The Sea Cucumber *Holothuria scabra* (Holothuroidea: Echinodermata): Its Biology and Exploitation as Beche-de-Mer

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One of the most intensively studied holothurians, Holothuria scabra *has been discussed in the literature since 1833. The species is important for several reason: (1) it is abundant and widely distributed in shallow soft-bottom habitats throughout the Indo-Pacific; (2) it has a high value on the Asian markets, where it is mainly sold as beche-de-mer; and (3) it is the only tropical holothurian species that can currently be mass produced in hatcheries. Research on* H. scabra *continues but because of commercial exploitation, wild stocks are declining. This review compiles data from 14 theses and 348 technical reports and scientific papers pertaining to the biology, ecology, aquaculture and fisheries of* H. scabra*. Although several references are likely to have been missed by our investigation, we present the most complete reference list to date, including obscure material published by local institutions and/or in foreign languages. Our main aim was to summarize and critically discuss the abundant literature on this species, making it more readily accessible to all those wishing to conduct fundamental research, or aquaculture and stock enhancement programs, on* H. scabra *across its entire geographic range.*

1. INTRODUCTION

Holothurians, commonly known as sea cucumbers, have been harvested for over 1000 years in the Indo-Pacific regions to supply markets in Asia for beche-de-mer, i.e. the dried body wall of the animal (Anonymous, 1975; Conand and Sloan, 1989; Conand, 1990; Conand and Byrne, 1993; D. B. James and P. S. B. R. James, 1994). The demand for beche-de-mer has been growing, especially with the re-entry of China into world trade during the 1980s. However, inadequate management of the sea cucumber fishery has resulted in severe overfishing in many countries, so that natural stocks are depleted almost everywhere within their geographic distribution (Preston, 1990a; Conand and Byrne, 1993; Holland, 1994a, b; Conand, 1998a; Battaglene, 1999a; Battaglene and Bell, 1999; Morgan 1999a; Battaglene *et al.*, in press). In addition to being exported, some species of sea cucumbers in Papua New Guinea, Samoa and Fiji, including *Holothuria scabra*, are also eaten locally (Shelley, 1985a; Conand, 1990; Adams, 1992; Conand and Byrne, 1993).

Although ca. 20 holothurian species are fished commercially around the world, only a few yield first grade beche-de-mer (Conand, 1989, 1990; Conand and Byrne, 1993; South Pacific Commision, 1994, 1995). The

sandfish *H. scabra* is one of these species and can fetch between ca. 50 and 100 US$ kg^{-1} dry weight as beche-de-mer (Conand, 1989; Mercier and Hamel, 1997). Interestingly, *H. scabra* has not always been so popular. Before commercial harvests bloomed in the 1970s, fishermen in Sri Lanka and other countries discarded *H. scabra* as an unclean animal and everyone who touched one would immediately wash their hands (Anonymous, 1978a). *H. scabra* fisheries have since become an important source of income for local fishermen in Indonesia, Papua New Guinea, India, Madagascar, Solomon Islands, Philippines and in many other Pacific and Indian Ocean countries (Conand and Sloan, 1989; Conand, 1990, 1998a; Conand and Byrne, 1993; Battaglene and Bell, 1999).

With the great demand for beche-de-mer and the response from local harvesters, the increasing harvest pressure on natural populations of *H. scabra* has created a severe crisis. Those wishing to restore depleted populations and to develop efficient aquaculture and stock enhancement programmes quickly encountered a lack of knowledge of most aspects of the biology and ecology of the species. The urgency of this situation has prompted many countries to conduct studies and rearing trials on *H. scabra* over the last decade, with the result that knowledge accumulated rapidly but has been inefficiently shared. Moreover, data were seldom assessed critically and results were often published in grey literature, if at all. The main problems encountered include doubtful identification of the species being studied and poor description of the methodologies used. Uncertainties and inexactitudes were widespread and many projects were duplicated, thus constraining the overall scientific progress in the field of *H. scabra* studies.

Since the first mention of *H. scabra* in the early 1800s, the species has been reported or discussed in hundreds of books, theses, reports, popular and scientific articles, of which D. B. James (1994a) made a partial list in his annotated bibliography on sea cucumbers. Some important contributions to the literature are often difficult to find or to consult, either because they were written in Malay, Indonesian or other languages, or because they were published in local journals or internal reports. This might explain why many researchers, such as Baskar (1994) and D. B. James (1994b), lamented a lack of knowledge of *H. scabra* in spite of the obvious interest and many ongoing research projects**.**

For this study, we have compiled and summarized the existing documents on the systematics, biology, ecology, culture and fisheries of *H. scabra* to make them readily accessible. This review should enable future research to focus more clearly on advancing our knowledge of this overfished species, which is both ecologically and commercially valuable throughout the Indo-Pacific.