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## Tropical sea cucumber fisheries: Changes during the last decade

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## ABSTRACT

Tropical sea cucumber fisheries are generally traditional, small-scale, multispecies and poorly managed. Many recent studies have improved our knowledge on the biology and ecology of the commercially important species; the main results are analysed and the remaining gaps discussed. The fisheries and the patterns of trade changes during the last decade are presented from the data available and confirm overexploitation in the traditional Indian Ocean and West Pacific countries and territories. Several Latino-American countries now have active fisheries. Despite the management and conservation issues which have recently received more attention at international, regional and national levels, more measures are still needed at all these levels, to ensure sustainable exploitations of these resources.

## 1. Introduction

Sea cucumbers (Echinodermata/Holothuroidea) are important benthic invertebrate marine resources. They are fished traditionally by Asian people, mostly Chinese who consume the product Beche de mer (trepanng or Hoi som) prepared from the dried body wall as a delicacy or a medicine (Conand, 1990). The fisheries for this product outside China date back to the seventeenth century in many countries. As the Chinese demand increased, the fisheries have progressively spread to most tropical countries. The issues of management and overexploitation have lead FAO to organise international workshops to provide information on this poorly known resource (Lovatelli et al., 2004; Toral-Granda et al., 2008).

In the book ‘The Biology of Coral Reefs’ published by Sheppard et al. (2009) the holothurians were briefly presented by Conand; and it is important to update the knowledge on their importance in coral reefs ecosystems and in the fisheries, after a decade of research.

Many recent results on this class of echinoderms have been published recently. These include those on the ecological roles of holothurians including exploited species (Purcell et al., 2016). Their feeding and excretion are important in nutrient recycling and bioturbation of the sediment; they host many species of parasites and symbionts thus enhancing biodiversity; they are preyed upon by many taxa and are important in trophic cycles. The biological characteristics of populations have been studied for many commercial species worldwide, especially in the tropics (Conand, 1989, 2006a, 2009). Much attention is now being paid to the fisheries and their commercial value (Purcell et al., 2013; Conand, 2017; Purcell et al., 2018).

The recent changes to taxonomy and molecular phylogeny are not discussed here but see Miller et al. (2017) for these changes. The diversity is still underestimated as many species belong to species complexes or are undescribed (Michonneau et al., 2015). The results of a Google alert on ‘holothurians’ published in the SPC Beche de mer Bulletin, published yearly, gives a thematic distribution of the number of references as they appear; and shows the current areas of research. From among nearly 500 references cited for 2015 and for 2017, 26% refer to biology and ecology, 47% to biochemistry, genetics and microbiology, 11% to aquaculture, and 18% to fishery and socio-economic issues (Conand, 2016, 2018).

This review concentrates mainly on tropical species of commercial interest and changes in their exploitation and trade during the last decade. Considering that there are presently around 1700 accepted extant holothuroid species (WoRMS, 2018), the estimated number of exploited species is relatively low; however, it nevertheless increased from 40 (Conand, 2006a, 2006b) to 66 (Purcell, 2010) of which 58 are presented with details and figures in Purcell et al. (2012). Many other species are probably now exploited in a few localities or in small quantities.

## 2. Material and methods

As a bibliographic synthesis, the data from several previous studies are grouped to present the results for the last decade and the main changes which have occurred during this period. Each of the following topics centred on tropical species is discussed: ecological roles, population biology, fisheries and trade, management and conservation. The

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temperate fisheries either Chinese or Japanese generally based on *Apostichopus japonicus* (Yang et al., 2015), or the more recent ones that have developed in the Mediterranean (González-Wangüemert et al., 2014, 2018) are therefore not considered here.

### 3. Results

#### 1) Ecology of tropical commercial holothurians

Tropical commercial species: they share the characteristics of being large as adults, with a thick integument which gives a valuable processed product; their populations are relatively dense and shallow subtidal (Conand, 1990, 2006a, 2006b; Purcell et al., 2012). They belong to the families Holothuriidae and Stichopodidae; some commercial Cucumariidae are temperate species. Three categories are generally distinguished according to their value: as large and common species they have generally been described a long time ago. Nevertheless, some differences between species with wide distributions or between Pacific and Indian Ocean sister species; have recently been detected using new molecular techniques. For example, the species of high value, called sandfish in the fishery now are referred to as *Holothuria scabra* (Jaeger 1833) and *Holothuria lessoni* Massin, Uthicke, Purcell Rowe and Samyn, 2009, whereas it had previously been identified as a single species *H. scabra* var. *versicolor* (Conand, 1990). Another group of high value species is the teatfish group that the fishermen used to call white teat and black teat. Cherbonnier (1980) first identified from New Caledonia specimens, those referred to the white teat as *H. fuscogilva* Cherbonnier, 1980 and to the black teat as *H. nobilis* Selenka (1867). This name is now valid for the black teat from the Indian Ocean, but later studies showed that the Pacific black teat is *H. whitmaei*, Bell 1887 (see Purcell et al., 2012). As found for the black teat, the Indian Ocean species of white teat is different and a new species will be described shortly (Paulay pers. comm.). Finally, a fifth teat species, which is very important in the Seychelles' fishery and referred to under the name of 'pentard' (Aumeeruddy and Conand, 2008) will also be described as a new species (Paulay pers. comm.).

The high commercial value category comprises these species and the stichopodid *Thelenota ananas*. The medium value and low value categories have changed little during the last decade, with a few up-grading given the increase in the demand and overexploitation. Several *Holothuria* spp., *Actinopyga* spp. and *Bohadschia* spp. are now also collected. The trends are clearly shown for some Melanesian countries in the tropical Pacific, despite the boost-and-bust nature of the fisheries and the moratoria that can obscure the changes (Govan, 2017). The shift from high to lower values species is evident with an increase in the number of species exploited, mostly from the Indo-Pacific. Eight species only are presently exploited in the Latino-American countries, four from the Atlantic and four from the Eastern Pacific (Purcell et al., 2012).

**Distribution and ecological roles:** the commercial species are found in different habitats of the coral reefs, mostly on the associated soft substrates. In the recent review by Purcell et al. (2016) the five main ecological roles they play are: 1) their contribution to sediment health by bioturbation and sediment cleaning, 2) recycling of nutrients, 3) influencing seawater chemistry, 4) enhancing biodiversity through symbioses and 5) energy transfer in food chains. Most of the examples presented in this review by Purcell et al. (2016) come from tropical environment and coral reef holothurians. High-density populations are characteristic of unfished reefs (Purcell et al., 2009; Eriksson and Byrne, 2013; Muthiga and Conand, 2014) and if these are exploited, fishery management should also take into account their ecosystem services (Purcell et al., 2016).

#### 2) Population parameters and dynamics of tropical holothurians

During the last decade many studies have increased our knowledge

on several commercially important species of holothurians, which is critical in order to develop sustainable management plans. These fields of research include detailed population densities and how these fluctuate over time in order to determine sustainable fishing levels.

The global review published by FAO (Toral-Granda et al., 2008) provides information on the main exploited populations, for three tropical world regions and a hotspot for each (Asia and Western Central Pacific including Australia, Africa and Indian Ocean, Latin America and Caribbean). The need of studies on the main species populations is emphasised.

The recommendations of the CITES workshop (Bruckner, 2006) point out the 'critical research needs on parameters for fishery models, include rates of growth, mortality and recruitment'.

During the last decade several programmes have been conducted on the main species, for example in the Indian Ocean by WIOMSA (Conand and Muthiga, 2007; Muthiga and Conand, 2014), in the Pacific by World Fish (Eriksson et al., 2015a, 2015b), ACIAR (Friedman et al., 2008) and involving scientists from many different universities or institutions.

Body size is an important parameter, related to reproductive fitness, when food is not limited.

It has been shown that larger individuals within a species have larger gonads, more gametes and higher fecundity. The black species *H. leucospilota* and *H. atra* are very common on the Indo-Pacific reefs, with large populations (Conand, 1989; Gaudron et al., 2008; Muthiga and Conand, 2014). These species as well as *Stichopus chloronotus*, are able to reproduce by fission which maintains the local populations and by sexual reproduction with larval dispersal which enhances genetic variability (Uthicke and Conand, 2005). The main parameters of the sexual reproduction (sex ratio, variations of gonad-index, seasonality, fecundity) are needed for comparisons between regions and for species specific management plans. Many publications are still appearing on these topics, especially when a fishery is either more focused or declining, and these parameters are now defined for many species (see SPC BDM Bulletins). Larval development and recruitment remain critical for developing these management plans as juveniles are rarely observed in the fields; they are also critical for mariculture intended for stock restoration, sea ranching or sea farming (Cecarelli et al., 2018). Growth and survival for most species need more investigation. When produced by hatcheries, which has only been successful for very few tropical species (mainly *H. scabra*), the mortality is generally high (Purcell and Simutoga, 2008; Hair et al., 2016).

#### 3) Fisheries and trade of tropical holothurians

The fisheries and trade of sea cucumbers from the Indo-Pacific, mostly as dried product, have been described for a long time (Sella and Sella, 1940; Panning, 1944), as they are generally not consumed in the country where they have been fished and processed (Conand, 1989).

Yearly FAO statistics for catches are the main source of information, but are sometimes difficult to use as they depend on the declaration of the countries. The processed dry product weight only represents a small percentage of the live weight of the catch, and is variable between species. The category sea cucumber is not specified in some countries and therefore not included in FAO statistics and therefore the figures are only approximate.

When considering one country or one territory, as New Caledonia for example (Conand, 1989), the data compiled from different sources between 1862 and 1984 show large variations. Phases of intense exploitation are followed by very limited ones, due to various biological, sociological or political reasons; which is an example of a 'boost and bust phylum', a term used for many populations of species of echinoderms (Uthicke et al., 2009).

**The landings for the world tropical fisheries of holothurians** are shown in Table 1, as yearly means in dry weight, for the last six years 2009–2014 and means for previous decades to evaluate the changes

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