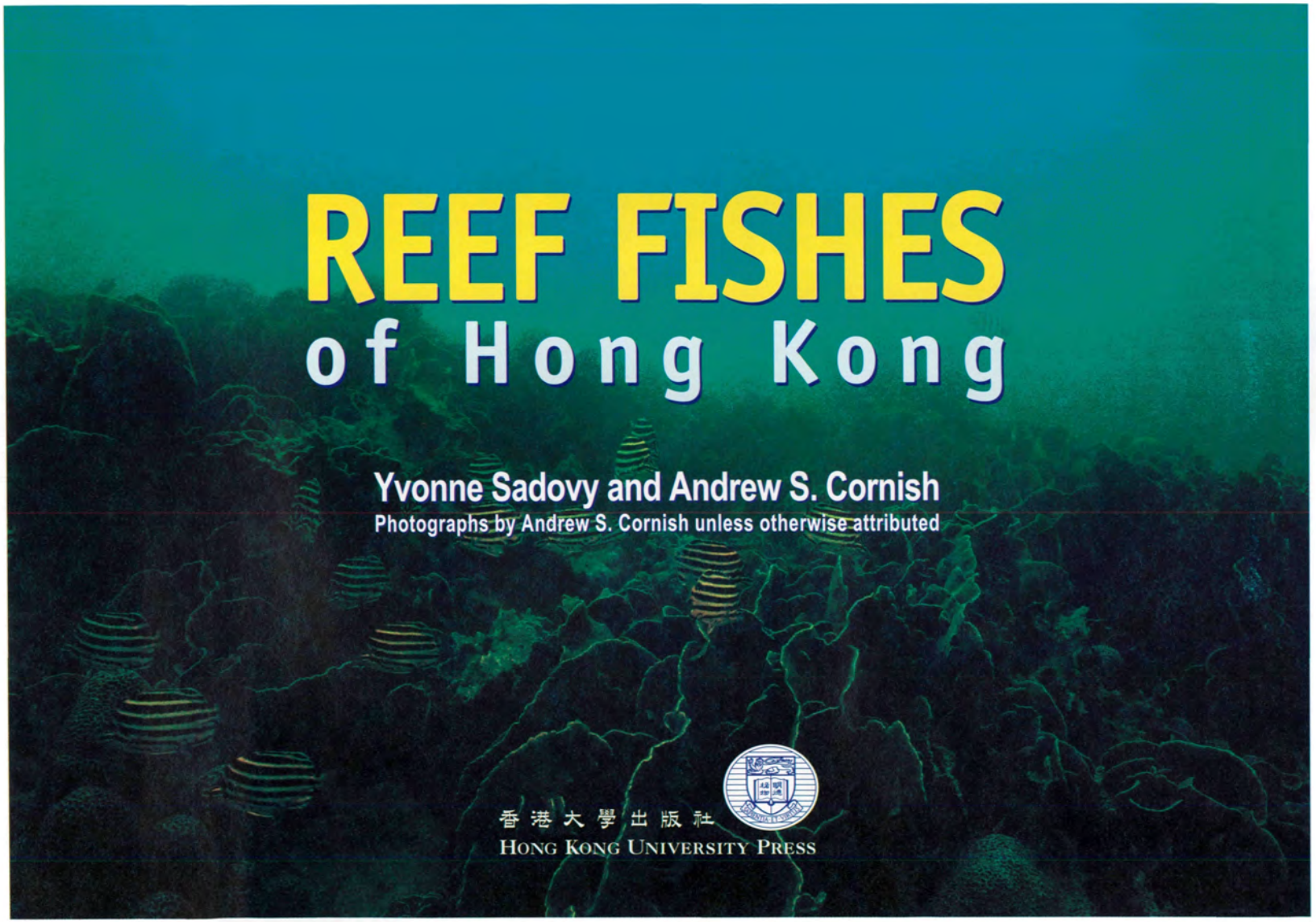

REEF FISHES
of Hong Kong

Yvonne Sadovy and Andrew S. Cornish

Photographs by Andrew S. Cornish unless otherwise attributed

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Foreword

It is indeed a pleasure to finally have available an attractive and informative guide to reef fishes from the northern sector of the South China Sea. Despite excellent compilations of fishes from Taiwan and Japan, there has never been a colour guide to the fishes of the reefs of the southern coastline of continental China and none specifically for Hong Kong. The hydrology of the area brings together both tropical and temperate components producing a fish fauna which is as diverse as it is interesting and rich. The authors have combined their knowledge and considerable skills to produce a highly readable and enjoyable book that will admirably serve both biologists and laypersons.

The fish fauna of Hong Kong has suffered from overfishing and pollution, resulting in reduced populations and the loss of some species. This was readily apparent to the authors from their review of the early literature and their interviews with fishermen and divers. It was also very evident from my own experience. I first dived in Hong Kong waters in 1975. My next visit was in 1998, at the invitation of the authors. The loss of water clarity and the fewer numbers of reef fishes, particularly any of even moderate size, was immediately apparent and most regrettable.

The many impacts on the marine environment from an area with one of the densest human populations on earth inevitably place strains on nearshore areas. It is now very important to take steps to prevent further deterioration of the marine environment and its marine life. Detailed knowledge of the Hong Kong marine fauna is essential for its long-term protection.

The present book is a very important first step in documenting the inshore fish fauna of Hong Kong. Knowing the species is the foundation for natural history studies necessary for the management of fish stocks. The most important effort for conservation of reef and shore fishes, and one that will have the most lasting effect, is the implementation of a system of well-enforced marine reserves that allow no fishing or the collection of any form of marine life. Studies suggest that a minimum of 30% of the coastline should be set aside as total reserves for the maximum benefit, so it is obvious that more needs to be done in Hong Kong. Such reserves should be selected with care to be well spaced and provide for protection of different inshore habitats. These reserves maintain breeding stocks of fishes, and their eggs and larvae seed the areas that remain open for fishing. Two reserves of the Mediterranean coast of France (Reserve Naturelle de Cerbère-Banyuls and Parc Régional Marine de la Côte Bleu), have improved fishing so well that local fishermen have asked that they be enlarged. What better testimonial of success than that of the fishermen! Make it happen in Hong Kong.

John E. Randall
Senior Ichthyologist Emeritus
Bishop Museum
January 2000

Introduction

Scope of book

The rocky reefs and coral communities of Hong Kong shelter a diverse and beautiful fish fauna largely unknown to those who have never ventured below local waters. This book documents the first comprehensive field survey of reef-associated fishes ever undertaken in Hong Kong or, indeed, anywhere along the coast of mainland China. It includes over 320 reef fish species in 70 families, a third of the species and 6 families never before recorded from local waters and at least one species which is new to science.

Most species are shown in colour and presented with details on their biology taken from field observations, local research and from other studies in the region. Wherever possible, indications of past and present abundance, fishery importance and conservation concerns are discussed. We hope that this book will be of value to the specialist and non-specialist alike who seek to identify local fishes, to learn something of their natural history and regional zoogeography in the South China Sea, and to understand some of the threats they face.

Fishes were recorded by underwater visual census surveys, using SCUBA, and collected by fishing gears such as nets, hooks, traps and anaesthetics. Some were purchased from fishermen if captured in local waters. Although poisons are often used to make fish collections, their use is illegal in Hong Kong waters and they were not applied. As a result, particularly small or secretive fishes, and those not readily taken by standard fishing gears, were almost certainly under-sampled. While we do not claim to have produced a definitive catalogue of reef fishes in Hong Kong, we believe we have documented most species that are widespread and common on coral communities and rocky reefs, as well as many that are rarely seen. Fishes in habitats marginally associated with reefs, such as inter-tidal rock pools or soft substrates around reefs, were also sporadically sampled because, for many reef species, such habitats are used at specific phases of their life history. For example, some species occupy reefs as adults while as juveniles they seek food and shelter in the inter-tidal zone or in other nearshore habitats such as seagrass beds or mangroves. Reefs clearly cannot be viewed in isolation from the surrounding areas on which such species also depend.

All fishes were collected and photographed from 1995 through 1999 within local waters, i.e., the waters of the Hong Kong Special Administrative Region (HKSAR) (Map 1 on p. 2), unless otherwise indicated. Identifications were made using a wide range of literature, the following being particularly useful: Masuda *et al.* 1984; Shen 1984; Randall *et al.* 1990; Myers 1991; Masuda and Kobayashi, 1995; FishBase 98, Indo-Pacific Fishes series, Bishop Museum and the Food and Agriculture Organization (FAO) Species Catalogues. Species we could not identify were sent to expert taxonomists. When species-level identifications were not possible, only the genus is given. Most collected

specimens were deposited in the museum of the Swire Institute of Marine Science, the University of Hong Kong, at Cape d'Aguilar, while some were lodged with major collections overseas.

Reefs and reef habitats in Hong Kong

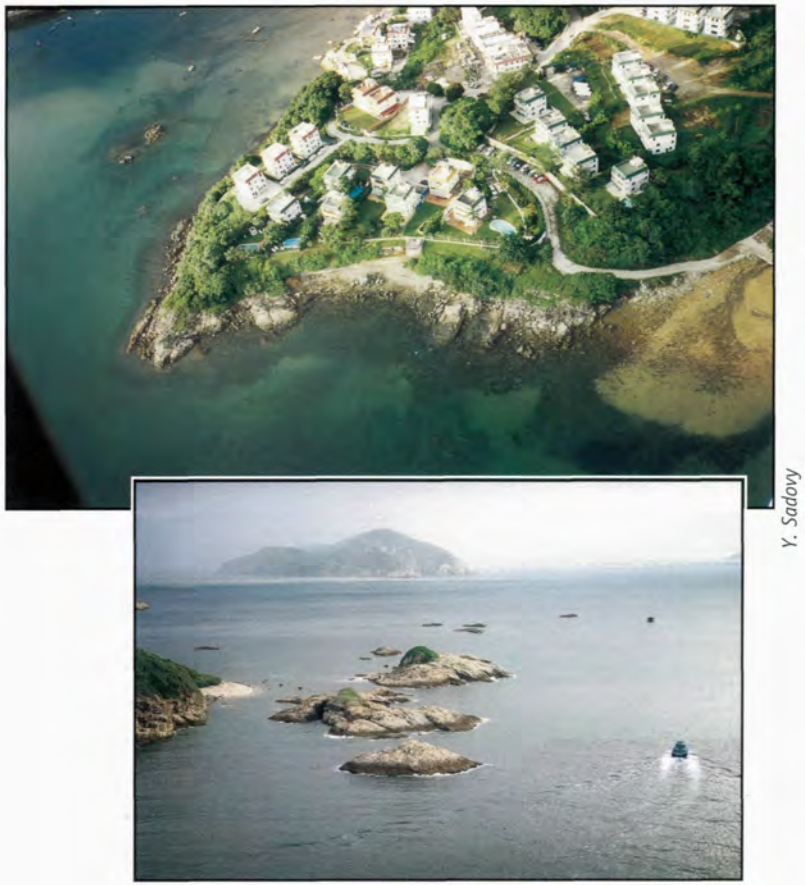
Reefs may be classified according to the type of hard substrate of which they are formed. Coral reefs are the product of the activities of living corals and of the benthic organisms closely associated with them. In Hong Kong, most corals are at the northern limits of their geographic range and do not form the massive calcium carbonate structures we typically think of as coral reefs. For this reason, they are better considered as coral communities rather than coral reefs, even though they provide the physical complexity and range of habitats required by many reef organisms. Rocky, inorganic reefs also form physical structures at different scales, supplemented by small-scale habitat features produced organically by invertebrates, such as barnacles and mussels, and algae.

Along the coast of mainland China, Hong Kong is one of the northernmost places where coral communities are known to flourish, although corals also occur patchily in Daya Bay, northeast of Hong Kong, and around nearshore islands. Coral growth is generally sparse along the mainland coast because of the turbidity and low salinities associated with river outflows and low winter water temperatures which inhibit coral growth. Well-developed coral reefs are largely restricted to offshore islands and archipelagos, such as Paracel shoals (Xisha Qundao), Macclesfield Bank (Zhongsha Qundao) and Hainan Island, and around disputed areas such as Pratas Reef (Dongsha Qundao or Tung-Sha), southeast of Hong Kong. The Pescadores Islands (Penghu Leidao), west of Taiwan and to the northeast of Hong Kong, also support coral communities.

Despite its subtropical setting, Hong Kong can boast an almost tropical species diversity of hermatypic (i.e., reef-building) corals; 52 species have been recorded, a richness comparable to that of Caribbean coral reefs. Local climatic conditions, however, are at the extremes of tolerance for many species. Winter water temperatures can drop below 15°C, well under that optimal for coral growth and development. In the summer, surface water temperatures can exceed 30°C, stressing corals at their upper physiological limits. Moreover, high summer monsoonal rainfall washes silt from the land reducing penetration of sunlight and smothering corals. Such conditions make it difficult for corals to flourish and render them particularly vulnerable to additional stresses imposed by nearshore human activities, such as dumping, dredging, reclamation and destructive fishing practices.

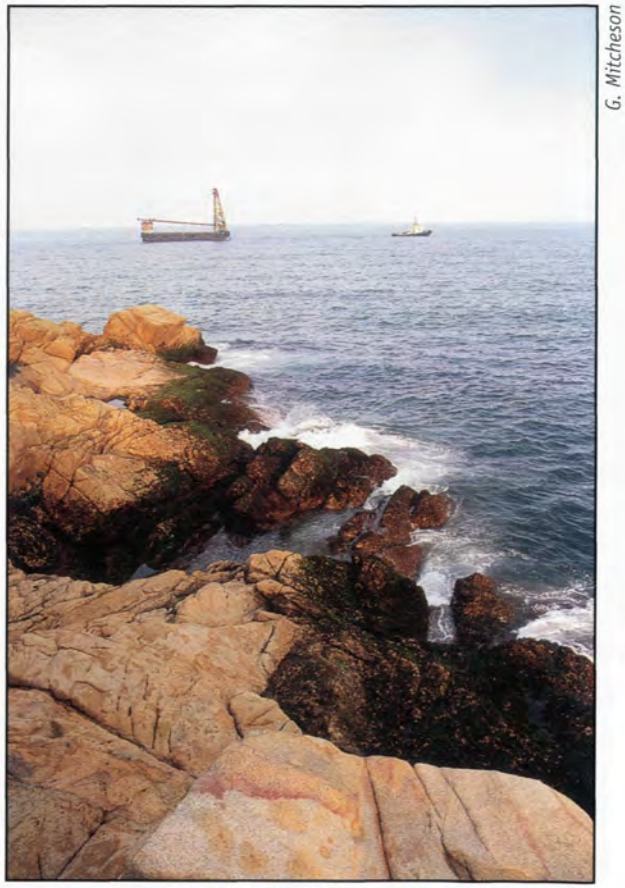
The total land area of Hong Kong, 1,070 km^2, is small, but her 800 km coastline is extensive with over 230 offshore islands. In western waters, the periodic turbidity and low salinity associated with the Pearl River discharge preclude extensive coral growth and coral communities are mostly

found in eastern and southeastern waters. In these areas the rocky coastline is well developed and there are steep and exposed shores interspersed with sandy beaches and sheltered bays. In some areas along this coastline, coral communities form a thin band. While this is most extensive at depths of less than 5 m, encrusting and isolated coral colonies can occur down to 20 m. These communities are particularly rich in sheltered areas, such as at (Tung) Ping Chau, Port Shelter, Hoi Ha Wan and Double Haven (Yan Chau Tong), where they fringe the shoreline and where coral cover



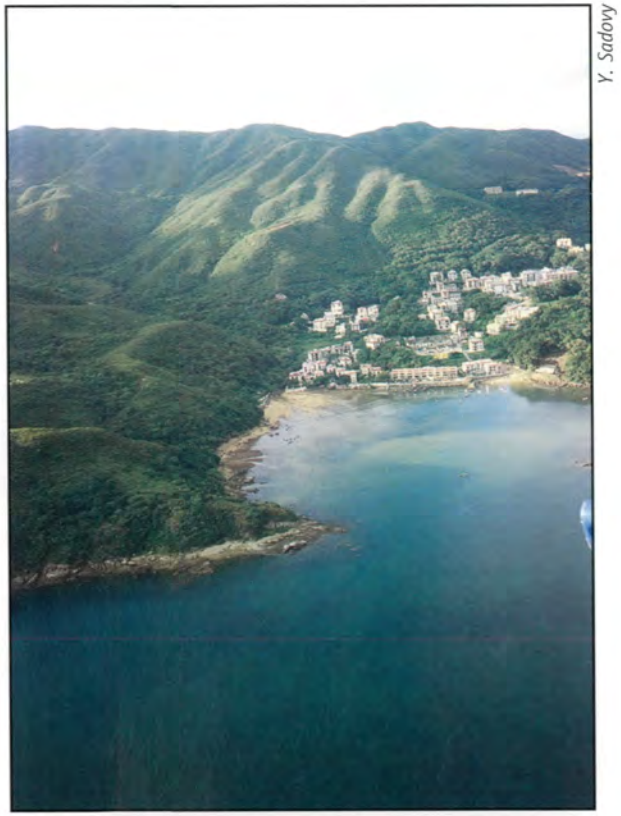
Y. Sadovy

Rocky shores and islands of Hong Kong's eastern waters



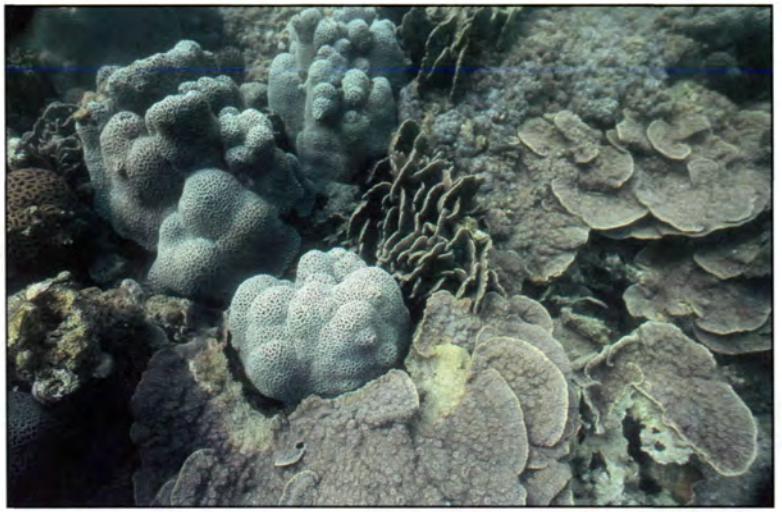
G. Mitcheson

Shek O coastline, eastern Hong Kong Island



Y. Sadovy

Sheltered bay in eastern waters



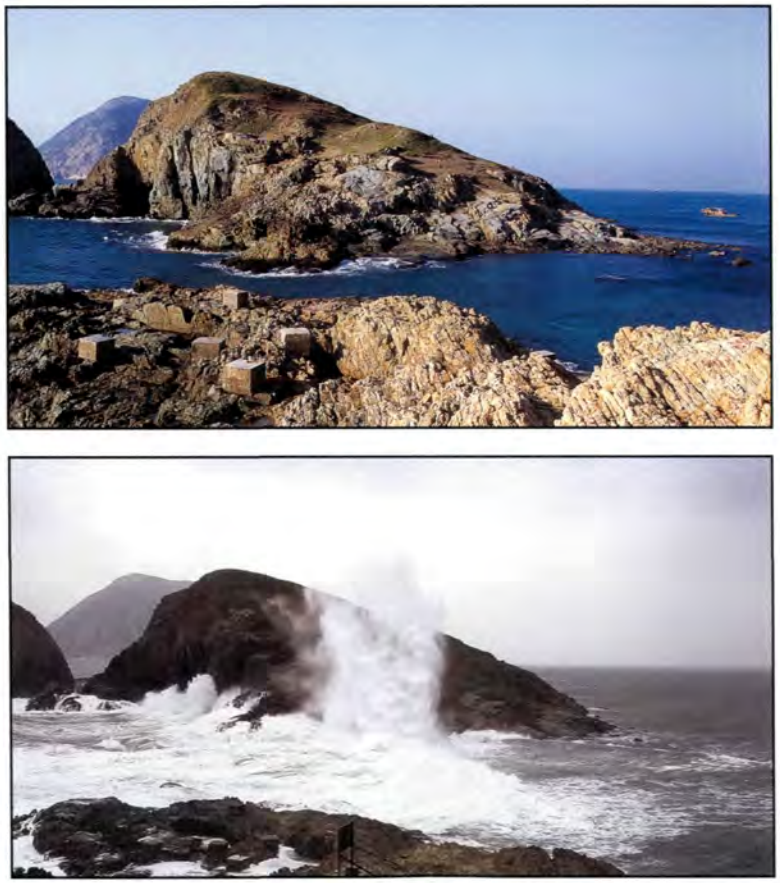
High coral cover at Hoi Ha Wan

may exceed 70%. Massive corals such as *Platygyra sinensis* (Edwards & Haime) provide sparse shelter to fishes, while the vertical plate-like stands of *Pavona decussata* (Dana) and the crevices of *Montipora informis* (Bernard) provide plenty of hiding-places. Branching *Acropora* spp. shelter juveniles of many species, and their polyps are eaten by corallivorous (coral-eating) butterflyfishes.

Platygyra sinensis dominated coral community at Hoi Ha Wan

Rocky, exposed, shores characterize eastern waters and the large cliffs of Tung Lung Chau, Bluff and Basalt Islands are typical. Wave action combines with chemical weathering to produce rock fragments that eventually become dislodged and tumble into the sea. The most extensive rocky reefs are found along east-facing shores which are typified by rocks and large boulders. Because of heavy wave action along these shores, branching and erect forms of coral are sparse and the corals are dominated by encrusting species.

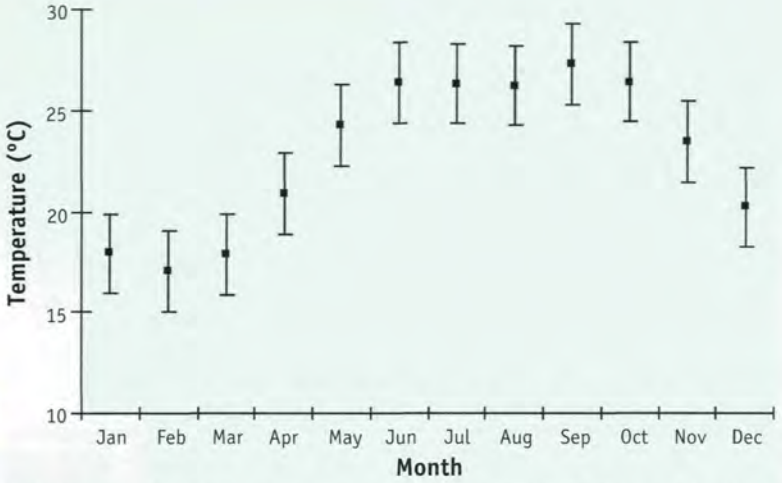
Rocky shores also surround the Lema Islands (Dangan and Jiapeng Islands), a largely uninhabited chain of 13 islands, 12 km to the south of Hong Kong (Map 2 on p. 8). These islands lie outside the waters of the HKSAR. Although similar to Hong Kong's outer islands in many ways, waters are generally deeper, rocky reefs may extend to 30 m depth and there are no extensive coral communities. Several species recorded from the Lema Islands, but not encountered in Hong Kong waters, are also included in this book because of the close proximity of the islands to Hong Kong; these species are clearly distinguished in the text.



Extremes in weather conditions shaping the coastline at Cape d'Aguilar. Hot summer day (above) and winter storm (below).

Hong Kong's climate and hydrography

Hong Kong lies 320 km south of the Tropic of Cancer and local hydrography supports a subtropical fauna and flora: annual mean sea surface water temperatures typically range from 17–27°C (see figure on p. 10). Temperature and salinity in nearshore waters are determined by three water masses from different sources and by seasonal discharges from the Pearl River (Map 2). In the the winter, the Kuroshio Current of high salinity and high temperature originates in the Pacific and invades the South China Sea



Monthly surface seawater temperature at North Point, 1990–1998 (Hong Kong Observatory; mean and standard deviation)

via the Luzon Straits. This current keeps the coastal waters of Hong Kong relatively warm and allows the persistence of subtropical coral communities. The moderate Taiwan current from the East China Sea is of reduced salinity and temperature and invades local waters in the winter. In the summer, the Hainan Current, with South China Sea waters of high salinity and variable temperature, moves past Hong Kong towards Taiwan. In western Hong Kong, waters are heavily affected by rainfall and by discharge from the Pearl River. Heavy rains, averaging 217 cm/year and associated with the summer monsoon season of May to September, dilute coastal waters and surface salinities may fall to 1–2 ppt. Western waters are also often turbid during this season, especially to the south and southwest of Lantau Island. In the southeast, mixing of oceanic waters means that the effects of the Pearl River are minimized and eastern waters are relatively unaffected by the freshwater drainage.

Reef fishes

Reef fishes associate directly or indirectly with reefs for all or part of their lives. They derive shelter from the complexity of the reef and food from associated organisms. Some species, such as certain snapper, tigerperch, damselfish and rabbitfish, may spend their early life in shallow nearshore 'nursery' areas such as mangroves and seagrass beds, or in the inter-tidal zone, and migrate out to reefs when larger and older. Others shelter around reefs at night and forage over nearby sand flats by day. Communities of coral reefs and reef fishes are shaped by both historical and ecological factors, while species diversity and abundance can be severely affected by heavy fishing pressure and habitat degradation.

Seasonal patterns of species occurrence and abundance are evident, primarily in response to fluctuating water temperatures. In the winter, brown algae proliferates in many of the quieter shallows providing a temporary source of food and shelter for fishes such as juvenile sweepers, cardinalfishes and cornetfishes. However, diversity and abundance are generally lower than in the summer. The juveniles of certain damselfishes appear in the summer but evidently do not survive the colder winter months, an

Algal growth in March at Waglan Island

example of a sterile distribution for these species in Hong Kong where the adults are not found. Members of the local fish fauna which have a more tropical range, such as the Chocolate hind, *Cephalopholis boenak*, and the Bubblefin wrasse, *Halichoeres nigrescens*, may become inactive and hide in the reef or sand in the colder winter months, while Pearl-spot spinefoot, *Siganus canaliculatus*, disappears from the fishery and reappears in catches as the waters warm. Not surprisingly, such species tend to reproduce in warmer summer months. Typically temperate species, such as the Marbled rockfish, *Sebastiscus marmoratus*, the porgies (seabreams) and several of the groupers, on the other hand, while tolerating high summer temperatures, limit their reproductive activities to the winter months.

Species diversity and composition around Hong Kong's reefs, however, show strong tropical characteristics. More than 70 families and 325 species of reef-associated fishes are included in this book, a diversity comparable to that of Caribbean reefs. While some families, such as the porgies, morwongs and filefishes, are more characteristic of temperate reefs, and reflect the high latitude position of Hong Kong, the diversity of families we more typically associate with coral reef communities, such as the wrasses, groupers, butterflyfishes and damselfishes, is particularly high, and it is tropical species that dominate (about 75% of species) the local fish fauna. The more species-rich families are each represented by about 20 species compared to 50–100 species we would expect to find in each of these families on more highly developed, lower latitude, reefs. We found approximately 10 species in each of the cardinalfishes, snappers, puffers, scorpionfishes, surgeonfishes, grunts, blennies, and parrotfishes (see p. 12).

Comparisons between reef fish diversity in Hong Kong and that recorded in surveys carried out at other similarly high latitude reef sites in the northern South China Sea were interesting. Data are available for three offshore sites: Pratas Reef (21°N), the nearest offshore reefs to Hong Kong at 274 km to the southeast, Hainan Island (19°N) to the southwest, and the Pescadores Islands (24°N) to the northeast (p. 8). The 25 most speciose families recorded in Hong Kong were used as the basis for comparisons and are shown in descending order of richness on p. 12. Families excluded were those difficult to survey without fish poisons,

and those with taxonomic problems that make species lists difficult to compare (e.g., seahorses and gobies). The results indicate that species diversity for most families is higher around offshore reefs than around those of the continental shelf environment of Hong Kong, irrespective of latitude. The high diversity is particularly striking at the Pescadores Islands, which lie at the northernmost extreme of coral reefs in the region.

While care should be taken with such comparisons, given the inevitably different degrees of sampling effort and collection methods applied among locations, some trends are apparent. It is noteworthy, for example, that certain reef fish families, especially the wrasses, parrotfishes and damselfishes, show a low diversity in Hong Kong compared with all three offshore sites. This probably reflects the generally low coral cover found in Hong Kong and along the mainland, a consequence of the coastal water conditions with runoff and periodic reduced salinities. On the other hand, the groupers, butterflyfishes, snappers, grunts and goatfishes exhibit a diversity comparable to, or greater than, some of the offshore sites. Overall, family species diversity in Hong Kong most closely resembles that of Hainan Island but was the least among the four locations compared, and poorer, for many families, than at offshore sites.

History of ichthyology in Hong Kong

Research into marine fishes in Hong Kong over the past 150 years has been sporadic and sparse. Despite a long cultural, economic and nutritional association with the sea and, over the last few decades, an affluent and educated population, there is still no comprehensive list of fishes covering all marine habitats in Hong Kong. For decades, the marine fishery was the top primary industry, yet remarkably little research, even on commercially important local fish fauna, has been carried out. There are several compendia of species records based largely on market samples, and several fishery, mainly trawl-based, surveys. Nomenclatural problems, however, make it arduous to compare species lists, and reef-associated species, in particular, have received scant attention.

The first records of Hong Kong's reef fishes were published in 1846 by Richardson, who described several species new to science. This work was based on a collection of specimens and illustrations of fishes from Guangzhou, Hong Kong and Macau by John Reeves. Among these new species were fishes still common in local waters such as the Chinese demoiselle, *Neopomacentrus bankieri* and the Freckled goatfish, *Upeneus tragula*. From 1905 to 1934, the *Hong Kong Naturalist* published articles on Hong Kong fishes, mainly in the form of species records. Fowler's 'A synopsis of the fishes of China', published in three journals between 1930 and 1962, was later republished as one volume in 1972 and an index produced by Darvell in 1992. Fowler's work includes fishes from a large area of coastal China, including Hong Kong. For unexplained reasons, these volumes did not cover some of the reef fish families that often come towards

the end of fish lists (e.g., scorpionfishes, flatheads, surgeonfishes, rabbitfishes and triggerfishes). Anon (1962) covers the fishes of southern China. More recent literature mainly includes commercially important and trawled fishes, with limited coverage of reef-associated or inter-tidal species (e.g., Ni & Kwok, 1999). The most complete list of reef fishes in Hong Kong, to date, including both old and new records and their synonymies, is that of Cornish (2000).

Most early fish collections include purchases from Hong Kong's various food markets; however these fishes may originally have come from hundreds, or even thousands, of kilometres away. For example, in the first half of this century, vessels ranged from 200 km east of Hong Kong, to more than 350 km southwest, as far as Hainan Island and the Gulf of Tonkin. Following World War II, the fishery sector was actively developed and sailing junks were mechanized. By the 1960s their range had extended as far as Taiwan to the northeast and to offshore reefs such as Pratas Reef and Macclesfield Bank, providing fishes to local markets. Considerable care is necessary, therefore, in evaluating these older species compilations if local occurrence is of particular interest, since such lists undoubtedly include species not occurring in Hong Kong. In recording fishes for this book, special care also had to be taken to exclude those species unlikely to occur here naturally that may have escaped from mariculture zones, where they are held alive after importation and prior to sale. In recent years, many species of coral reef fish have been brought into Hong Kong from as far afield as the Seychelles to the west, and Fiji to the east, to be sold alive in restaurants as part of the burgeoning live reef fish trade. Escapes from mariculture zones occur periodically, or fishes are intentionally released during religious ceremonies, and may survive in the wild. Specific examples are given in the relevant sections of this book but it has become clear that establishing whether Hong Kong is within the natural range of imported Indo-Pacific species may become increasingly difficult, given the volume of live fishes being imported. Reports of range extensions will need to be evaluated carefully.

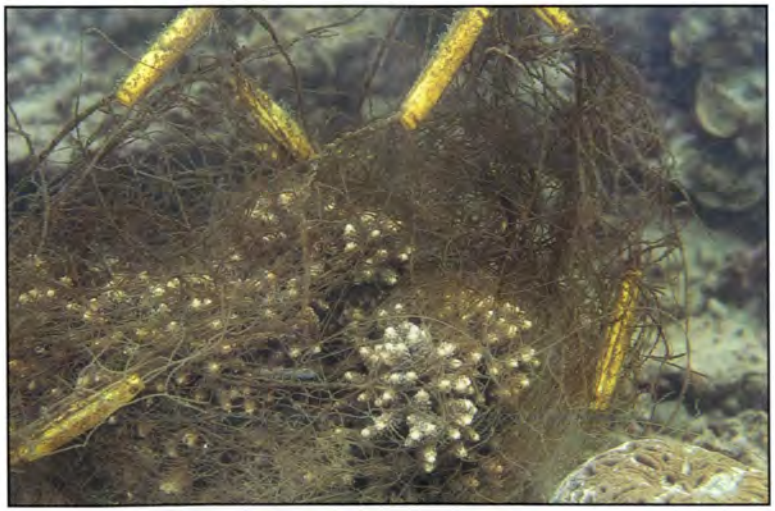
Threats to coral communities and associated fishes

A barrage of threats faces nearshore coral communities in Hong Kong. There is particular concern over the actual and potential impacts of pollution, overfishing, destructive fishing practices, dredging, and reclamation. Given the limited and patchy nature of live coral cover around Hong Kong's shores and islands, it is not surprising that most local reef fishes also find food and shelter among rocky reefs. Some species, however, such as butterflyfishes, that feed exclusively on coral polyps, must have access to live coral. Reclamation potentially poses the most serious threat to nearshore communities although most, to date, has been away from eastern shores where coral communities occur. Dredging activities have smothered corals at the Ninepin Islands. Pollution threatens many areas along the coast.

Although ocean-influenced waters to the east are relatively free of dissolved pollutants, waste from the new towns of Tai Po and Sha Tin is known to have eliminated live corals in Inner Tolo Harbour and Channel. Toxic oil spills represent a persistent major threat in all local waters, and poor mariculture practices foul many nearshore areas.

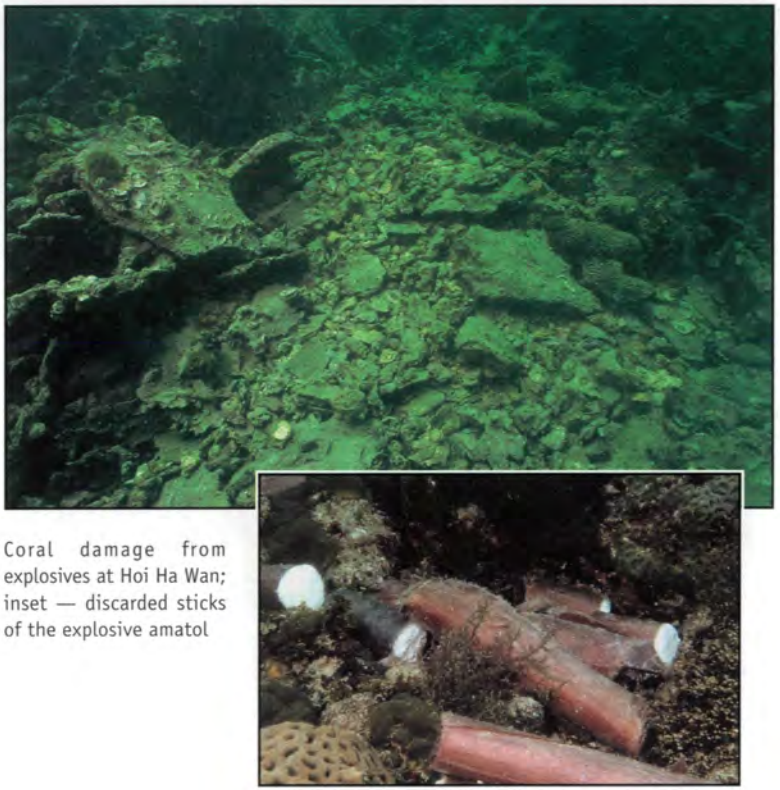
Particularly damaging to living reefs and reef fishes are underwater pollution and destructive fishing practices. Solid waste in the form of submerged bags and sacking frequently becomes entangled in corals, often smothering them; branching *Acropora* spp. are particularly vulnerable. Discarded and abandoned monofilament gill nets are even more widespread and have the same effect. These nets continue to kill by 'ghost-fishing', fatally ensnaring fishes and invertebrates long after they are discarded. The loss of biomass through ghost-fishing on Hong Kong's reefs is likely to be substantial since trapped animals rarely succeed in freeing themselves and lost nets are commonplace. Even in Hong Kong's Marine Parks, nets are discarded over corals and licensed fishing with both nets and traps continues to damage coral communities.

Ghost fishing by gill net. This 30 cm Chicken grunt died in a scrap of net barely bigger than itself.



Live coral bound in gill netting

Unfortunately, one particularly destructive fishing technique continues in Hong Kong waters. This is the use of explosives (amatol) to stun fishes which sometimes float to the surface for collection by hand nets. When this activity takes place over shallow coral communities, hard corals may be damaged within a 1–2 m radius of the blast. Many fishes may be killed but not collected since local fishermen do not



Coral damage from explosives at Hoi Ha Wan; inset — discarded sticks of the explosive amatol

D.C. Cook

Unharvested dead and dying fish as a result of fish bombing

enter the water. Fishing with explosives has been banned in Hong Kong since 1903 but continues to take place in the more remote areas of northeastern waters; in 1996, enough explosives to make several thousand fish bombs were seized. A second destructive technique is the use of poisons which cause wasteful bycatch and kill corals. There are occasional reports of sodium cyanide and naturally derived poisons, both banned, being used to catch fish.

It is overfishing, however, that represents the most serious threat to the diversity and abundance of reef fish communities in Hong Kong. Several reef-associated species have essentially disappeared from local waters, very likely the result of overfishing, and larger individuals of many species of groupers, wrasses and snappers, once common, are rarely seen today. Interviews with divers and fishermen, for example, consistently suggest that the Hong Kong grouper, *Epinephelus akaara*, the Longtooth grouper, *E. bruneus*, and the Blackspot tuskfish, *Choerodon schoenleinii*, were commonly caught 20–30 years ago but are scarce nowadays. The Leopard coral grouper, *Plectropomus leopardus*, and the parrotfishes in general were also once much more common than they are today. Overfishing is almost certainly the major cause of decline, whether on

adults or on juveniles. The Hong Kong grouper, for example, was heavily fished as juveniles for mariculture grow-out, the process by which small, typically wild-caught, fish are held captive and fed until they attain market-size. Fisheries of the fry (early juvenile phase) of several species, such as mullet, several seabreams, rabbit fishes and snappers, have also declined from their former glory or have disappeared altogether. Nowadays, the local mariculture industry depends almost exclusively on imported fry for its operations.

Fishing pressure is high and reef fishes are undoubtedly overfished; the local fishery is now largely one of young, immature, fishes. Thousands of small boats ply the limited waters over nearshore rocky and coral-rich reefs using nets, traps, and hook and line. Most commercial trawl catches consist of small (<10 cm long) fishes; even the smallest may have value as feed in mariculture zones so little is returned and there is no management of the fishery. Recreational fishing is increasingly popular; the local amateur recreational angler association estimates that over 1,000 anglers are active locally. Given the intensity of fishing activity over such a limited area, there probably remain few undisturbed refuges for fishes inshore, while less accessible offshore locations, such as the Lema Islands, also face increasing pressure. Indeed, recent estimates indicate that inshore Hong Kong has one of the lowest biomasses, per unit area, in the Indo-Pacific. Local reef fish will continue to decline in numbers unless afforded more protection from fishing and from damage to the habitats on which they depend for food, shelter, spawning and nurseries.

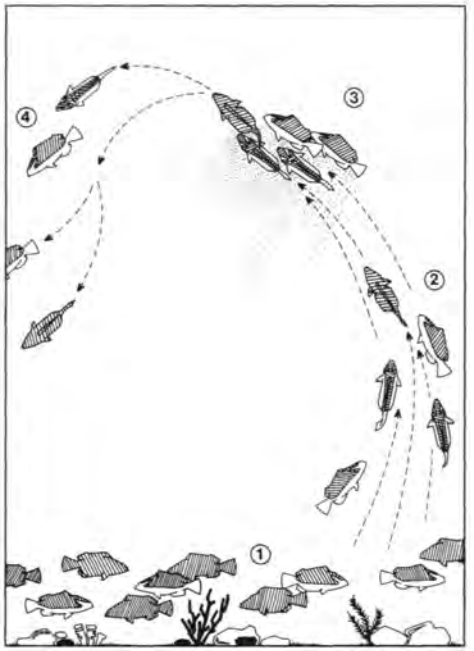
On the positive side, Hong Kong now has three Marine Parks and one Marine Reserve, all designated in 1996 (Map 1). The parks are at Hoi Ha Wan (260 ha), well-known for its corals, Yan Chau Tong (680 ha), in northeastern waters and selected for the seagrass bed and mangrove areas at Lai Chi Wo, and Sha Chau and nearby Lung Kwu Chau (1,200 ha), created to protect the local resident population of the Chinese white dolphin, *Sousa chinensis* Osbeck. The Marine Reserve, at Cape d'Aguilar (18 ha) on Hong Kong Island, is particularly diverse in marine habitats and over 150 species of fishes have been recorded. In the Marine Parks, trawling is banned but licensed gill netters, purse seiners and fish trappers continue to operate, while no activities of any kind are permitted within the Marine Reserve without a permit. We hope that existing Parks will eventually be fully protected and that further coastal areas with rich reef communities, vulnerable habitats, or that are important nursery and spawning areas for reef species, will also receive protection. The government is deploying artificial reefs in an attempt to enhance commercial fishery production.

Reef fish biology — a short primer

Reef fishes are extremely diverse in almost every aspect of their life history; shape, colour, size, behaviour, means of reproduction, length of life and social structure. A few generalizations can be made, however, which help us to understand their close relationship to reef habitats, their

vulnerability to its loss or degradation and the potential effects of overfishing. The following discussion is intended as a general background to the more detailed introductions provided for the families of fishes included in this book; terms commonly applied when describing reef fish biology are introduced.

Most reef fishes produce eggs that are fertilized externally. In a few cases, such as in the rockfishes or seahorses, fertilization is internal and live young are produced, but these are truly exceptions. More typically, males and females release eggs and sperm directly into the water column (pelagic spawning), in pairs or groups, or eggs are fertilized and remain on the substrate (demersal spawning) until hatching. The tiny larvae which emerge from these 1 mm, or so, eggs are planktonic (live in the plankton) for several weeks or months, depending on the species, after which time they settle in their adult or juvenile habitat; this process of settlement we refer to as recruitment. Pelagic spawning is the most widespread mode of reproduction in reef fishes and involves no parental care of the eggs or larvae. Demersal spawning often involves nest preparation and parental, usually male, care in various forms. In many species, such as damselfishes, blennies, gobies and triggerfishes, the eggs are laid in a nest of rock, shell, coral or other substrate, or on sand, and the male protects them until they hatch. In species like the cardinalfishes, males protect the eggs until hatching by retaining them in the mouth, whereas in rabbitfishes, the demersal eggs are simply scattered and sink and are not protected.



Four stages of pelagic spawning as a group. 1 and 2, rise; 3, egg release; 4, return to substrate. Reprinted from Sadovy (1996) with kind permission from Kluwer Academic & Publishers

Mating systems can be monogamous whereby a male and female stay together for extended periods, or, more typically, polygamous, whereby individuals have multiple mates. In polygamous species, a male might mate exclusively with several females within an established social unit, or males and females may each have numerous partners. In many of the larger polygamous species which produce pelagic eggs, individuals temporarily move away from the areas in which they feed, to gather in aggregations to spawn.

Some species have particularly complex means of reproduction which can involve sex change of adults and different types of mating strategies, especially among males (known as alternative mating strategies). For example in some wrasses, groupers, gobies and parrotfishes, individuals typically start life as one sex, usually female, and then change sex later to become a male. The anemonefish has the opposite pattern, young fish are males and larger, older, individuals are females. In certain species, there may be different types of mating strategies with males mating either in pairs or in groups with a single female. See family sections for details of these interesting complexities.

Reef fishes tend to be sedentary; once they leave the plankton and settle onto the reef, most do not move far from the shelter and feeding areas that the reef provides. Many will defend a territory or shelter hole, or move around a loosely defined living area, or home range. Others wander in groups, or schools, which confer some protection, enabling them to travel or feed in the water column above the reef. Most species are active during the day (i.e., they are diurnal) and rest at night. Some, like the cardinalfishes, however, emerge only at night (i.e., they are nocturnal) and rest during the day. Most reef fishes feed on animals (carnivores), fishes (piscivores), plankton (planktivores), or take a wide range of food types (omnivores) while a few graze on plant matter (herbivores).

In some areas in the tropics, reef fishes harbour naturally occurring toxins that come under a class referred to as ciguatoxins. The importance of these toxins to humans is that they cause a type of food poisoning known as ciguatera, which, in rare cases, can be fatal. These toxins accumulate up the food chain but originate in dinoflagellates, the best known being *Gambierdiscus toxicus*, which are ingested along with algae by herbivorous species. When the herbivores are eaten by carnivores, the toxins remain. The effects on the fishes themselves of high levels of accumulated toxins are not known but humans can get ciguatera if they eat an affected fish. There are certain areas in the Pacific and Caribbean where ciguatoxic fishes are quite common, especially among the larger, carnivorous, reef species. While not a problem among local fishes, hundreds of cases of ciguatera have been reported in Hong Kong in the last couple of years because many live reef fishes are now being imported from areas in the Pacific where this is a common problem. Since live fish are not officially classified as 'food' in Hong Kong, the public enjoys little protection from ciguatera. Species accounts include information on potentially ciguatoxic fishes.

The vivid colours and elaborate patterning of reef fishes are important both for species identification and for communicating sexual or social status. In many species, males and females differ permanently in colour, a state known as sexual dichromatism; in others, colour differences are only seen temporarily during courtship or spawning. At night, the body colours often become subdued in resting animals, conferring a degree of camouflage (or crypsis). Alternatively, protection from predators, while resting, is achieved by burying in sand or secreting a cocoon of mucus. Colours may

be used as a warning, such as the bold patterning on the bodies of certain scorpionfishes, indicating that they can deliver a painful venom if provoked. Juveniles of many species may be more or less brightly coloured than the adults, depending on the biology of the species and may sometimes be so different in colour, form and behaviour that it is hard to recognize that adults and juveniles are the same species.

Reef fishes, because of their natural history and dependence on reefs for food and shelter, are particularly vulnerable to loss of habitat and disruption of social structure through habitat destruction and fishing. Many fishes can live a long time, up to several decades among the larger species, and many establish long-term and often quite complex social relationships; even smaller species, like the anemonefish, can live for more than 10 years. These life-history characteristics, combined with a strong dependence on the reef for food and shelter and relatively low rates of replacement, mean that loss of habitat, or rapid removals of substantial numbers of animals through fishing, are inevitably disruptive. One approach to maintaining reef fish assemblages that is gaining popularity and support worldwide, is to establish areas of reef that are completely protected from human activities. Hong Kong has just one such Marine Reserve, at Cape d'Aguilar, which protects less than 1% of local waters. More, however, are needed to protect local reef fish fauna and to act as a refuge for species of commercial importance. Marine Reserves protect both habitats and the organisms that depend on them, and, if large enough, well-managed and properly located, would not only help to maintain local reef fish biodiversity but could also increase fishery production in surrounding areas.

How to use this book

This book is a guide to the identification and biology of local reef-associated fishes. The species are arranged approximately according to the taxonomic relationships among the families (which end in –idae) to which they belong; we follow Nelson (1994) in this organization. The typical shape of each family is given on the endpapers of this book for easy reference. Most species are presented in colour; live individuals are featured whenever possible while dead specimens were photographed shortly after death to preserve natural colours and patterns. Colour descriptions are based on living or freshly dead fish, not on preserved specimens. The fishes depicted were taken from Hong Kong waters; supplementary photographs taken elsewhere are clearly indicated as there are often subtle colour differences within a species in different areas of its range. Whenever a species exhibits various colour phases, these are shown or verbal descriptions are usually given if a photograph is unavailable. In referring to colour, a stripe refers to a horizontal marking and a bar to a vertical one.

For each species, all available literature on their biology was reviewed; it is striking how little natural history information there is on reef species of the region. All pertinent identification keys and detailed biological studies

are included in the bibliography as well as more general fish guides of broader interest.

In the species accounts, the two-part Latin scientific name (*Genus species*) is provided with the authority (the person who first described the species) and the year of the description; the authority appears in brackets if the species was originally described in a different genus (congeners are species of the same genus). An English common name is given, as well as the local English name in the case of some of the commercially important species. When several English names are used for a species, that most commonly applied locally or regionally appears first, or the FishBase 98 name was selected (FishBase is a global fish database). Occasionally, a particular species may have been misidentified in the literature, or synonyms (names given to what was originally thought to be an undescribed or different species) applied by which the species might be well-known locally. *For simplicity, we also use the term 'synonym' when a species was placed in a different genus in the past.* The locally relevant synonyms or incorrect names are included for easy cross-referencing of species identifications. Where a species identification could not be confirmed, just the genus is given or the term 'cf' is used to indicate a tentative identification.

Important morphological features used in the identification of fishes are illustrated on pp. 22 and 23. Among the most important characters are 'meristics'. These are counts of fin spines, rays, and other morphological features. Details on the meristics of the dorsal, anal and, usually, the pectoral fins, are provided as these may be used to distinguish among species, genera or families. It should be noted that these meristics can vary even within a species and so a range is often given for particular characters. Other features may be provided if these are needed to distinguish among similar species. Also noted is the maximum size recorded for the species which can be substantially higher than any individuals likely to be seen locally. This may be specified as Standard Length (SL), Total Length (TL) or as length type not given (NG). Note that the posterior extreme of the standard length is best located by bending up the tail of the fish and locating the crease that forms. Occasionally fork length (FL) is used which extends from the mouth to the indented margin of the forked tail. Special features used for identifications within particular families are given in the relevant sections.

Most bony fishes have both hard spines and soft rays in their dorsal and anal fins. To distinguish between spines and rays, the counts of spines, which are not branched or segmented and are often sharp, is given in Roman numerals. The number of soft rays, which are segmented, flexible and often branched, is given in Arabic numerals. Note that the last (posterior-most) two rays are counted as one ray if they are joined at the base. Therefore, a dorsal fin count of 'D XI, 10–12' would indicate eleven spines and between 10 and 12 soft rays. Some species have two dorsal fins, each of which has spines. In such cases, the meristic count would be expressed as 'D VIII+I, 9–10' for eight spines on the front dorsal and one spine on the second dorsal fin, plus 9 to 10

rays on the second dorsal fin. Letter 'A' denotes anal spines and rays, whereas 'P' is for pectoral and 'D' is for dorsal.

For some species, other characteristics must be used. For example, scale or gill raker counts are made and in families like the seahorses, the number of body rings are important in species identifications. In others, internal features must be examined and the specialized keys listed in the bibliography should be consulted. Typically, the scale count is made of the number of pored scales (scales with small holes) along the lateral line from the upper end of the operculum to the crease in the caudal peduncle. If there is no obvious lateral line, then the longitudinal series of scales is counted between the same two points. For most bony fishes commonly found on reefs, the scales are typically thin and light. In others, scales may be modified into interlocking plates or otherwise specialized. Counts of gill rakers may be needed to distinguish species that are closely related. Gill rakers are knobs along the inner edge of the first gill arch (to which the gill filaments, underneath the operculum, are attached) and are counted from the top. For details of other special features used in identification, see the individual family accounts or appropriate keys.

The text for each species describes aspects of the biology from direct observations, from the literature and from research undertaken locally, as well as its geographic distribution. Information from studies done outside of Hong Kong is referred to as coming from 'Elsewhere', or the country is specified. We have attempted to provide a measure of abundance by indicating 'common', 'moderately abundant' or 'rare' for most species. 'Common' indicates that the species was seen on most dives in the preferred habitat of that species, or was common in catches from reefs; 'rare' indicates that fewer than 5 fish were seen over the four-year survey period or that individuals were seen on less than 5 occasions in fish markets or in the field. 'Moderately abundant' falls somewhere between these two categories. New records for Hong Kong are species not noted in literature reviewed by Cornish (2000) or by Ni & Kwok (1999).

The geographic distribution of each species is given in general terms with particular emphasis on records of occurrence in the South China Sea to place the presence of the fishes of Hong Kong in a regional context. In describing broad distributions, the Indo-Pacific refers to an area from the coast of East Africa to the easternmost islands of Oceania. The Indo-West Pacific comprises the Indian Ocean and Western Pacific out to the Caroline Islands, and the Western Pacific stretches from the Andaman Islands to the west, east to the Caroline Islands, north to southern Japan, and south to Australia. Circumtropical refers to a global distribution in the tropics and antitropical to species found north and south of the tropical zone but not in the tropics. Antiequatorial species are those found south of the Tropic of Cancer and north of the Tropic of Capricorn but which do not occur within equatorial latitudes.

Finally, a word, or two, on fish, or is it fishes? When referring to many individuals within a species, the correct term is 'fish'. If talking about many different species of fish, the term to use is 'fishes'. Just in case you were wondering!

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