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THE STATE OF MARINE BIODIVERSITY IN THE SOUTH CHINA SEA

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The South China Sea (SCS) is of particular promise for biodiversity researchers globally. Covering some three million square kilometers of sea and with over 200 coral islets, the SCS stretches from the equator near Singapore to the Tropic of Cancer crossing the Taiwan Strait. While most of SCS consists of the Sunda Shelf which is less than 200 metres in depth, the northern part includes the South China Sea Basin, which in some areas are more than 5000 metres deep. Indeed, the SCS encompasses a tremendous diversity of natural ecosystems, ranging from coral reefs, rocky and sandy shores, mangroves, estuaries and mudflats to open waters and abyssal habitats, and are home to hundreds of thousands of species of organisms. Its waters wash the shores of 12 countries, and the maritime coasts of Brunei, Cambodia, Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam (all of which belong to ASEAN, the Association of South East Asian Nations), People's Republic of China, Hong Kong and Taiwan are all connected via the SCS. Not withstanding political, economic and social differences, the people in these countries depend upon the biological resources of the SCS in no small terms.

As part of ongoing efforts to better understand the rich marine bioresources in the SCS and bring scientists from all the SCS countries closer together, several initiatives have been implemented by the countries in the region (see Djalal, 1999). One of these initiatives (part of the Technical Working Group on Marine Scientific Research) culminated in a workshop on SCS biodiversity held in Singapore in May 1997, and was hosted by the National University of Singapore. This workshop and subsequent discussions brought together biodiversity scientists from throughout the SCS region, as well as international experts from Australia, Europe, Japan and the United States. The plant and animal diversity of the SCS, however, is far too diverse to allow a detailed study of all of them. The workshop therefore focused on several key groups, viz. algae and nearshore and intertidal vascular plants, sponges, corals, polychaetes, molluscs, crustaceans, echinoderms, and of course, fish. Many are key plants and animals (e.g. as biofoulers, bioindicators) in their respective ecosystems, but they also include species important for fisheries, aquaculture and other commercial applications.

Scientists from the countries around the SCS have been conducting independent marine biodiversity research in their respective countries for many years, but while national floral and faunal inventories are available for some countries (e.g., Huang, 1994), efforts to identify knowledge gaps and provide useful solutions are few and far between, with the exception of the highly successful series of marine flora and fauna workshops conducted in Hong Kong (see e.g. Morton & Tsang, 1986; Morton, 1997, 1998). Moreover, with the multitude of sampling methods (not all of which are exhaustive or appropriate), variety of data gathering and identification tools used (much of which is obsolete or outdated), there is often extensive misidentification of key organisms in existing literature. Further, the use of outdated publications can lead to much confusion with synonyms and generic placements of species. This is also made more difficult by the fact that new species are still being described at a steady rate (Bouchet, 1996). The frequent misidentifications and/or underestimation of biodiversity have serious consequences when marine areas need to be studied, assessed and/or conserved. A fundamental requirement in coming to terms with our biological heritage is surely the correct identification of species. For more detailed studies, including those on conservation and habitat management to be conducted on the flora and fauna of the SCS, there is a critical need to consolidate the regional biodiversity data, arrange for and train local staff in the precise identification of key plants and animals, and to make available accurate regional inventories of these organisms (Stork, 1994).

The present volume attempts to resolve some of the above-mentioned shortcomings, and it is the result of hard work put in by participants of this workshop. It contains a total of 13 checklists treating the vascular plants, sponges, polychaetes, several molluscan and crustacean groups, echinoderms and marine fish. The checklists were compiled and checked by experts in their respective groups, and include many personal observations made by the authors themselves. All are accompanied by detailed lists of pertinent literature. These lists will be useful to scientists dealing with flora or fauna outside their field of expertise, while at the same time allowing specialists and investigators to have a better perspective of the regional flora and fauna. The checklist of fish is especially important as it treats a group with substantial economic and social importance to the people of the SCS. It is also a remarkable contribution, put together by no less than 67 ichthyologists (see Randall & Lim, 1999, this volume).

Vascular plants, including the ferns, are listed by Turner et al. (1999). A total of 39 species of ferns, eight species of gymnosperms and 656 species of angiosperms from more than 120 families are provided in the list. For each species, brief notes on its size, habitat and geographical distribution are given. Of particular interest are listings of habitat-specific plant species. In a separate bibliography, Turner (1999) has given more than 170 references to recent and/or useful monographs, books and papers dealing with the plants in and around the SCS region.

Compared to the vascular plants, the marine fauna of the SCS is poorly known. Except for fish and some groups of crustaceans, the lists given for the other groups of animals remain preliminary and incomplete, as pointed out by the authors themselves. Hooper et al. (1999) have listed more than 1500 species in 102 families of sponges but estimate the number of species to be as many as three times higher than now known, of which only 5% of the SCS sponge fauna is distributed throughout the Indo-west Pacific! The authors state that this high endemism, coupled with ecological specialization and possibly fast speciation rates, suggest there is still a large number of species yet to be discovered. These are very significant revelations from one of the top sponge research teams in the world.

Polychaetes are treated by Paxton & Chou (1999) who have listed 661 species in 54 families. They stress that the number of species does not show the true situation in the SCS, but rather reflects the past collecting efforts of biologists. A similar situation appears to be true for the crustaceans. The Amphipoda is a case in point. Lowry (1999) has listed 272 species from 48 families, but he states that these small, laterally compressed malacostracans from algal forests, seagrass meadows and coral reefs in the SCS have not been studied and remain poorly known. The same conclusion is echoed by Komai (1999) who list 157 species in 14 families of mud lobsters and anomurans other than hermit crabs, the latter which is treated by Rahayu (1999) in which 102 species in the families Diogenidae, Paguridae and Parapaguridae are listed. However, crustaceans of economic importance are perhaps better known. A tone of quiet confidence can be detected in the conclusions reached by Moosa (1999) who lists 116 species of stomatopods in 13 families, and by Jones et al. (1999) who list 316 species in 21 families of thoracic (non-rhizocephalan) barnacles.

The coverage of molluscs in this volume does not do justice to their important ecological and economic roles they play in the SCS, but in some ways reflect the extent of specialization required of workers to grapple with the taxonomic difficulties inherent in the speciose malacofauna of the SCS. Amongst the gastropods, 130 species of Muricidae (Neogastropoda) are listed by Tan (1999) and 193 species of nudibranchs listed by Sachidhanandam et al. (1999). The preliminary cephalopod list provided by Norman & Lu (1999) has 120 species in 31 families, and the authors have included a useful compilation of erroneous literature records of cephalopod species found in the SCS. The echinoderms are a less speciose, but nevertheless important phylum amongst the marine fauna. Lane et al. (1999) have listed 982 species in 102 families, of which 12% are thought to be endemic to SCS.

The list of marine fishes in the SCS is edited by Randall & Lim (1999, pages) and is a grand compilation of the work of 67 fish taxonomists (including the editors themselves) from 12 countries currently working on various fish families and groups. Personal preferences and dissent were cast aside to agree on the contents, which list a total of 3365 species in 263 families. A useful list of key references grouped under taxonomic orders and/or families is also provided. Although this marine fish species list is perhaps the most comprehensive to date for an area this size in the Indo-west Pacific, the editors are careful to state that the pelagic and abyssal fish fauna are far from being well documented. In fact, the SCS is on the whole poorly explored biologically as reiterated by the contributors of this and other floral/faunal lists, and there is much to be gained from a more systematic and co-operative approach. The fish list can be hailed as an epitome of scientific cooperation and it is hoped that the same spirit and gusto can be extended to other aspects of SCS initiatives.

Despite the severely limited repertoire of organisms covered by these lists, it is clear that the SCS is biologically diverse. More than 8600 species of plants and animals are included in the list, but these exclude important, speciose groups such as the cyanobacteria, eukaryotic algae, protozoa, cnidarians, platyhelminthes, nematodes, bivalves, copepods, isopods, major decapod crustaceans (e.g. true crabs, lobsters and prawns) and tunicates. When these missing groups are considered the number of species will certainly increase significantly. This will be in addition to many new records and new species being discovered every year in and around the SCS. This will be expected to continue, given that the region is still relatively unexplored biologically, and that it is located in the Indo-West Pacific epicentre of biodiversity. This is not only true for demersal and abyssal fauna, but also applies to the smaller organisms living in shallow-water ecosystems, such as in the mangroves, coral reefs, seagrass meadows and sandy shores (meiofauna). In addition, once the proper global

systematic revisions are done at the global level, many species of "well known" animals will probably turn out to be new to science, unusual or endemic to the region. Our knowledge of the biology and ecology of these multitudes of species is obviously unimpressive. These problems should be considered in the light of modern economic development in the SCS, where man competes with other organisms for resources. Destruction of habitats and pollution are two activities that are expected to escalate in the next 50 years around the SCS, and the need to inventorize and find out as much as we can about the organisms and their interactions with the environment are more urgent than ever before. There are also major challenges. Taxonomic impediments are at the forefront of the biodiversity crisis, and the problems associated with finding and training a new and competent crop of younger marine taxonomists are serious. Yet, most of the current political attention and available international funding, unfortunately, is still squarely focused on "management" rather than systematic research. It still confounds the authors how an effective management can be designed when the organisms composing the ecosystem are still so poorly known, and even less is known of the ecological interactions. While species checklists themselves cannot address the above mentioned problems directly, it is hoped that the friendships and contacts developed during the workshop will encourage scientists to take the first joint international step toward a better understanding of the biological processes in the SCS.

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