable with the assurance of sound management.

13) That further research, on the biology of the most vulnerable taxa (Volutidae and uncommon Cypraeidae) and the most heavily exploited species listed, be encouraged, in the form of supportive funding.

14) A management programme for the Australian shell trade has been proposed by Willan (1986); the recommendations are currently under review by Australian National Parks and Wildlife Service. Willan proposes that all shells be exempt from export controls, with the exception of a list of species which includes those species already protected, endemic shells and those considered potentially threatened by collecting for the souvenir, ornamental and specimen shell trade, and for culinary purposes. Management at the species level imposes a responsibility of identification upon those involved in the enforcement, such as customs officials. If specific shells are to be listed, then identification guidelines should be produced and appropriate authorities be available for referral if necessary. Due consideration must be given to the importance of the exchange trade highlighted in this report when developing export controls at the species level.

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APPENDIX

QUESTIONNAIRE- INDIVIDUAL CLUB MEMBERS

INTERVIEWER: _____

DATE: _____

LOCATION: _____

PERSON INTERVIEWED: _____

NAME OF CLUB: _____

1. How long have you been a specimen shell collector? (years)

☐

2. Are you a member of any other shell-collecting club?

Yes ☐

No ☐

If yes, which clubs?

_____

_____

3. From which sites have **you** collected over the past 3 years on CLUB collecting trips, and which were the main species collected by you?

DATE	REEF NAME	SPECIES record nos. where possible	HABITAT (eg. back reef, sand bank etc.)
1994			

DATE	REEF NAME	SPECIES	HABITAT
1995			
1996			

4. From which sites have **you** collected over the past 3 years, INDEPENDENT of club collecting trips? Please list the shells collected, and place an asterisk (*) beside those which are considered **local** to that area.

DATE	REEF NAME	SPECIES	HABITAT
1994			
1995			

DATE	REEF NAME	SPECIES	HABITAT
1996			

5. Do you keep a log-book of your collecting activities?

YES ☐
NO ☐

6. Please describe your method of collection:

Reef walking ☐
Snorkelling ☐
Scuba ☐
Other..... ☐

7. What tools do you use?

8. Have you noticed any change in abundance of shells over the past 3 years on sites visited on both club trips and independent trips?

Increase ☐
Decrease ☐
No change ☐

If so, please answer Q.8a.

8a. In your opinion, what species or families have changed in abundance, and at which sites has this occurred?

	SPECIES	REEF/LOCATION	HABITAT
Increase			
Decrease			

9. In your opinion which are the most important collecting sites? Please give reasons.

10. Do you specialize in collecting any particular groups of shells?

YES ☐
NO ☐

If yes please specify.

11. Are you conducting any research related to your shell collecting activities?

YES ☐
NO ☐

Please describe:

ECONOMIC SECTION

12. What % of the shells that you collect are retained for your private collection?

% ☐

13. What were the costs of your shell collecting activities in 1984-1986?

	SHELL PURCHASE	TRAVEL	OTHER (please specify)
1984			
1985			
1986			

14. What % of the shells which you collected during the past 2 years were obtained by:

	%	COST($)
(i) personal collecting.....		
(ii) exchange with other Qld collectors.....		
(iii) exchange with collectors from other states or countries (please specify).....		
(iv) private purchase from QLD. shell club members.		
(v) private purchase from wholesale or retail outlets.....		
(vi) private purchase from trawlers.....		
(vii) private purchase from interstate or overseas collectors (please specify state or country).		

15. Do you sell any shell specimens?

Yes ☐
No ☐ If NO please go to Q. 18

16. What % of shells which you sold during the past 2 years were originally obtained

	%
(i) during personal shell collecting	
(ii) through exchange with other QLD collectors	
(iii) through exchange with interstate or overseas collectors (please specify state and country)	
(iv) by private purchase from other QLD collectors	
(v) by private purchase from interstate or overseas (please specify state and country)	

17. Who did you sell your specimen to during the last 2 years?

(i) private collectors (QLD)	
(ii) private collectors (interstate or overseas: please specify state and country)	
(iii) retail outlets	
(iv) wholesalers	
(v) other (please specify)	

(END OF ECONOMIC QUESTIONS)

18. What species are most commonly requested for exchange interstate and overseas?

INTERSTATE	OVERSEAS

19. Has the zoning of the Marine Park affected your collecting activities?

YES ☐
NO ☐

If yes, in what way?

20. Do any other activities interfere with your shell collecting (eg. tourism, coral collecting, trawling etc.)?

ACTIVITY	LOCATION

21. Do you practice any deliberate conservation methods?

YES ☐
NO ☐

If so please give details.

22. Do you have any recommendations to make concerning your shell collecting activities?

Thank you for participating in this questionnaire

VISITOR ACTIVITY SURVEY

BAREBOAT CHARTERS

PLEASE COMPLETE FOR COLLECTION AT END OF CHARTER

This survey is being conducted on behalf of the Great Barrier Reef Marine Park Authority and will assist in future management. Your time in answering the questions is greatly appreciated. All information will be treated anonymously.

1. Please indicate:

Male ☐

Female ☐

Usual place of residence _____

2. Duration of charter: _____

3. Where did you anchor during your trip?

_____

_____

_____

_____

4. At these sites, which of the following activities did you participate in: (Tick one box per row)

	MAJOR ACTIVITY	MINOR ACTIVITY	NO ACTIVITY
swimming / snorkelling			
sunbaking			
beachcombing			
fishing			
reef walking			
shell collecting			
walking in the National Park			

5. Do you feel that the activity information available to visitors to the Whitsundays is:

GOOD ☐

ADEQUATE ☐

POOR ☐

6. Would you like to make any further comments which may be of value in assessing visitors needs in the Whitsundays?

_____

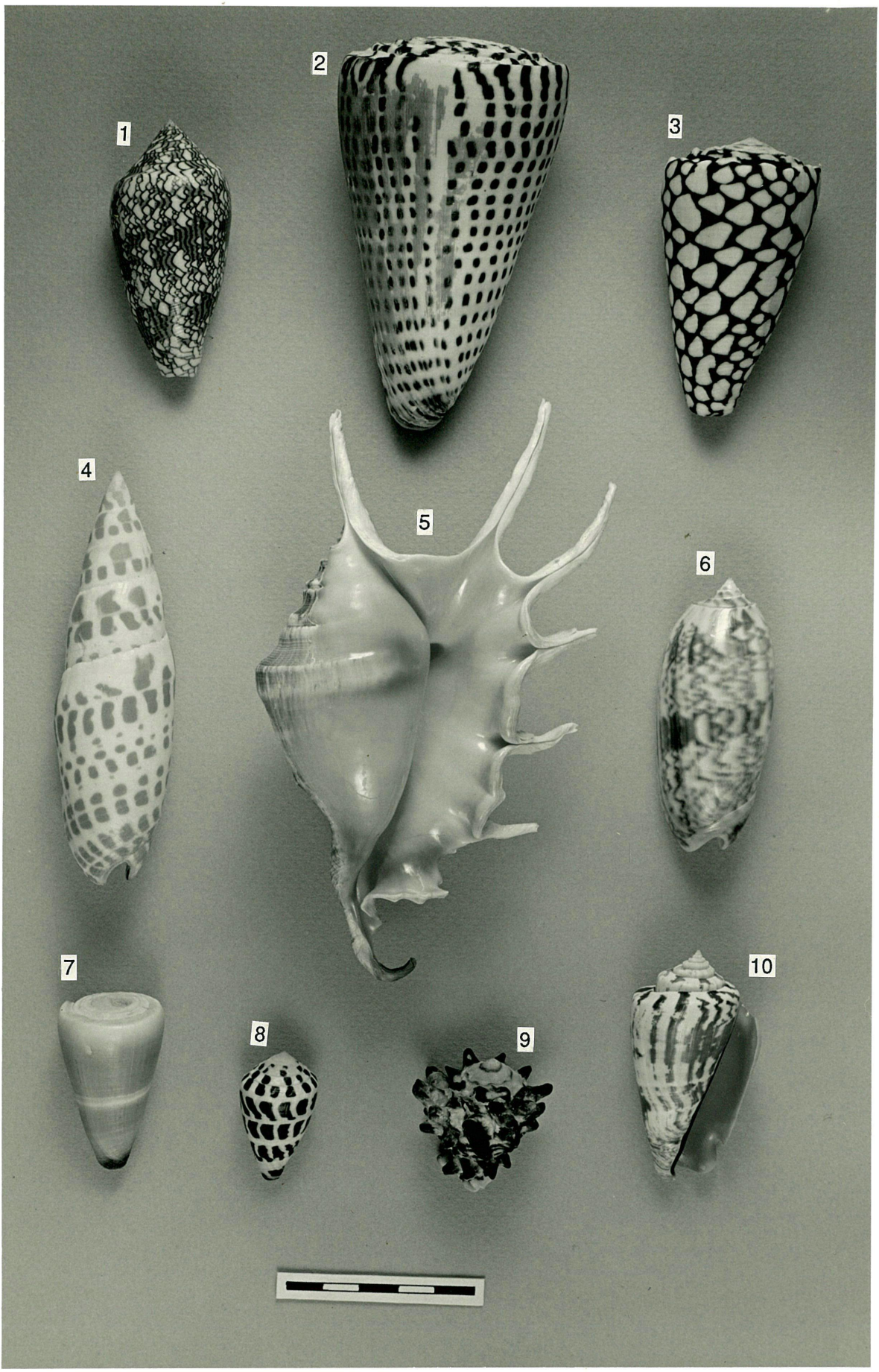
_____

_____

_____

_____

THANKYOU FOR YOUR HELP ☺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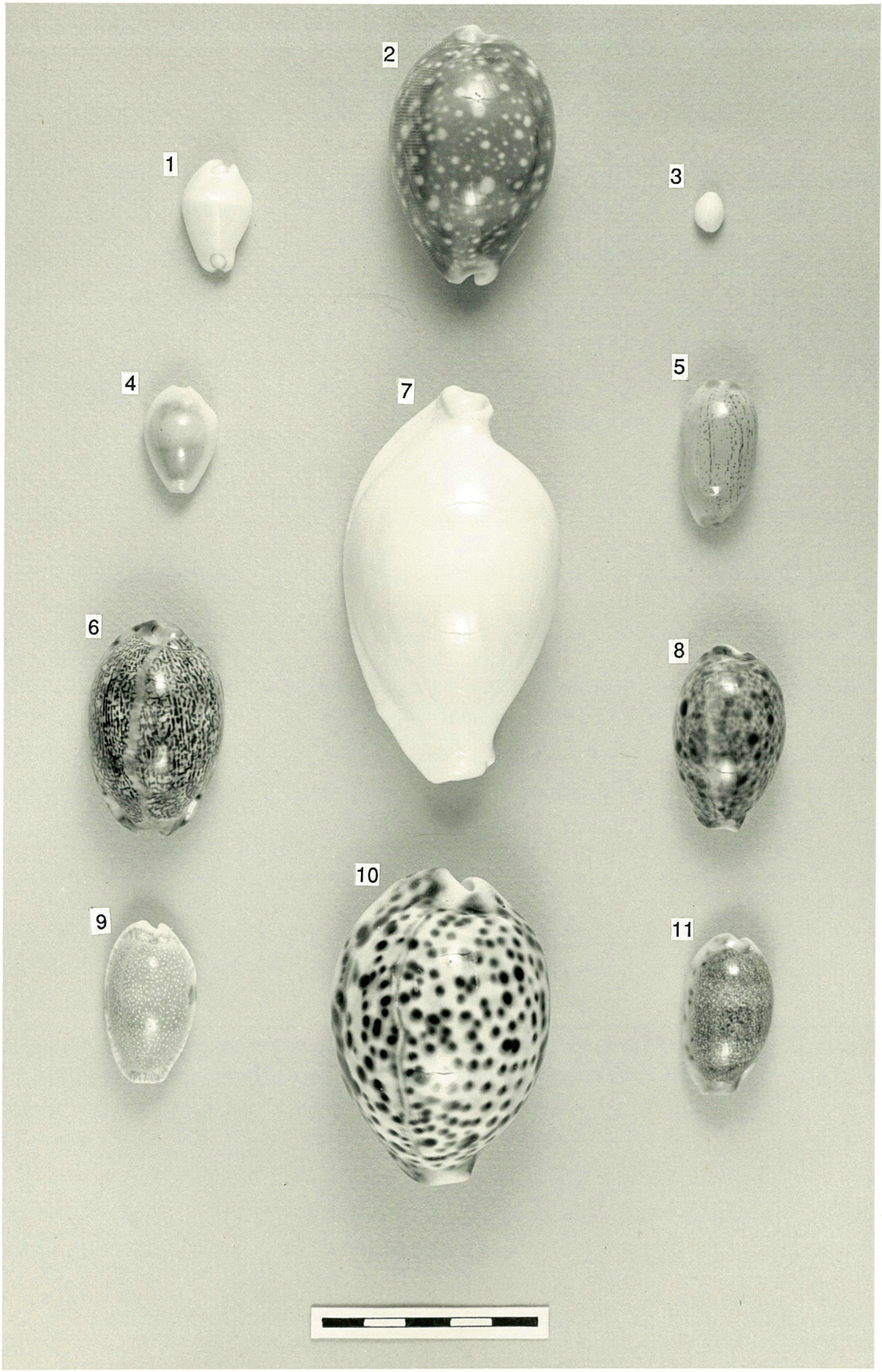
PL 4

PLATE 4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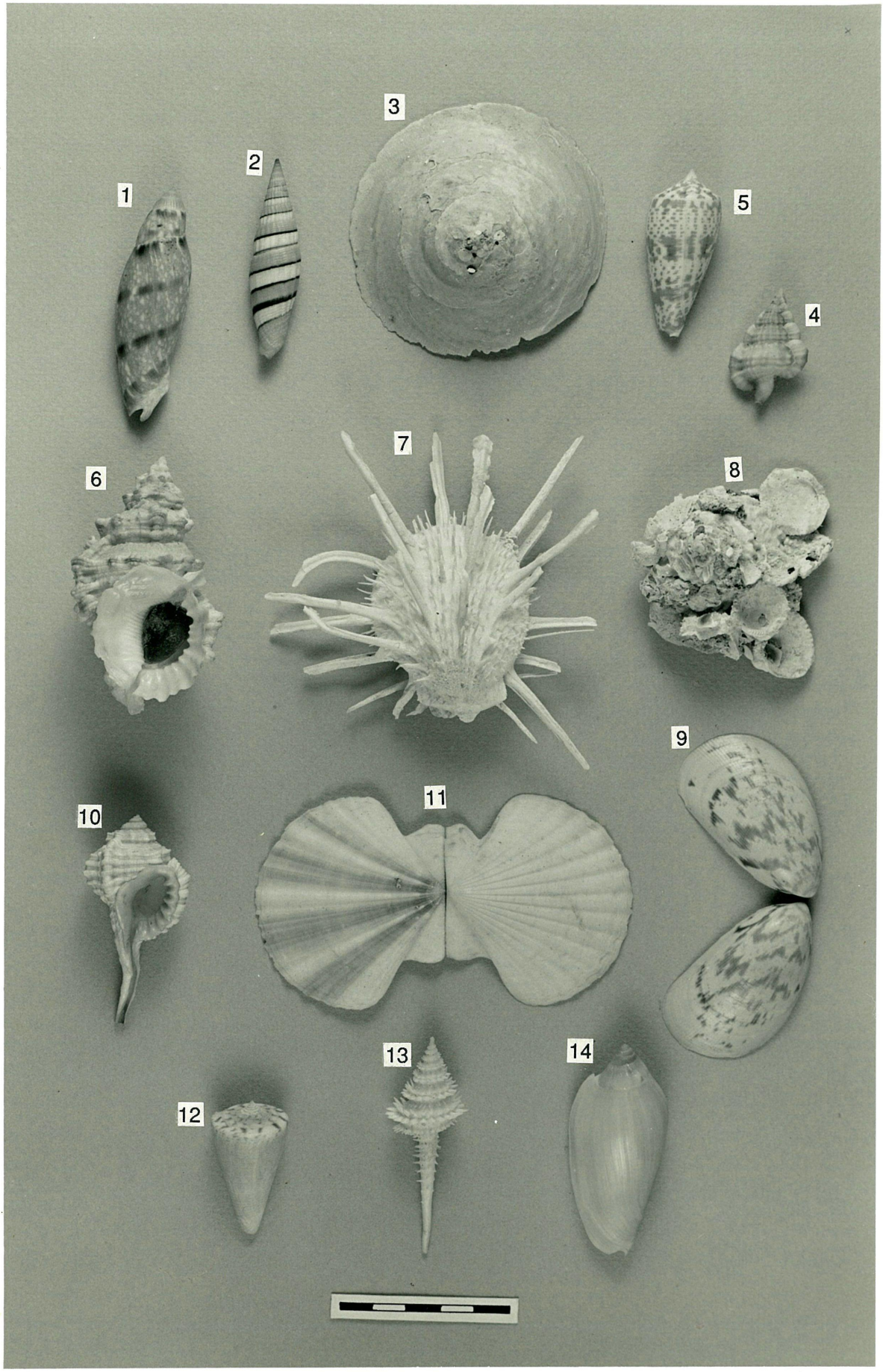
Pl. 5

PLATE 5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PL 6

PLATE 6

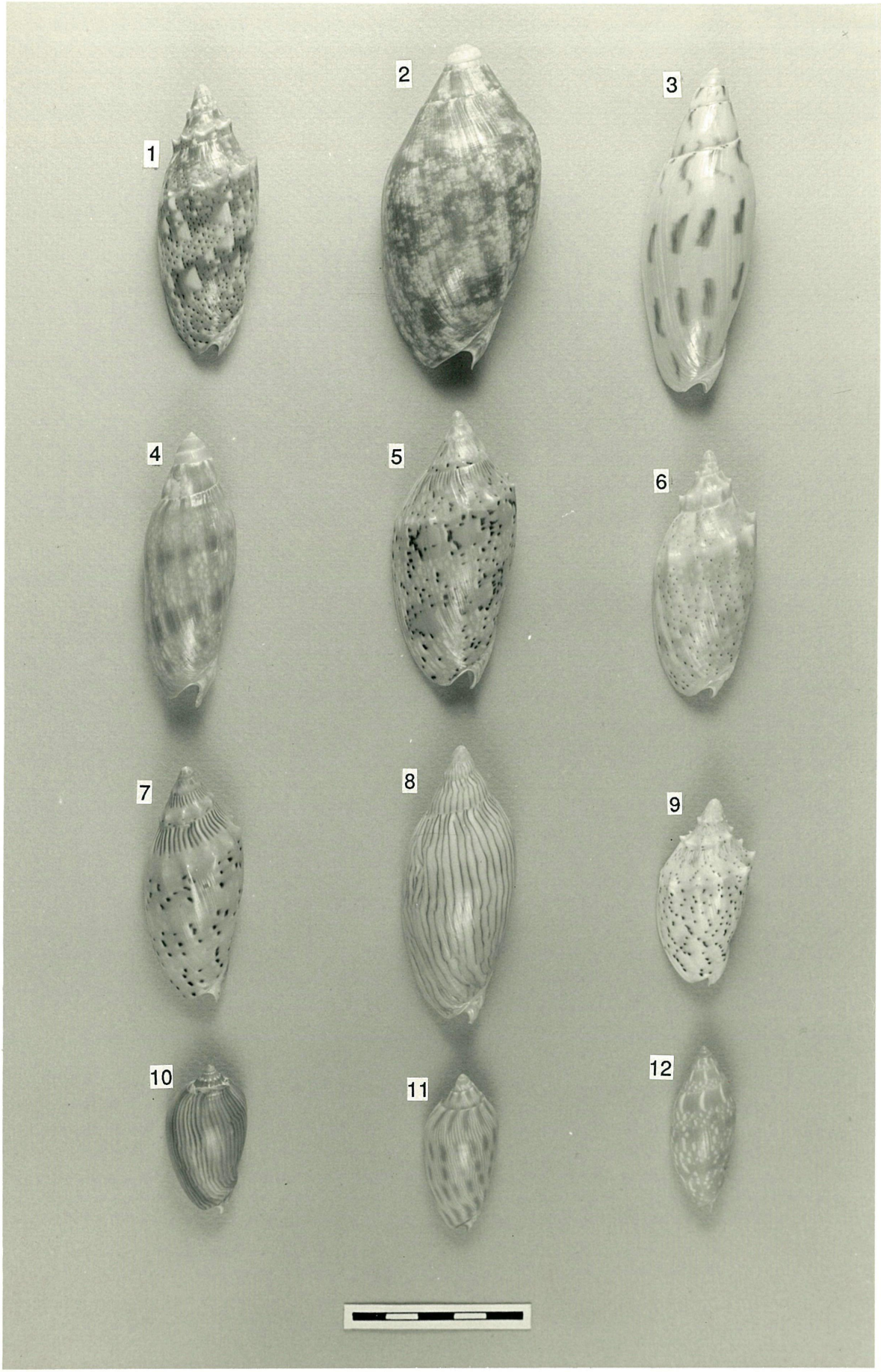
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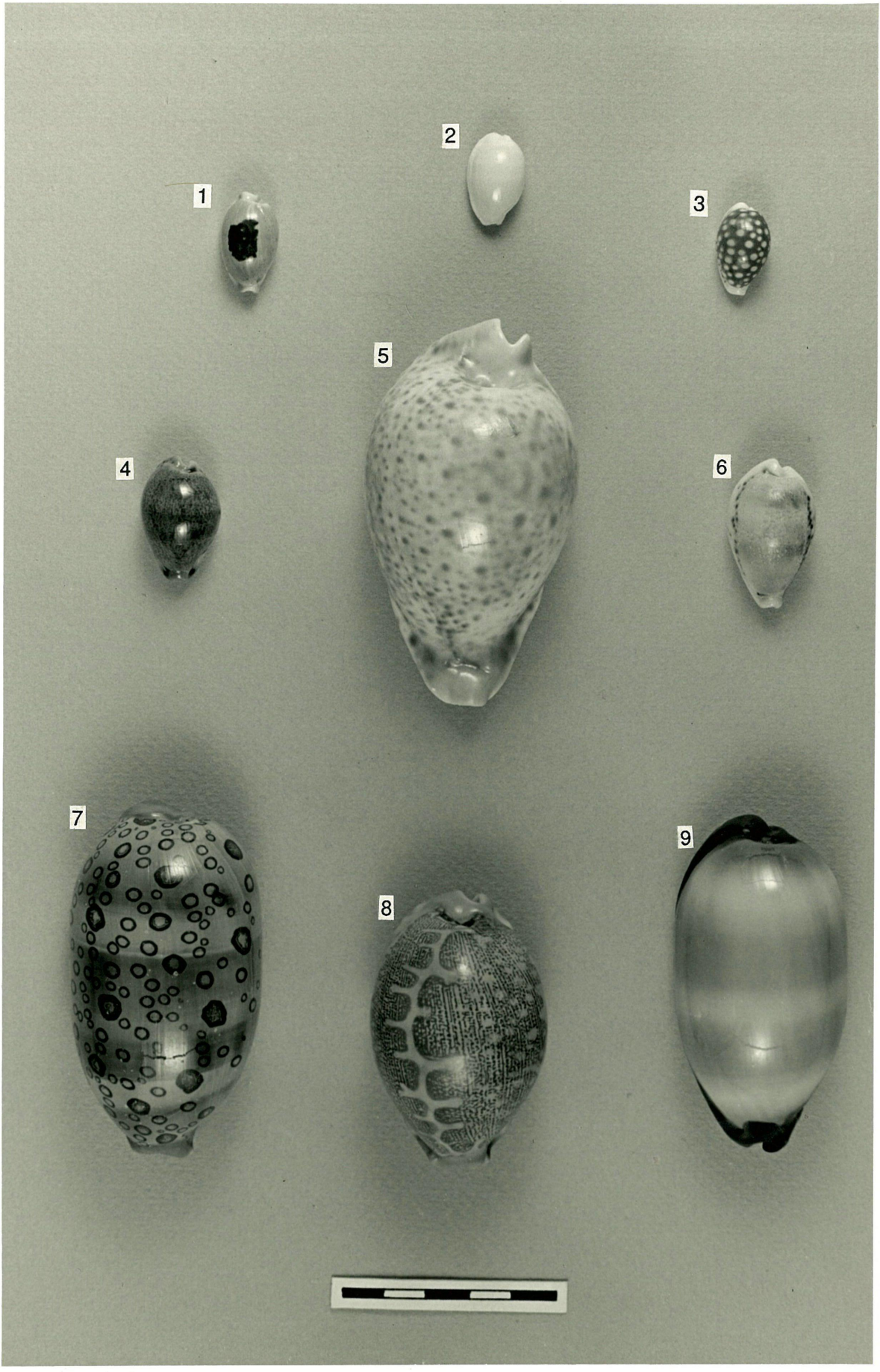
PLATE 7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Pl. 8

PLATE 8

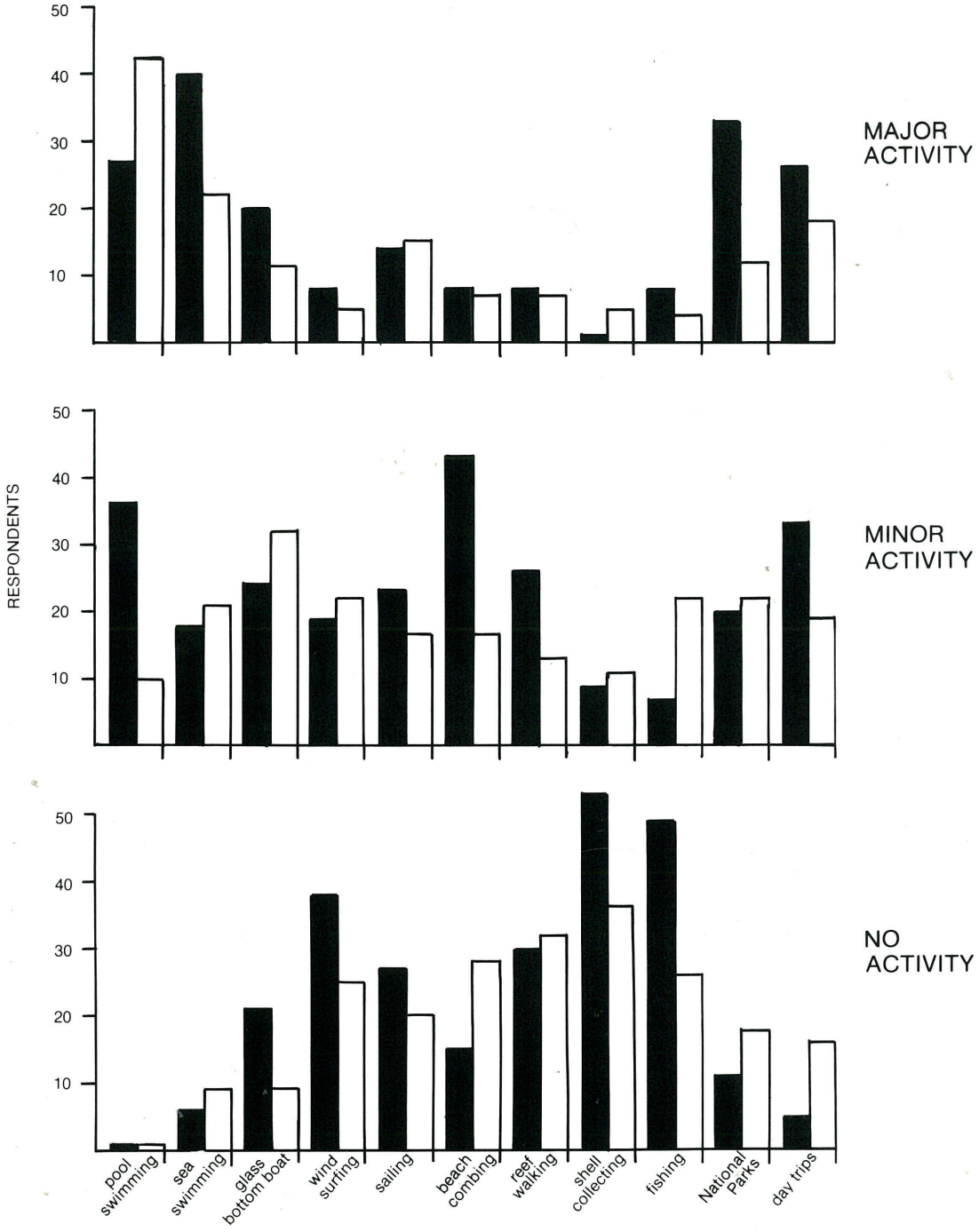


FIG.2 VISITOR ACTIVITIES AT SOUTH MOLLE RESORT (■-64 RESPONDENTS) AND DAYDREAM RESORT (□-52 RESPONDENTS) SURVEYED IN APRIL-JUNE, 1987.

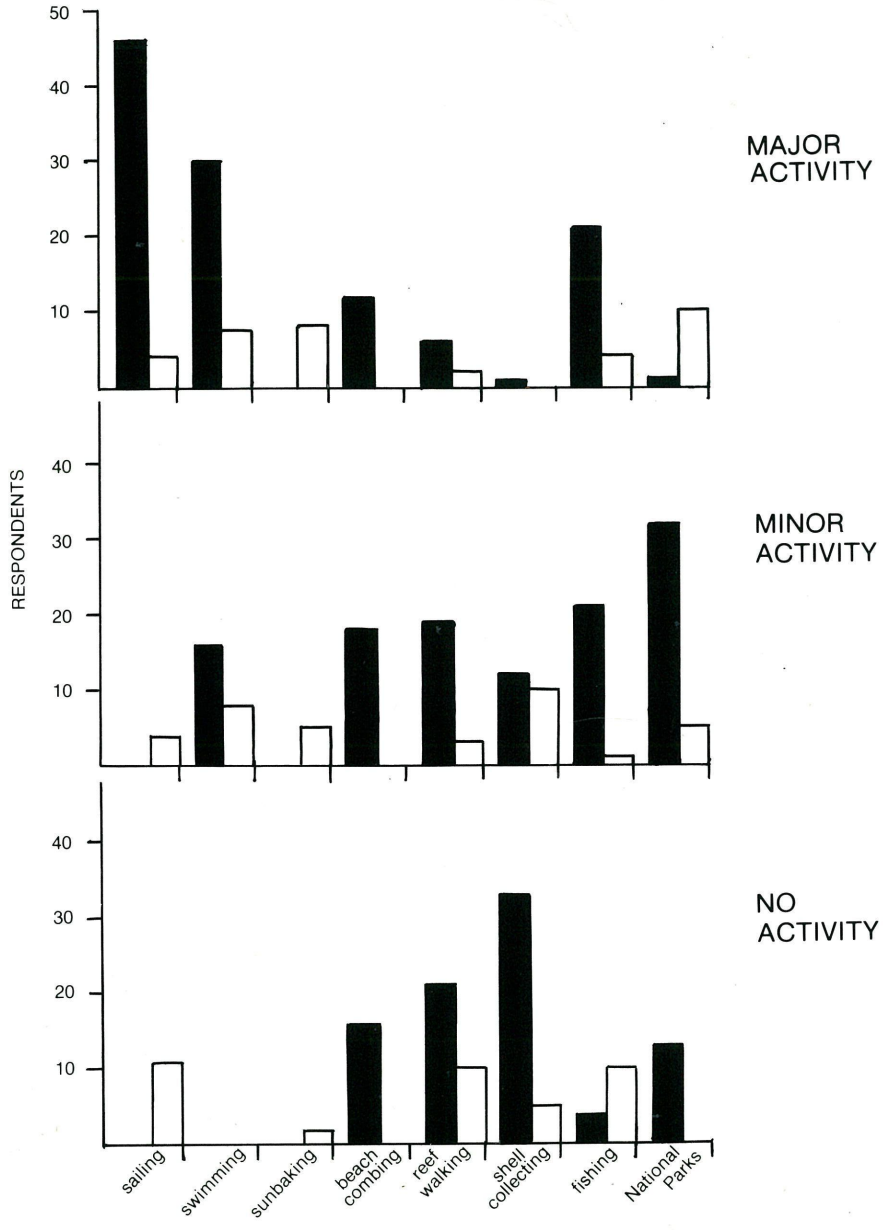


FIG. 3 ACTIVITIES UNDERTAKEN BY BAREBOAT PASSENGERS (■-46 RESPONDENTS) AND CAMPERS (□-15 RESPONDENTS) IN THE WHITSUNDAYS, SURVEYED IN APRIL-JULY, 1987.

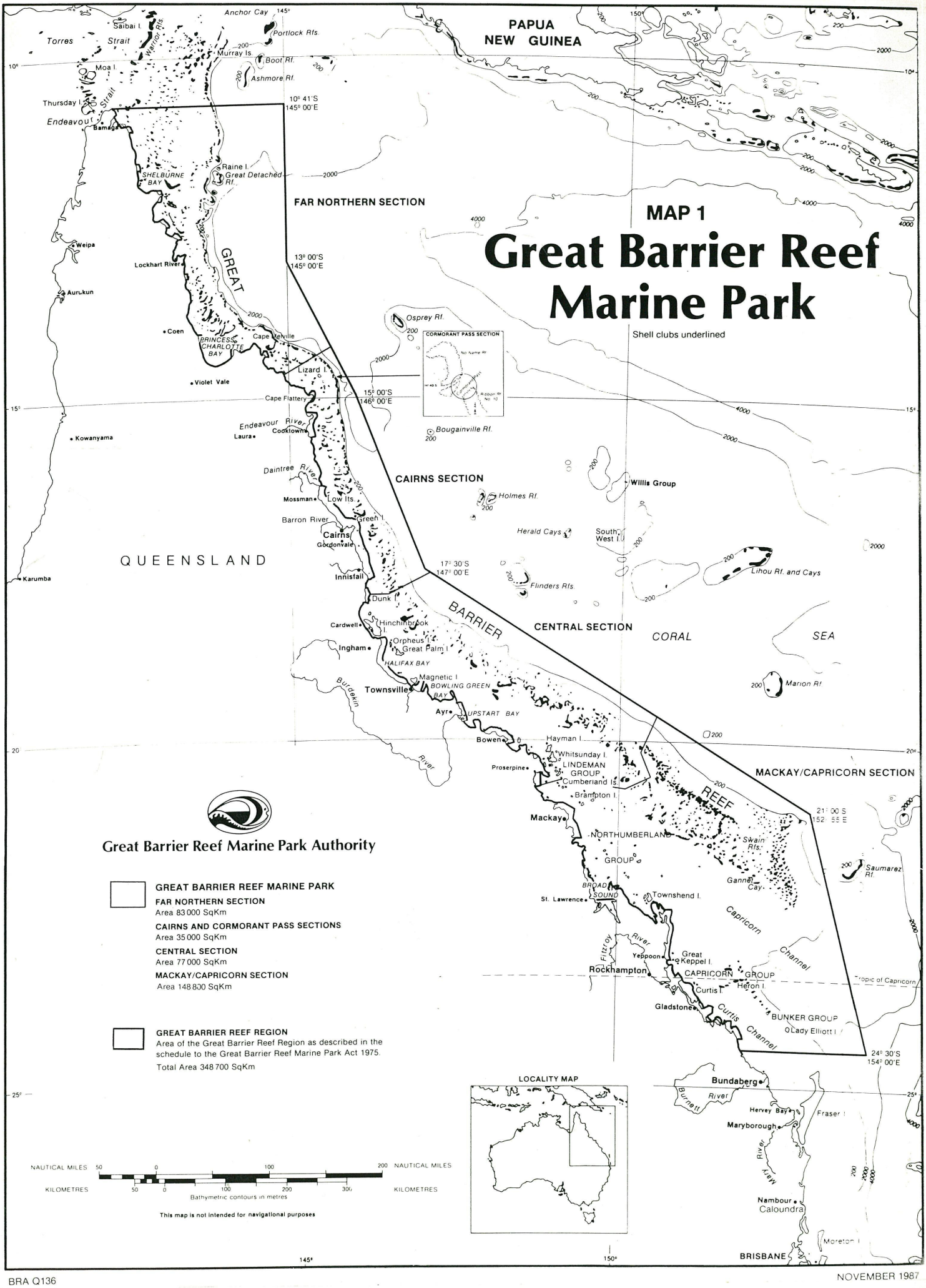
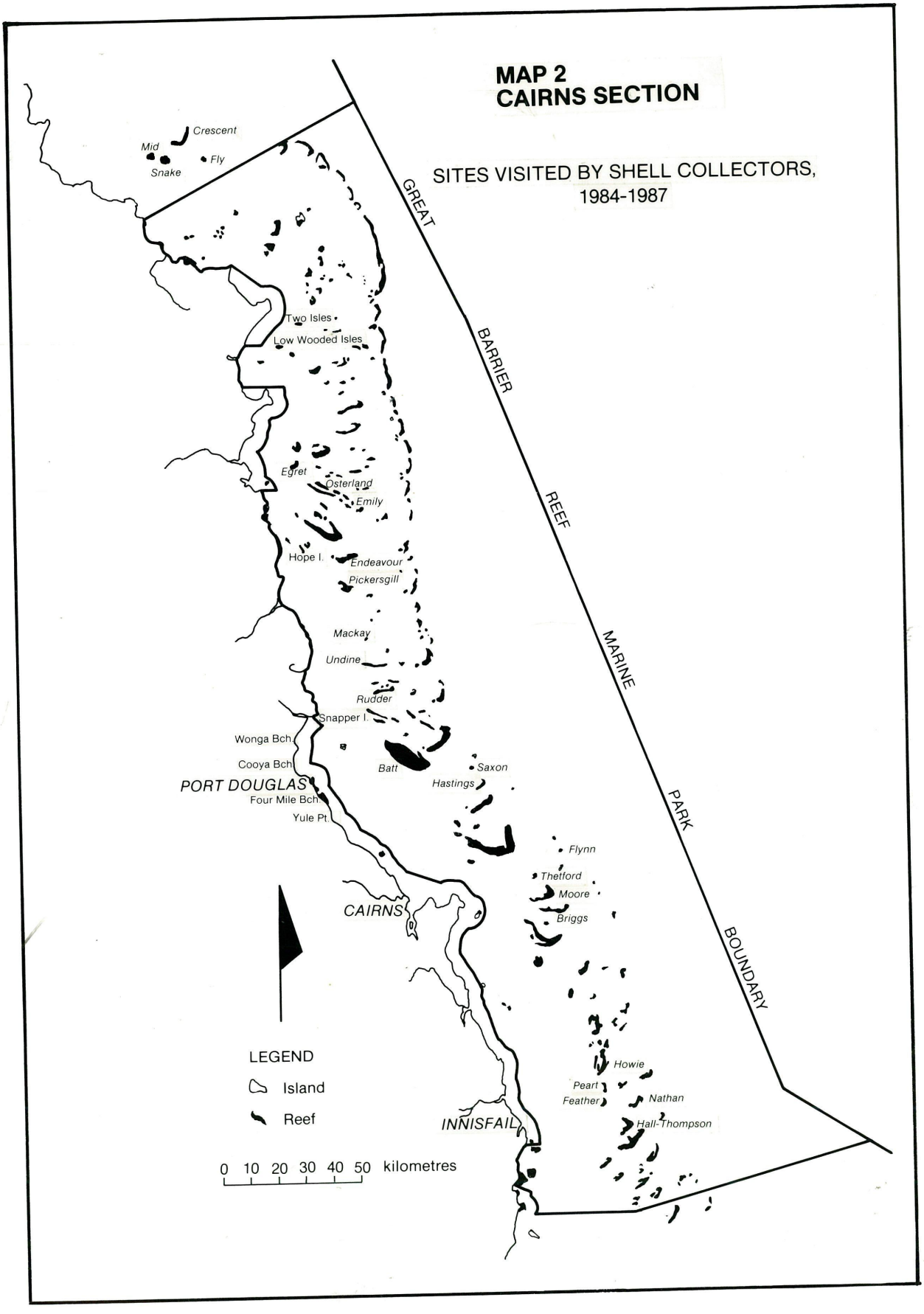
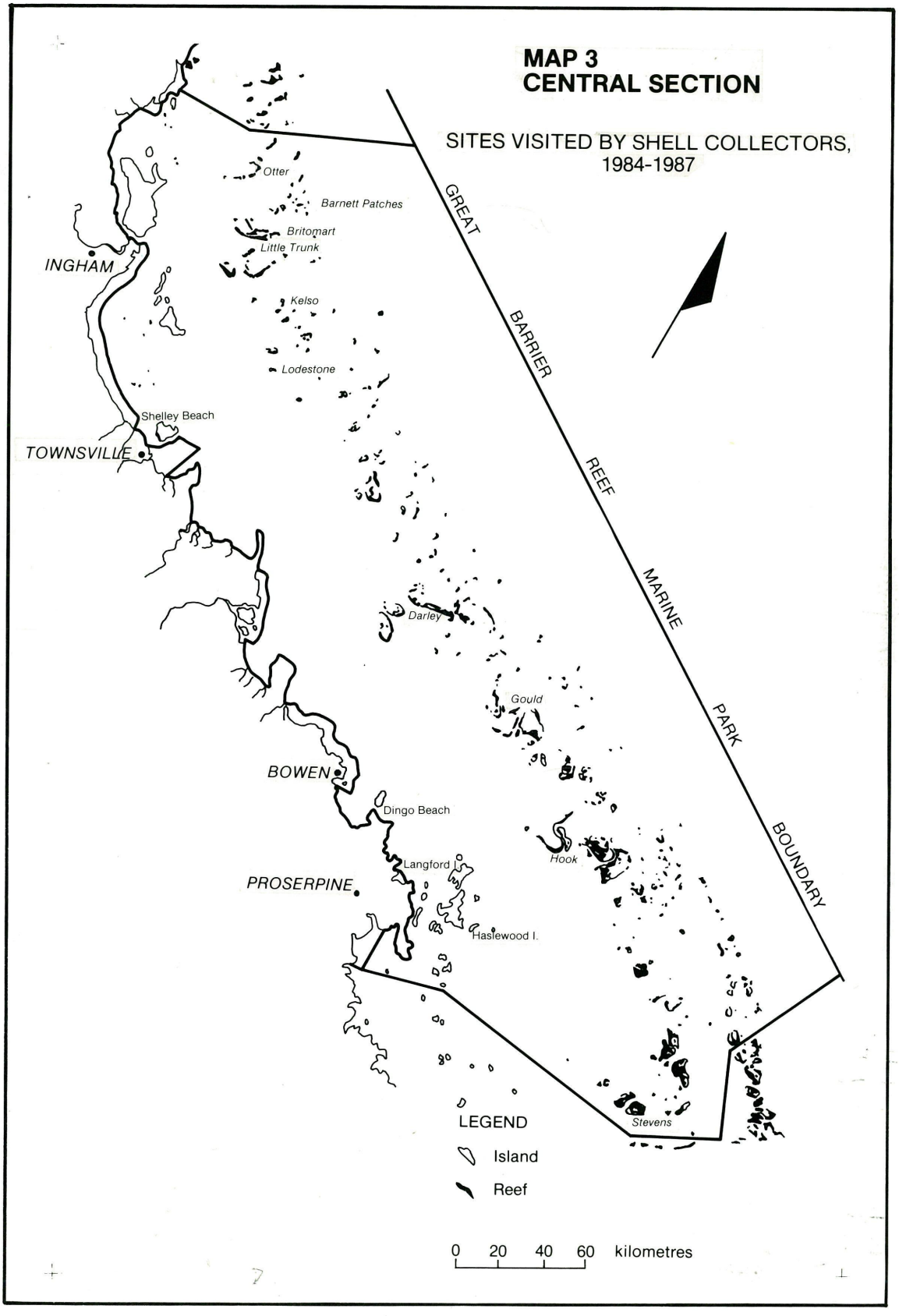

MAP 1
Great Barrier Reef Marine Park
Shell clubs underlined
PAPUA NEW GUINEA
QUEENSLAND
FAR NORTHERN SECTION
CAIRNS SECTION
CENTRAL SECTION
MACKAY/CAPRICORN SECTION
CORMORANT PASS SECTION
CORAL SEA
GREAT BARRIER REEF
Torres Strait
Thursday I.
Endeavour Strait
Moa I.
Saibai I.
Warrior Rfs.
Anchor Cay
Portlock Rfs.
Murray Is.
Boot Rf.
Ashmore Rf.
Bamaga
Raine I.
Great Detached Rf.
SHELBURNE BAY
Weipa
Lockhart River
Aurukun
Coen
PRINCESS CHARLOTTE BAY
Cape Melville
Lizard I.
Violet Vale
Cape Flattery
Kowanyama
Endeavour River
Cooktown
Laura
Daintree River
Mossman
Low Its.
Barron River
Green I.
Cairns
Gordonvale
Karumba
Innisfail
Dunk I.
Cardwell
Hinchinbrook I.
Orpheus I.
Great Palm I.
Ingham
HALIFAX BAY
Burdekin River
Townsville
Magnetic I.
BOWLING GREEN BAY
Ayr
UPSTART BAY
Bowen
Hayman I.
Whitsunday I.
LINDEMAN GROUP
Cumberland Is.
Brampton I.
Proserpine
Mackay
NORTHUMBERLAND GROUP
BROAD SOUND
St. Lawrence
Townshend I.
Swain Rfs.
Gannet Cay
Saumarez Rf.
Capricorn Channel
Fitzroy River
Yeppoon
Great Keppel I.
Rockhampton
CAPRICORN GROUP
Heron I.
Curtis I.
Tropic of Capricorn
Gladstone
Curtis Channel
BUNKER GROUP
Lady Elliott I.
Bundaberg
Burnett River
Hervey Bay
Fraser I.
Maryborough
Mary River
Nambour
Caloundra
Moreton I.
BRISBANE
Osprey Rf.
Bougainville Rf.
Holmes Rf.
Herald Cays
South West I.
Willis Group
Flinders Rfs.
Lihou Rf. and Cays
Marion Rf.
10° 41'S 145° 00'E
13° 00'S 145° 00'E
15° 00'S 146° 00'E
17° 30'S 147° 00'E
21° 00'S 152° 55'E
24° 30'S 154° 00'E
Great Barrier Reef Marine Park Authority
GREAT BARRIER REEF MARINE PARK
FAR NORTHERN SECTION
Area 83 000 SqKm
CAIRNS AND CORMORANT PASS SECTIONS
Area 35 000 SqKm
CENTRAL SECTION
Area 77 000 SqKm
MACKAY/CAPRICORN SECTION
Area 148 800 SqKm
GREAT BARRIER REEF REGION
Area of the Great Barrier Reef Region as described in the schedule to the Great Barrier Reef Marine Park Act 1975.
Total Area 348 700 SqKm
LOCALITY MAP
NAUTICAL MILES
KILOMETRES
Bathymetric contours in metres
This map is not intended for navigational purposes

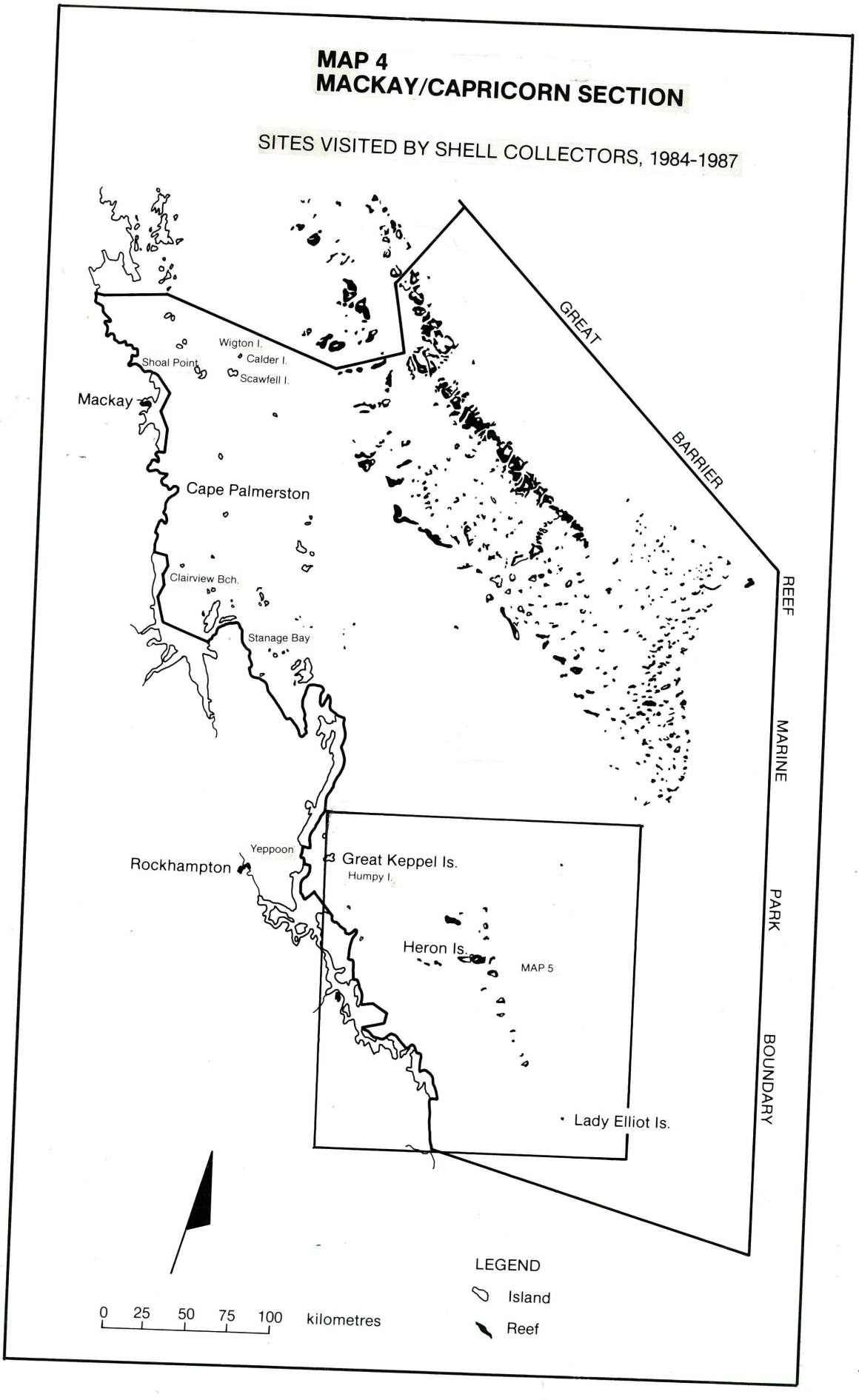
Figure 7. Transplanted corals (a) carefully placed and (b) attached to the substrate. The attached corals have a more natural appearance.

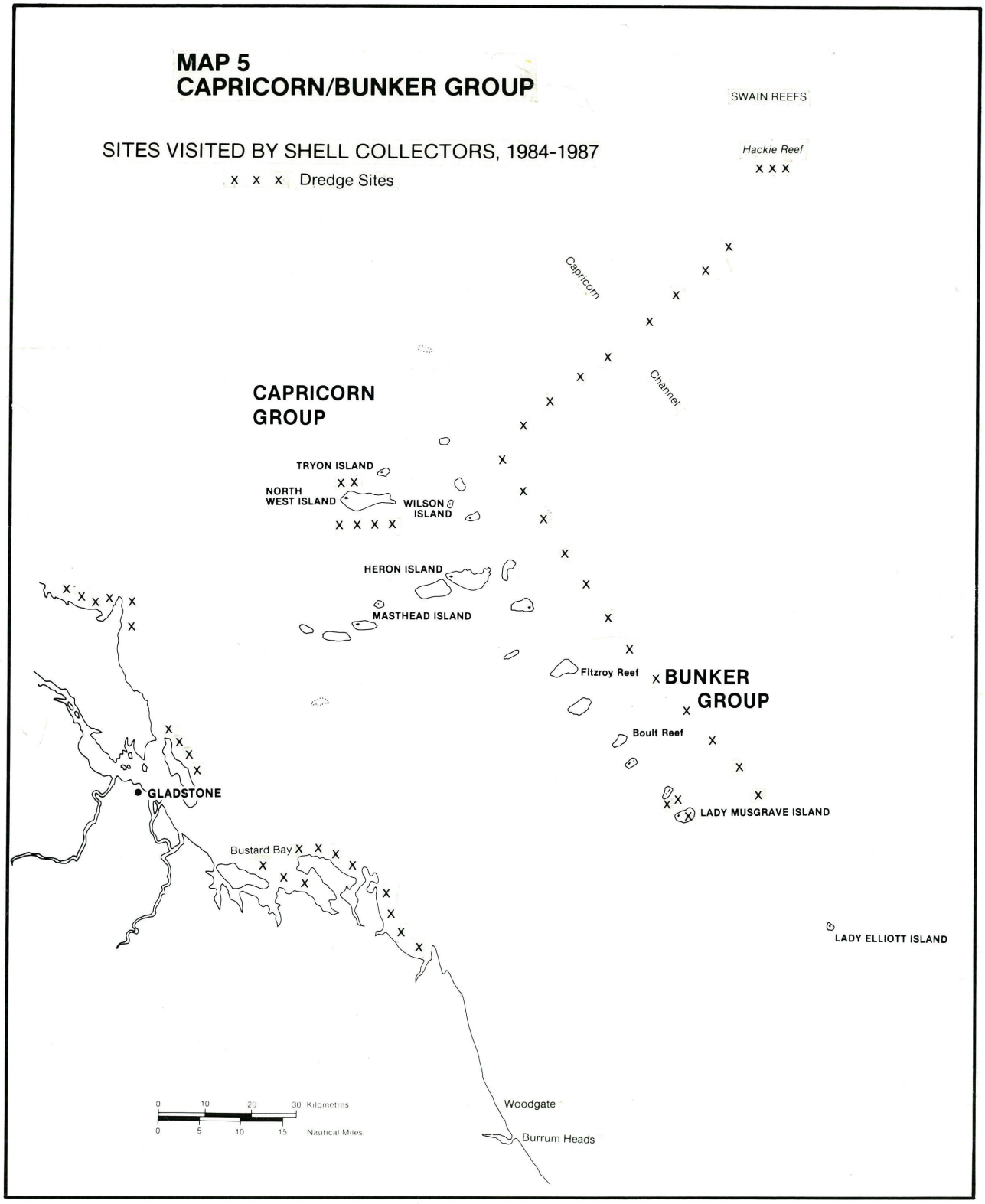
Table 6: Most Heavily Collected Mollusc Species on the Great Barrier Reef, Recorded by Permit Holders, 1984-87.

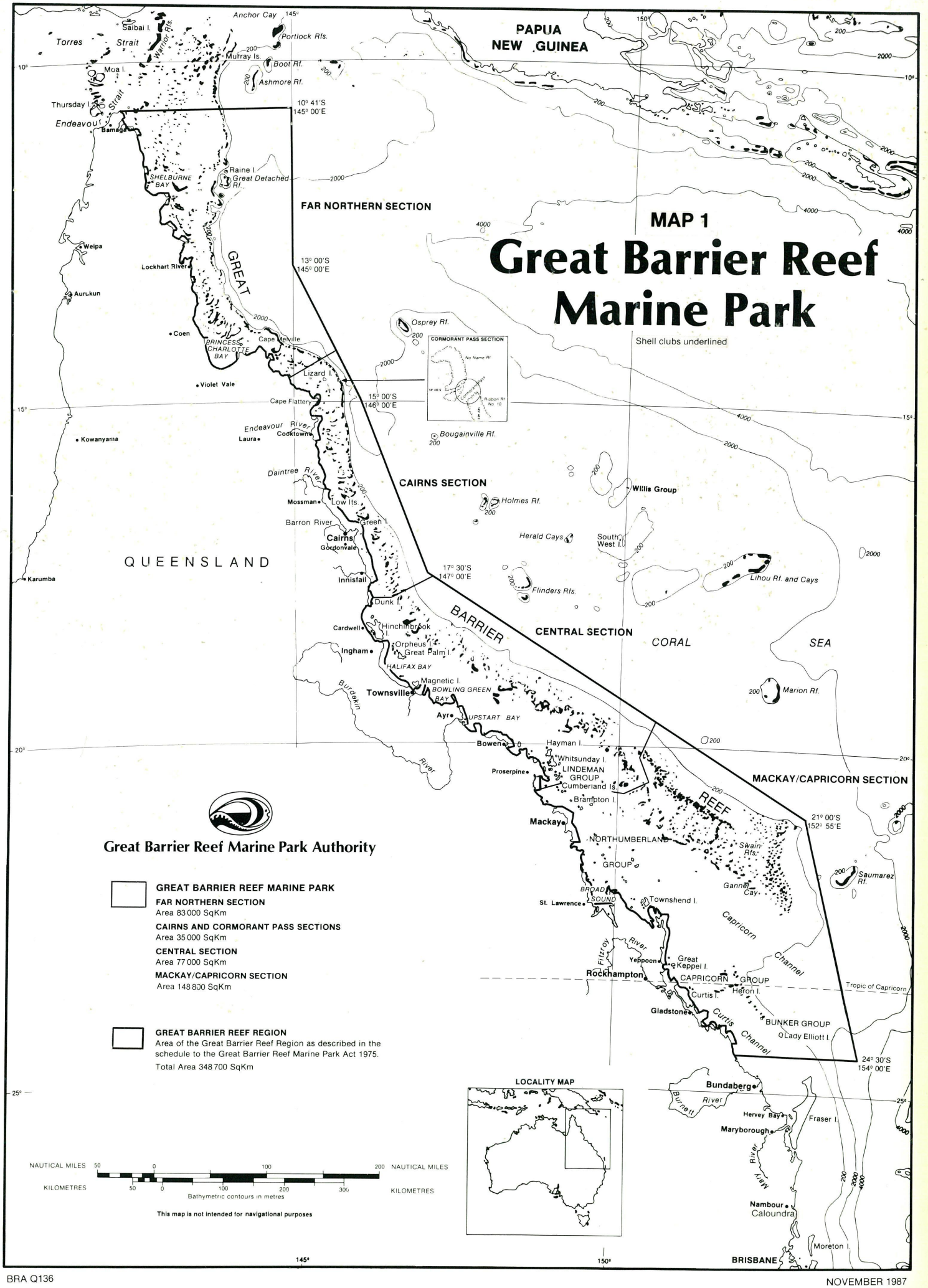
	ALL SECTIONS	Total	CAIRNS SECTION	Total	CENTRAL SECTION	Total	CAPRICORNIA SECTION	Total
1.	Lambis lambis LINN.	496	Lambis lambis LINN.	473	Strombus luhuanus LINN.	19	Cypraea arabica LINN.	152
2.	Cypraea annulus LINN.	300	Conus marmoreus LINN.	282	Terebra chlorata LAMARCK	18	Cypraea annulus LINN.	119
3.	Cypraea arabica LINN.	299	Strombus luhuanus LINN.	201	Conus flavidus LAMARCK	12	Cypraea moneta LINN.	65
4.	Conus marmoreus LINN.	291	Oliva miniacea RODING	200	Conus litteratus LINN.	12	Conus ebraeus LINN.	51
5.	Strombus luhuanus LINN.	220	Cypraea annulus LINN.	180	Cerithium nodulosum BRUG.	11	Cypraea erosa LINN.	51
6.	Oliva miniacea RODING	210	Conus litteratus LINN.	177	Cypraea moneta LINN.	10	Cypraea cribraria LINN.	45
7.	Conus litteratus LINN.	191	Oliva tessellata LAMARCK	159	Cypraea stolida LINN.	10	Cypraea felina GMELIN.	43
8.	Cypraea vitellus LINN.	160	Cypraea arabica LINN.	142	Oliva miniacea RODING	10	Strombus aratrum RODING	40
9.	Oliva tessellata LAM.	159	Ovula ovum GMELIN	21	Cypraea caurica LINN.	9	Cypraea vitellus LINN.	38
10.	Cypraea moneta LINN.	156	Vasum turbinellum LINN.	113	Cypraea lynx LINN.	8	Cypraea tigris LINN.	36
11.	Cypraea erosa LINN.	139	Mitra mitra LINN.	111	Conus marmoreus LINN.	8	Cypraea errones LINN.	30
12.	Conus textile LINN.	130	Cypraea vitellus LINN.	106	Conus textile LINN.	7	Cypraea caurica LINN.	28
13.	Cypraea lynx LINN.	124	Cypraea lynx LINN.	106	Cypraea cribraria LINN.	7	Conus catus HWASS	25
14.	Ovula ovum GMELIN	123	Conus textile LYNN.	102	Cypraea erosa LINN.	7	Conus textile LINN.	20
15.	Mitra mitra LINN.	122	Conus arenatus HWASS	101	Conus leopardus LINN.	7	Oliva oliva LINN.	20
16.	Vasum turbinellum LINN.	121	Terebra maculata LINN.	94	Conus miliaris HWASS	7	Cymbiolacca pulchra SOW.	17
17.	Conus ebraeus LINN.	120	Conus flavidus LAMARCK	91	Conus virgo LINN.	7	Lambis lambis LINN.	17
18.	Conus flavidus LAMARCK	117	Cypraea erosa LINN.	81	Turbo chrysostoma LINN.	7	Cypraea asellus LINN.	16
19.	Conus arenatus HWASS	108	Cerithium fasciatum BRUG.	80	Cypraea vitellus LINN.	6	Cypraea carneola LINN.	16
20.	Cypraea tigris LINN.	104	Cypraea moneta LINN.	80	Drupina grossularia RODING	6	Cypraea hammondae IREDALE	16
21.	Terebra maculata LINN.	97	Cypraea isabella LINN.	79	Lambis lambis LINN.	6	Cypraea melwardi IREDALE	16
22.	Cypraea isabella LINN.	93	Turbo chrysostoma LINN.	79	Trochus maculatus LINN.	6	Conus miliaris HWASS	15
23.	Conus leopardus RODING	88	Conus leopardus RODING	78	Turbo argyrostomus LINN.	5	Cypraea staphylaea LINN.	15
24.	Cypraea caurica LINN.	87	Trivirostra oryza LAM.	73	Cypraea arabica LINN.	5	Cypraea clandestina LINN.	14
25.	Turbo chrysostoma LINN.	86	Calpurnus verrucosus LINN.	71	Cypraea felina GMELIN	5	Conus coronatus GMELIN	14
26.	Cypraea errones LINN.	83	Conus miles LINN.	69	Cypraea gracilis GASKOIN	5	Conus flavidus LAMARCK	14
27.	Cerithium fasciatum BRU.	80	Conus ebraeus LINN.	68	Cypraea isabella LINN.	5	Cypraea eglantina DUCLOS	10
28.	Cerithium nodulosum BRU.	80	Cypraea tigris LINN.	65	Conus omaria HWASS	5	Cypraea lynx LINN.	10
29.	Terebra chlorata LAM.	76	Cerithium nodulosum BRUG.	63	Conus planorbis BORN	5	Cypraea isabella LINN.	9
30.	Trivirostra oryza LAM.	76	Conus virgo LINN.	60	Oliva annulata GMELIN	5	Cypraea kieneri HIDALGO	8
31.	Conus miles LINN.	75	Terebra chlorata LAMARCK	56	Trochus niloticus LINN.	5	Conus virgo LINN.	8
32.	Calpurnus verrucosus L.	74	Conus quercinus LIGHTFOOT	55	Conus arenatus HWASS	4	Haliotis asinina LINN.	8
33.	Conus lividus HWASS	67	Conus capitaneus LINN.	54	Cypraea asellus LINN.	4	Lambis truncata KIENER	8
34.	Cypraea cribraria LINN.	66	Terebra dimidiata LINN.	53	Conus aulicus LINN.	4	Pyrene testudinaria LINK	8
35.	Conus capitaneus LINN.	62	Cyp.caputserpentis LINN.	51	Cypraea eglantina DUCLOS	4	Rhino. brettinghami CERN.	8
36.	Cyp.caputserpentis LINN.	60	Cypraea caurica LINN.	50	Conus glans HWASS	4	Rhinoclavis asper LINN.	7
37.	Cypraea carneola LINN.	56	Conus striatus LINN.	49	Conus miles LINN.	4	Conus capitaneus LINN.	7
38.	Terebra dimidiata LINN.	56	Conus eburneus HWASS	48	Conus vitulinus HWASS	4	Cyp.caputserpentis LINN.	7
39.	Cypraea felina GMELIN	55	Trochus niloticus LINN.	47	Lambis truncata KIENER	4	Conus frigidus REEVE	7
40.	Strombus aratrum RODING	52	Vasum ceramicum LINN.	40	Lambis chiragra LINN.	4	Cypraea minoridens MELVILL	7


MAP 2
CAIRNS SECTION
SITES VISITED BY SHELL COLLECTORS,
1984-1987
GREAT
BARRIER
REEF
MARINE
PARK
BOUNDARY
Crescent
Mid
Fly
Snake
Two Isles
Low Wooded Isles
Egret
Osterland
Emily
Hope I.
Endeavour
Pickersgill
Mackay
Undine
Rudder
Snapper I.
Wonga Bch
Cooya Bch
PORT DOUGLAS
Four Mile Bch
Yule Pt.
Batt
Saxon
Hastings
Flynn
Thetford
Moore
Briggs
CAIRNS
Howie
Peart
Feather
Nathan
Hall-Thompson
INNISFAIL
LEGEND
Island
Reef
0 10 20 30 40 50 kilometres


MAP 3
CENTRAL SECTION
SITES VISITED BY SHELL COLLECTORS, 1984-1987
GREAT BARRIER REEF MARINE PARK BOUNDARY
Otter
Barnett Patches
Britomart
Little Trunk
INGHAM
Kelso
Lodestone
Shelley Beach
TOWNSVILLE
Darley
Gould
BOWEN
Dingo Beach
Hook
Langford
PROSERPINE
Haslewood I.
Stevens
LEGEND
Island
Reef
0 20 40 60 kilometres

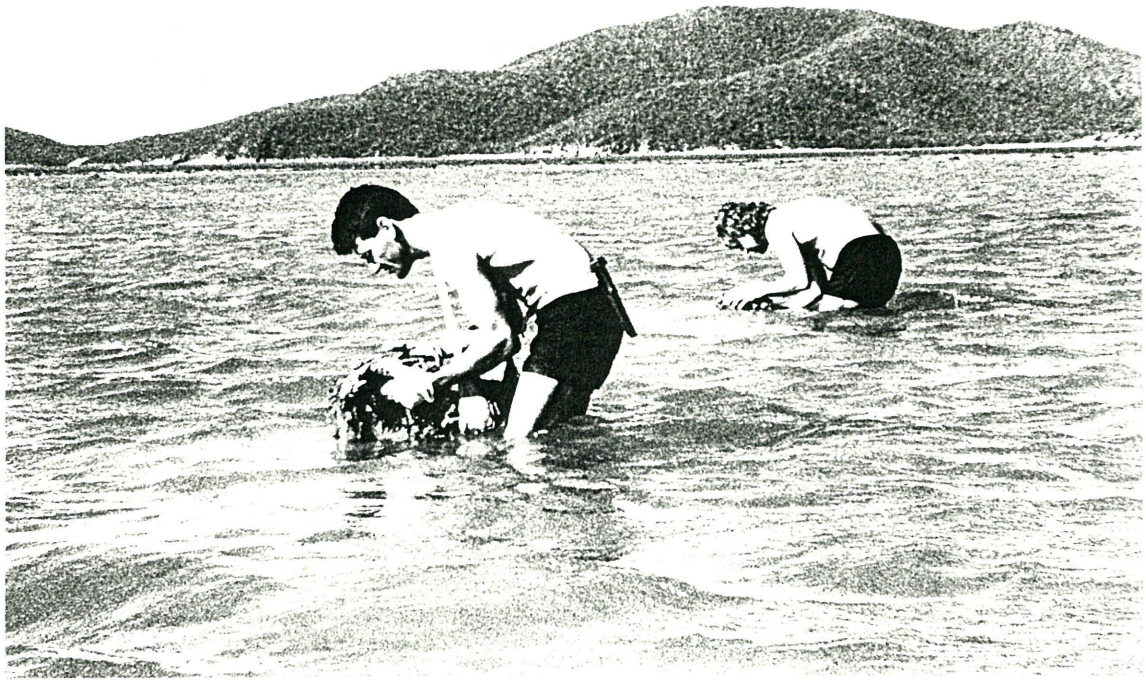

MAP 4
MACKAY/CAPRICORN SECTION
SITES VISITED BY SHELL COLLECTORS, 1984-1987
GREAT
BARRIER
REEF
MARINE
PARK
BOUNDARY
Wigton I.
Calder I.
Shoal Point
Scawfell I.
Mackay
Cape Palmerston
Clairview Bch.
Stanage Bay
Yeppoon
Rockhampton
Great Keppel Is.
Humpy I.
Heron Is.
MAP 5
Lady Elliot Is.
LEGEND
Island
Reef
0 25 50 75 100 kilometres


MAP 5
CAPRICORN/BUNKER GROUP
SITES VISITED BY SHELL COLLECTORS, 1984-1987
x x x Dredge Sites
SWAIN REEFS
Hackie Reef
x x x
Capricorn
Channel
CAPRICORN GROUP
TRYON ISLAND
NORTH WEST ISLAND
WILSON ISLAND
HERON ISLAND
MASTHEAD ISLAND
Fitzroy Reef
BUNKER GROUP
Boult Reef
LADY MUSGRAVE ISLAND
LADY ELLIOTT ISLAND
GLADSTONE
Bustard Bay
Woodgate
Burrum Heads
0 10 20 30 Kilometres
0 5 10 15 Nautical Miles



BRA Q136

NOVEMBER 1987



A. Collectors in search of *Cyprae stolida* f. *Brevidentata* wade on a falling tide to maximise search time.

B. Rocks are lifted and returned on the exposed reef flat.

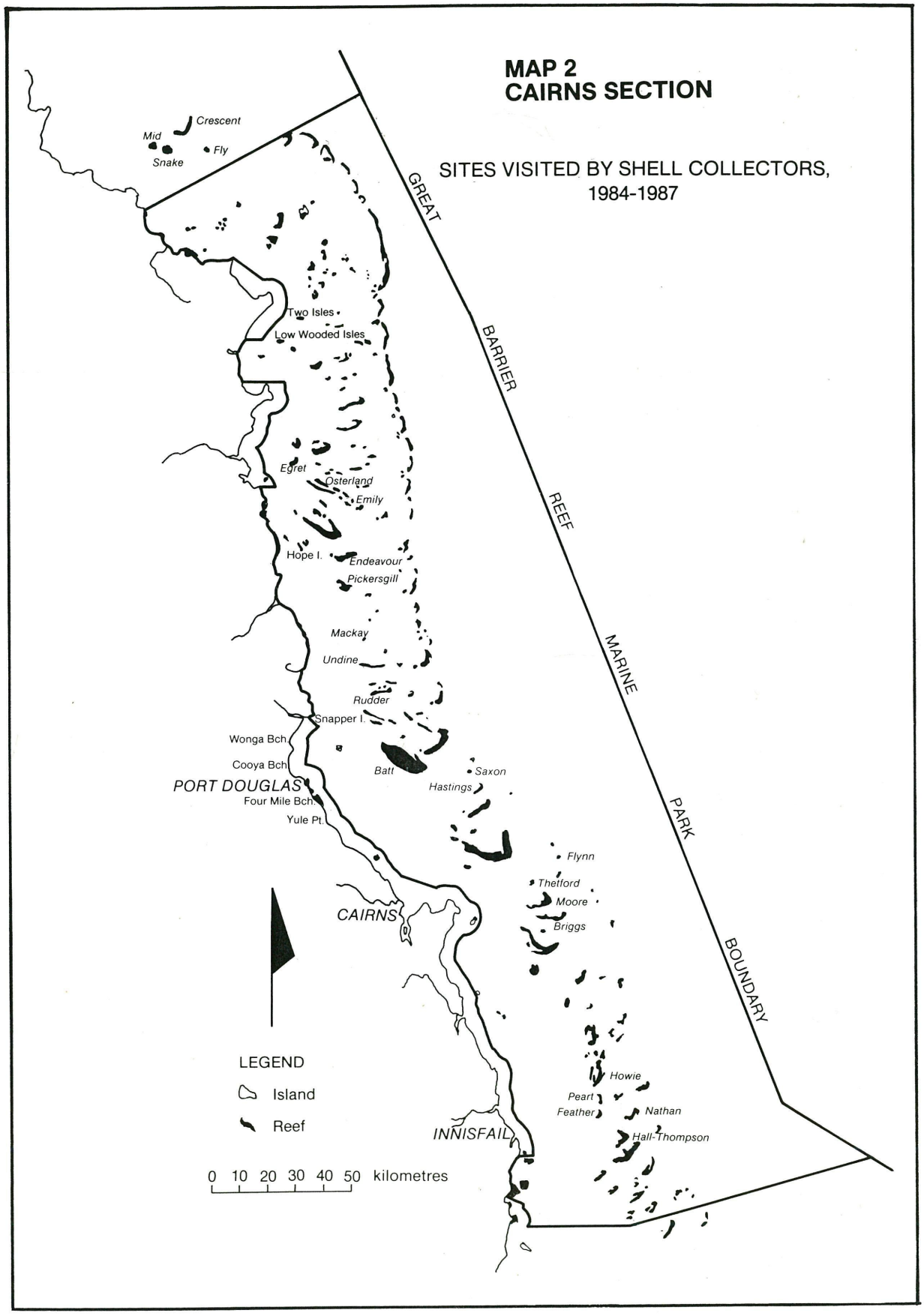

MAP 2
CAIRNS SECTION
SITES VISITED BY SHELL COLLECTORS,
1984-1987
GREAT BARRIER REEF MARINE PARK BOUNDARY
Crescent
Mid
Fly
Snake
Two Isles
Low Wooded Isles
Egret
Osterland
Emily
Hope I.
Endeavour
Pickersgill
Mackay
Undine
Rudder
Snapper I.
Wonga Bch
Cooya Bch
PORT DOUGLAS
Four Mile Bch
Yule Pt.
Batt
Saxon
Hastings
Flynn
Thetford
Moore
Briggs
CAIRNS
Howie
Peart
Feather
Nathan
Hall-Thompson
INNISFAIL
LEGEND
Island
Reef
0 10 20 30 40 50 kilometres

Table 3A cont.

		1984												1985											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
Otter	18018								1																	
Barnett Patches	18019																			1						
Little Trunk	18026								1											1						
Kelso	18030								1																	
Lodestone	18078																			1						
Darley	19043								1																	CENTRAL
Gould	19072																									SECTION
Hook	19136																			1						
Langford	20019																			1						
Stevens	20294							1																		
Wigton Island	20262							1																		
Calder Island	29289																		1	1						
Scawfell Island	220290																				1					
Double Island	21034																									SOUTHERN
Tryon Island	23046																					1				SECTION
North West Island	23049							1											1							
Masthead Island	23069												1													
Boult	23079																									
Hoskins	23080															1										
Lady Musgrave Is.	23082															1										South

Table 3B: Number of Recorded Shell Collecting Trips on the Great Barrier Reef, 1986-87.

		1986												1987											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Mid	14066																			1					
Crescent	14082																			1					
Snake	14087																			1					
Fly	14109																			1					
Two Isles	15002																			1					
Low Wooded Isles	15003									1															
Egret	15013																			1					
Osterland	15078																				1				
Emily	15082																		1						
East Hope Island	15065						2	1											2		1				
Endeavour	15089						1	2													1				
Pickersgill	15093						1	2											1						
Evening	15095																								
Snapper Island	16006																			1					
Mackay	16015					1	1	2	1	1									2	1	1				
Undine	16020					1	1	3	3										1	1					
Rudder	16023					1	2	2	2	1									1		1				
Batt	16029																		1		1				
Saxon	16032																								
Hastings	16057																		1						
Flynn	16065	1	1	2	1							1		1	1	1	1								
Thetford	16068					1								2	1	1									
Moore	16071					1																			
Briggs	16074																								
Howie	17018					1																			
Peart	17024																								
Feather	17034						1	1	1										1						
Nathan	17035																								
Hall-Thompson	17037																		1						

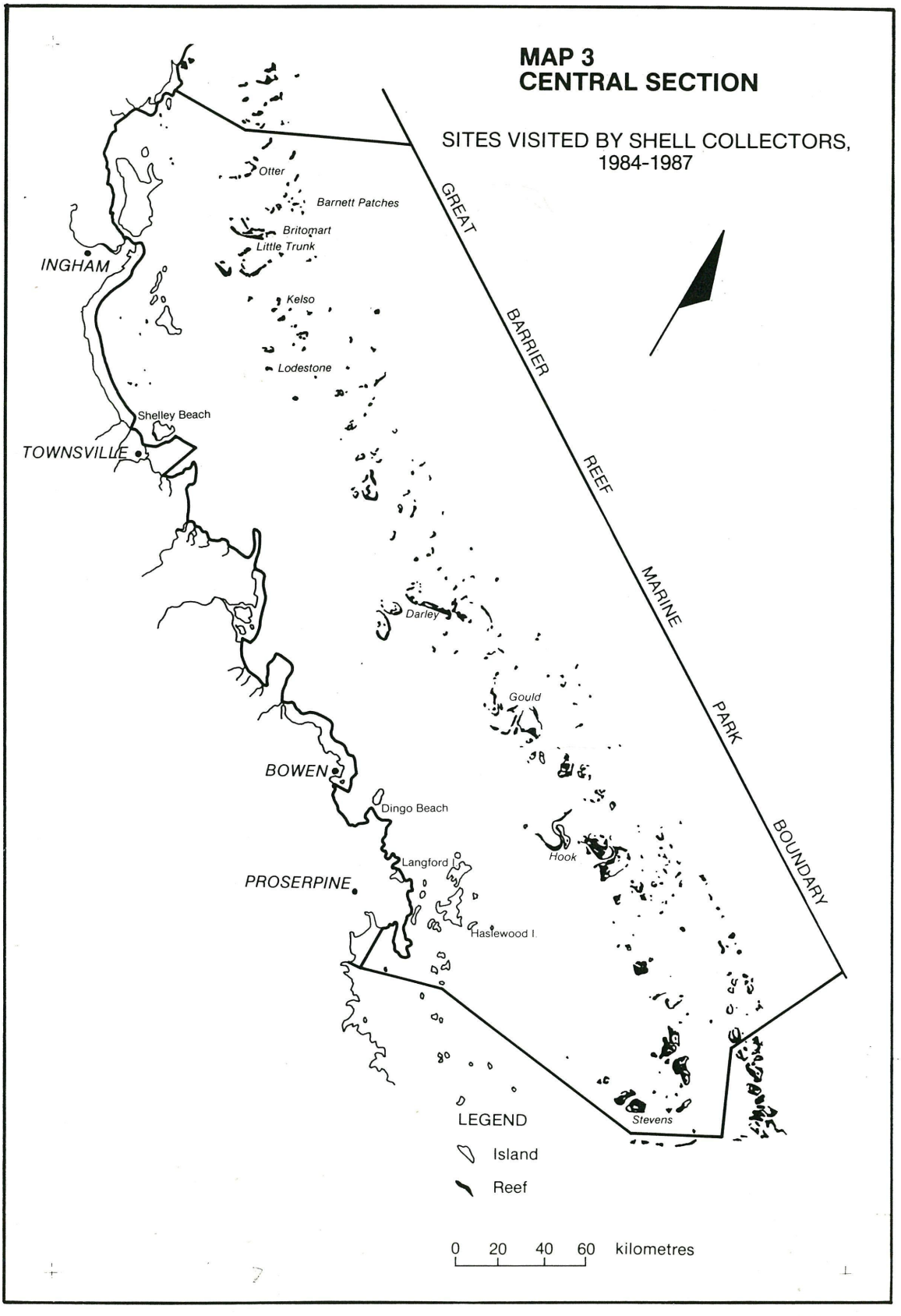
	North
	FAR NORTH
	SECTION
	CAIRNS
	SECTION

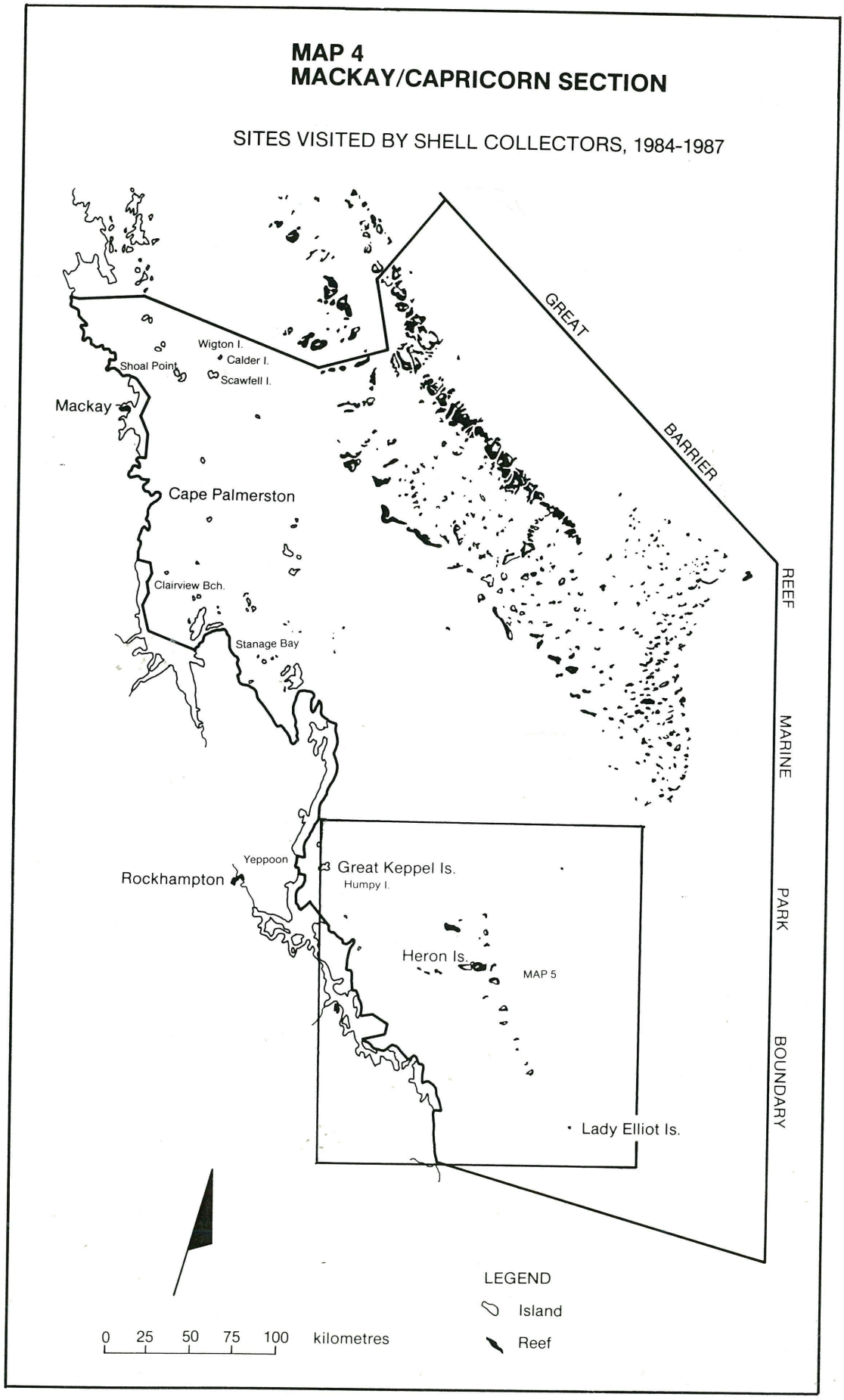
Table 3B cont.

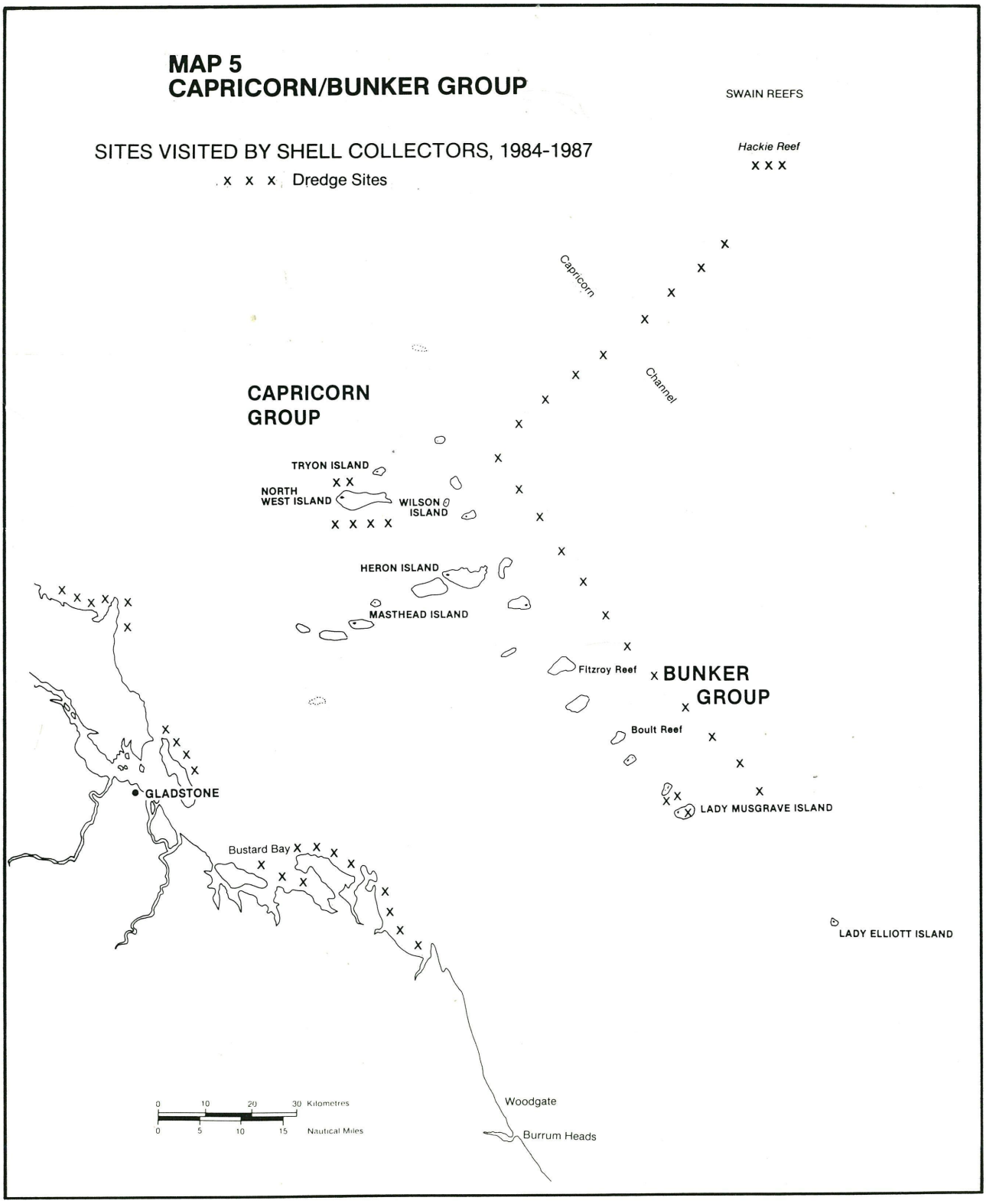
		1986												1987											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
Otter	18018																									
Barnett Patches	18019																									
Little Trunk	18026								1																	
Kelso	18030																									
Lodestone	18078																									
Darley	19043																									CENTRAL
Gould	19072								1																	SECTION
Hook	19136																									
Langford	20019							1																		
Stevens	20294																									
Wigton Island	20262																									
Calder Island	20289																									
Scawfell Island	20290																									
Double Island	21034					1									1											SOUTHERN
Tryon Island	23046						2	2	1	1											1					SECTION
North West Island	23049																									
Masthead Island	23069																									
Boult	23079																		1							
Hoskins	23080																	1								
Lady Musgrave Is.	23082					1			1																	South

Table 3A: Number of Recorded Shell Collecting Trips on the Great Barrier Reef, 1984-85.

		1984												1985											
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	
Mid	14066																									North
Crescent	14082																									FAR NORTH
Snake	14087																									SECTION
Fly	14109																									
Two Isles	15002																									
Low Wooded Isles	15003																									
Egret	15013																									
Osterland	15078																									
Emily	15082																									
East Hope Island	15065									1																
Endeavour	15089																									
Pickersgill	15093									1																
Evening	15095									1																
Snapper Island	16006																									CAIRNS
Mackay	16015					1	1	1		1								1	1							SECTION
Undine	16020					1	2	1	1	1								1	1							
Rudder	16023						3	2	2	1								1	2		2					
Batt	16029					1	2	1																		
Saxon	16032																									
Hastings	16057																									
Flynn	16065																							1		
Thetford	16068																									
Moore	16071																									
Briggs	16074							1																		
Howie	17018																									
Peart	17024						1													1						
Feather	17034						1												1	1	1					
Nathan	17035							1													1					
Hall-Thompson	17037							1																		


MAP 3
CENTRAL SECTION
SITES VISITED BY SHELL COLLECTORS,
1984-1987
GREAT
BARRIER
REEF
MARINE
PARK
BOUNDARY
Otter
Barnett Patches
Britomart
Little Trunk
INGHAM
Kelso
Lodestone
Shelley Beach
TOWNSVILLE
Darley
Gould
BOWEN
Dingo Beach
Hook
Langford I.
PROSERPINE
Haslewood I.
Stevens
LEGEND
Island
Reef
0 20 40 60 kilometres


MAP 4
MACKAY/CAPRICORN SECTION
SITES VISITED BY SHELL COLLECTORS, 1984-1987
GREAT
BARRIER
REEF
MARINE
PARK
BOUNDARY
Wigton I.
Calder I.
Shoal Point
Scawfell I.
Mackay
Cape Palmerston
Clairview Bch.
Stanage Bay
Yeppoon
Rockhampton
Great Keppel Is.
Humpy I.
Heron Is.
MAP 5
Lady Elliot Is.
LEGEND
Island
Reef
0 25 50 75 100 kilometres

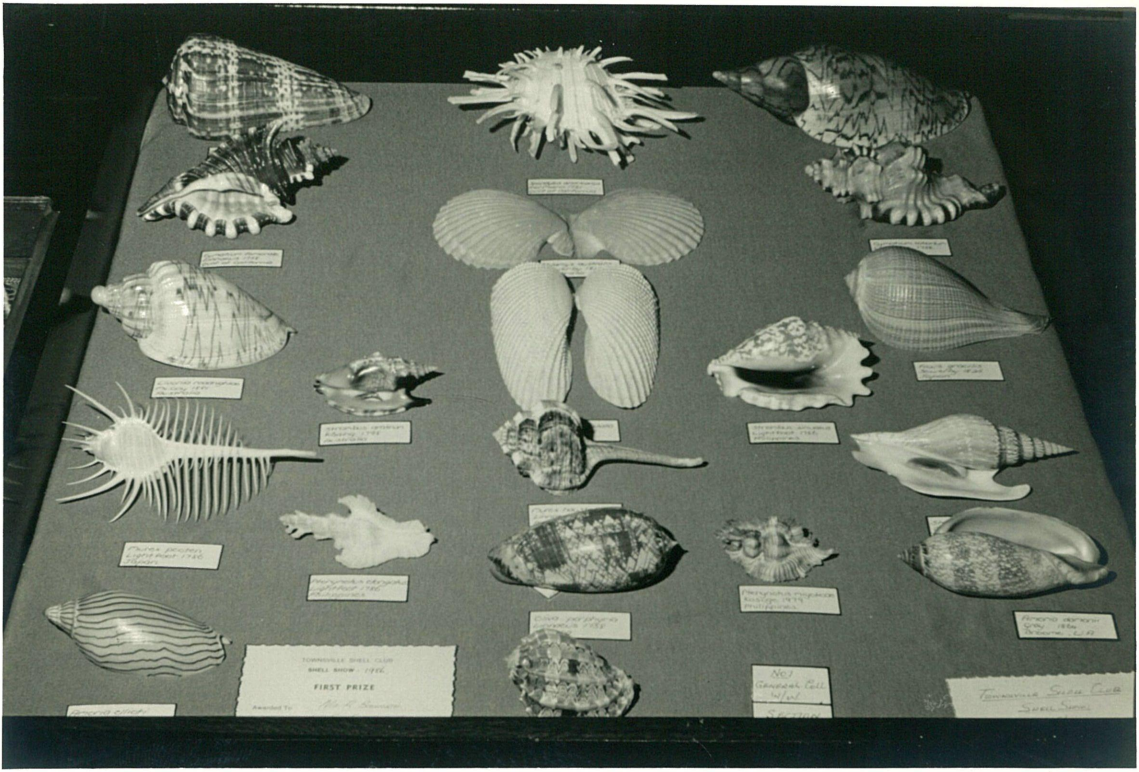

MAP 5
CAPRICORN/BUNKER GROUP
SITES VISITED BY SHELL COLLECTORS, 1984-1987
x x x Dredge Sites
SWAIN REEFS
Hackie Reef
x x x
Capricorn
Channel
CAPRICORN GROUP
TRYON ISLAND
NORTH WEST ISLAND
WILSON ISLAND
HERON ISLAND
MASTHEAD ISLAND
Fitzroy Reef
BUNKER GROUP
Boult Reef
LADY MUSGRAVE ISLAND
LADY ELLIOTT ISLAND
GLADSTONE
Bustard Bay
Woodgate
Burrum Heads
0 10 20 30 Kilometres
0 5 10 15 Nautical Miles

PLATES 1(A+B)
2(A+B)
3(A+B)
9(1,2,3)

STEEL REPORT
PHOTOS

Processed

MRS. B. BARNETT


TOWNSVILLE SHELL CLUB
SHELL SHOW - 1966
FIRST PRIZE
Awarded To
Townsville Shell Club
Shell Show

PL. 1 A

PLATE 1A

Cone shells are capable of delivering a venomous sting via a harpoon-like dart They should not be handled.
CONE SHELLS
1. PISCIVOROUS Feed on Fish and are regarded as deadly! CONUS GEOGRAPHUS
2. MOLLUSCIVOROUS Feed on other molluscs and are potentially dangerous! CONUS
3. VERMIVOROUS Feed on Marine Worms and can deliver a sting!
Conus geographus Conus aulicus
These shells are found in sand under
Diagram of venom apparatus & actual venom duct
Conus arenatus Conus pulicarius Conus quercinus
These cones live in sand & weed near sand cays
Conus marmoreus in situ.
Conus marmoreus
Conus textile
Conus terebra in situ.
Conus textile with egg capsules.
DISPLAY:

PLATE 13


1

(1)

PLATE 9

(1)

PLATE 3B

PLATE 3A

PLATE 2A

PLATE 23

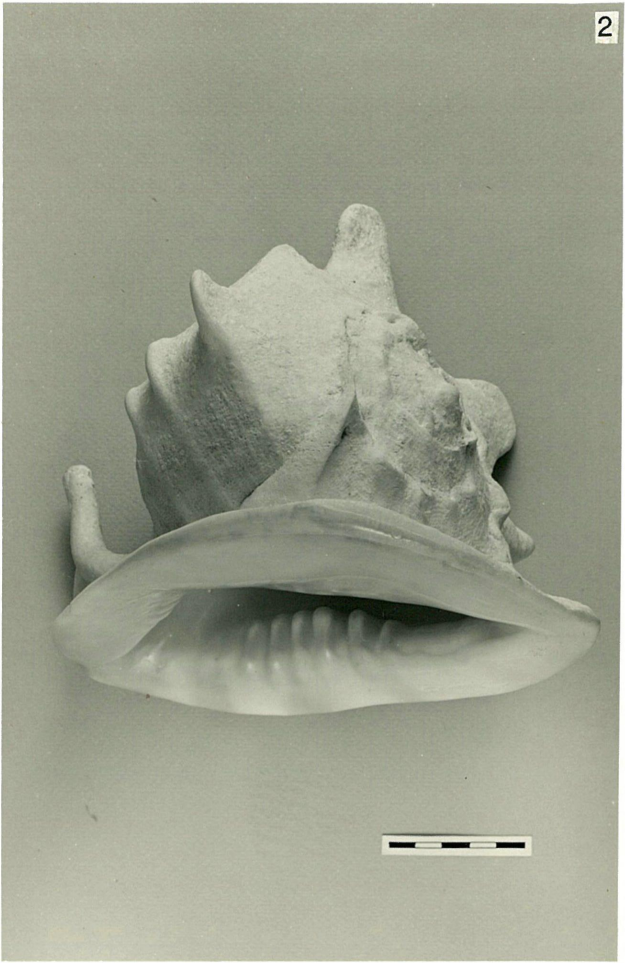

2

PLATE 9
(2)

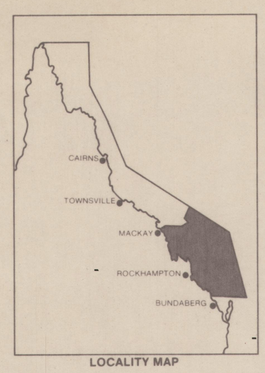

3

(3)

PLATE 9
(3)

CAPRICORN SECTION

DISTRIBUTION OF TRAWLED SHELL



LOCALITY MAP

KILOMETRES 0 10 20 30 40 50 KILOMETRES
NAUTICAL MILES 0 5 10 15 20 25 NAUTICAL MILES

Great Barrier Reef Region Boundary

Marine Park Section Boundary

Islands

Reef and Shoal Edge

THIS MAP IS NOT INTENDED FOR NAVIGATIONAL PURPOSES

MAP 6

Great Barrier Reef Marine Park Authority