COMMERCIAL SEA CUCUMBERS AND TREPANG MARKETS

C. Conand
Laboratoire d'Ecologie Marine, Université de La Réunion, Saint-Denis, France

Keywords: sea cucumber, holothurian, aspidochirotid, dendrochirotid, trepang, beche-de-mer, biology, ecology, fishery, market, processing, statistics, stock, overexploitation, management.

Contents

UNESCO – EOLSS SAMPLE CHAPTERS

Summary

Characteristics of the morphology, anatomy, and biology of the sea cucumbers, particularly the commercial species, used to prepare trepang or "beche-de-mer," a delicacy for Asiatic people, is presented in the introduction, before an overview of the complex fishery system. The main commercial species are then listed, and summary described, according to the fishery zones and traditions. The harvesting, processing, and grading methods for trepang are traditional and help maintain high grade, valuable products. The main world fisheries, tropical and temperate, traditional and recent, and their recent catches are analyzed, and show an increase of interest; many recent fisheries raise conflicts in relation with conservation needs. The processed product generally passes from the producer country to the main world markets, Hong Kong, Singapore, and Taiwan, before being imported in the consumer countries. From diverse indices, over-exploitation is more and more often evoked worldwide, as the demand for trepang increases; durable management should become a priority, and regulations should be adapted for these fisheries. In conclusion, further studies should develop on the fishery biology of the commercial species, on stock assessments, on improving the statistics on catches and markets, and on alternative measures for conservation based on mariculture. Despite an increasing interest, all these fields are still poorly known; they yet deserve more attention, as their social value in small artisanal activities is high.

1. Introduction

1.1 General Remarks on Sea Cucumbers

Sea cucumbers or holothurians are invertebrates belonging to the phylum Echinodermata, which is recognized by a radial symmetry, generally pentamerous, an intra-dermic skeleton consisting of closely fitted plates or small ossicles, and a water–vascular system; a peculiar system of tubes filled with fluid.

The following introduction on the characteristics of the morphology and anatomy, and aspects of the biology mainly concerns one order of holothurians, the order Aspidochirotids, which comprise most of the commercial species; the species of the order Dendrochirotids are more common in the temperate regions, but less valuable.

Concerning the external morphology, the holothurians have a body elongated, in form of a cylinder, with at one end the mouth encircled by tentacles and at the other the anus often edged by papillae. The pentamerous symmetry is sometimes evidenced by the presence of five meridional ambulacra bearing podia. They often lie on the substrate upon a ventral surface, which bears the locomotory podia, while on the dorsal surface the podia are often represented by papillae. The mouth terminal, displaced dorsally, is surrounded by a thin buccal membrane and bordered by a circle of tentacles. Their number, between 10 and 30, is generally a multiple of 5. The tentacles are buccal podia containing extensions from the water vascular system. The form and number of the tentacles differs between the different orders and is a character used in the keys. In Dendrochirotids they are dendritic, branching in an arborescent manner. The Aspidochirotids have peltate tentacles, each with a central stalk. They are very retractile and are contracted into the mouth by retractor muscles.

UNESCO – EOLSS SAMPLE CHAPTERS

The general body surface is thick, slimy in many species, and wears warts, tubercles or papillae. Podia typically are hollow tubular projections from the body wall, which can lengthen, flex or retract. Each podium terminates by a flat disc, which allows it to adhere to the substratum during locomotion. The anus is often displaced dorsally and is encircled by small papillae or anal teeth. The coloration varies between species and sometimes between individuals of the same species. The creeping sole is often brighter and lighter than the dorsal face.

Concerning the internal anatomy (see Figure 1), the body wall is relatively thick, particularly in Aspidochirotids. It constitutes the part processed for human consumption. Commercial species are therefore characterized by a thick body wall. Its structure consists of a thin cuticle over the epidermis and a thick dermis underneath. Under the dermis a layer of circular muscles form a cylinder generally interrupted by five longitudinal muscle bands situated in the radial positions.

Also called ossicles, the spicules constitute one characteristic of the class and are of primary importance for identifications, which is done from alcohol-preserved specimens. Spicules are fenestrated calcareous bits of microscopic size. There are a very large variety of shapes, more or less complicated. The simpler shape is found in rods, which can be simple or branching, smooth, warty or spiny, or can display a “C” or “S” characteristic shape. Fenestrated plates, buttons, tables, rosettes are some examples of the variety of forms. Their developmental stages can differ from the definitive shapes in the adults and thus can complicate the identifications.

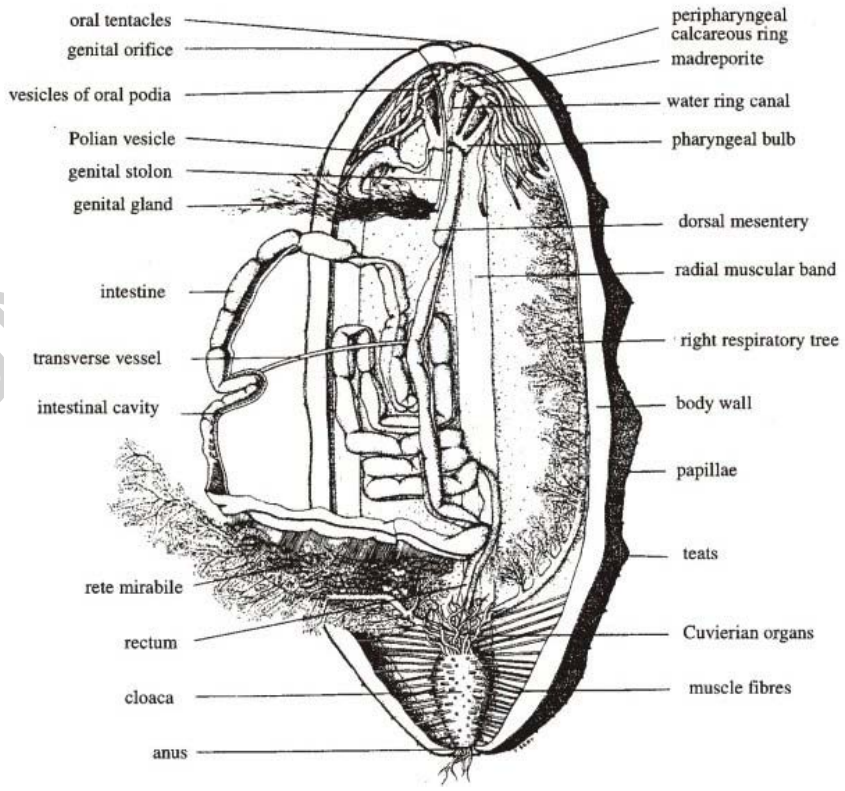

Figure 1. Anatomy of the holothurian *Holothuria nobilis* (from Conand 1990).

The gut is composed of a pharynx, an esophagus, a stomach and a very long intestine, in three loops; the third, descending, loop is connected to the cloaca, where the respiratory trees are also opening. A haemal system is associated with the digestive system. Its importance is variable. The respiratory exchanges occur partly by the podia and partly by specialized organs, as respiratory trees. Cuvierian tubules, present in some Aspidichirotid species, are sticky defensive structures, expelled through the anus and able to regenerate. The genital system is composed of one gonad, composed of one or two tufts of tubules.

Holothurians are found throughout the oceans, at all latitudes and depths. Most species are sedentary (slow-moving); some species of the family Stichopodidae can move faster, especially when disturbed; some species as *Bohadschia spp*. exhibit feeding rhythms and burrow during feeding. The ecological impact of the feeding habits of Aspidochitotids is related to the ingestion of large amounts of sediment and excretion of feces. Sexual reproduction modalities are important for fishery biology; the following parameters are known only for a few species: sex ratio, size at first sexual maturity, reproductive cycles, and fecundity. Sexes are generally separated, but cannot be distinguished externally. Mature gametes are released in the sea for most species; the spawning behavior observed in many aspidochirotids, involves an upright rearing of both sexes while the gametes are released; after fertilization, the development often goes through planktonic larvae with a bilateral symmetry, which metamorphose into benthic juveniles. A few species also present asexual reproduction by fission. Growth and mortality are still not evaluated for most species; the biometry is difficult to determine because the variability of the measurements of length or weight is particularly high, due to the body wall consistency, the variable amounts of coeliac water and sediment in the gut... Holothurians have few predators, but most tropical species have toxins in their body. They host a large assortment of commensals and parasites, including for example diverse protozoans, polychaetes, copepods, crabs, snails, and pearl fish.

1.2 The Holothurian Fishery System

Holothurian fisheries are mostly based on deposit feeding species; they belong to around thirty species amongst the thousand existing. Sea cucumbers are eaten raw, boiled or pickled, either processed in a dried product, beche-de-mer. In Japan and Korea, the body wall and viscera of sea cucumbers are eaten raw or pickled. The most important sea cucumber product, however, is the dried body wall, which is marketed as beche-de-mer (trepang or hai-som), throughout the tropical regions. Beche-de-mer fisheries have a long history, as the Chinese have sought sea cucumbers for a thousand years or more in India, Indonesia, and the Philippines. During the eighteenth and nineteenth centuries, traders gathered them in a wider area. Conand has described the temporal and spatial variability in the harvest of sea cucumbers. These fisheries are still poorly documented and, in many cases, not well managed.

The fisheries can be divided according to the geographical area and the species harvested. Tropical fisheries tend to be multi-specific whereas temperate fisheries are generally mono-specific. Traditional tropical fisheries in the Western Pacific, and Indian Oceans produce dry product; recently, some countries have started exploitations on the

UNESCO – EOLSS SAMPLE CHAPTERS

Eastern Pacific coasts. Temperate fisheries for fresh or frozen product were long limited to the North Western Pacific Ocean and there are now new countries interested.

Chinese traders largely control the world beche-de-mer market, and historical data from 1917 to 1994 have been reviewed. Statistics for the last decade are presented here for the three main market centers, Hong Kong, Singapore and Taiwan. These markets are also the major re-exporting centers. Evaluation of the sea cucumber landings and beche-de-mer production is useful in documenting the main characteristics of the sea cucumber fishery, and prospects for its development and management.

The whole "Holothurian Fishery System" is presented in Figure 2, on the example of the tropical Indo-Pacific fishery for beche-de-mer. There are at least five levels between the resource on the seafloor and the plate of the consumer. At each level, different actors may intervene. The figure partly highlights the complexity of the different levels; numerous interactions take place at each level and between the levels. It appears that this system could be taken as a good example of artisanal fisheries for export and should be considered as a whole for an integrated management.

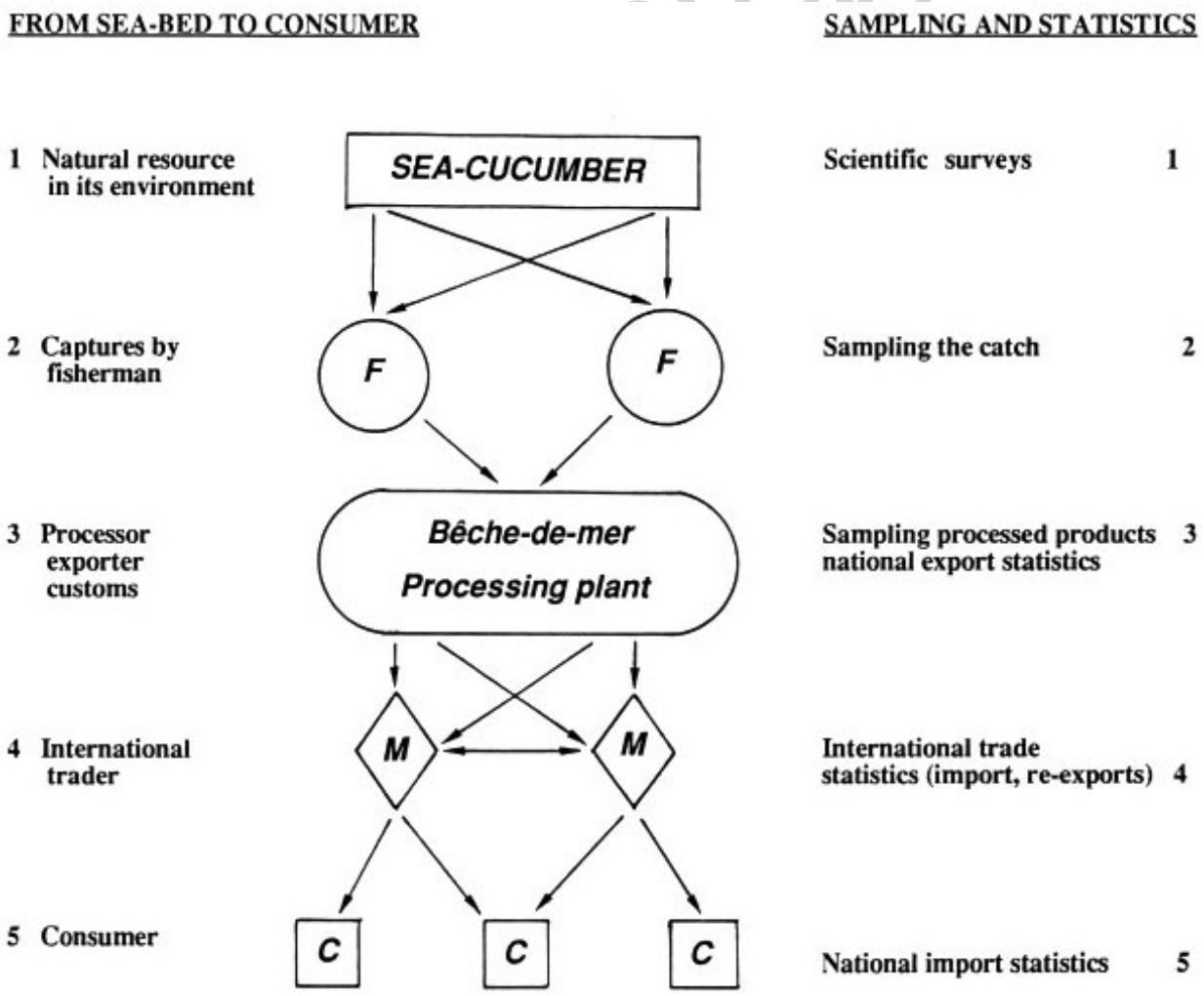

Figure 2. Holothurian Fishery System (from Conand 1998).

2. The Commercial Sea Cucumbers

Different holothurian species are harvested according to the main geographical areas. In general, more interest has been given to the biology of the species targeted in traditional fisheries than in more recent ones. Despite the abundance and large size of these animals, and their importance in benthic communities, little information is published on their population biology compared with other living marine resources.

The different commercial species share a few characteristics:

- Abundance in shallow waters
- Large size of the specimens
- Thickness and quality of their body wall
- Absence of Cuvierian tubules (or not easily rejected)

From these characteristics, and the information from the markets, it has been possible to grade the species into four categories, grade 1 being the highest and grade 4 corresponding to the lowest one, which is generally not valuable to fish.

Table 1 summarizes the commercial species, worldwide, according to the present fisheries; the description is given according to the main geographic regions (tropical and temperate) and the history of the fisheries (traditional or recent). The FAO species identification guides for fishery purpose present sometimes information on the sea cucumbers; it is the case for sea cucumbers included in the Mozambique species guide, and the recent guide for the Western Central Pacific. Useful information is found in a monograph for the tropical Indo-Pacific. Data concerning particular country are found in specialized literature, as the *Beche-De-Mer Information Bulletin* published by the SPC (Secretariat of the Pacific Community) (eleven issues have been published from 1990 to 1999), and in the Proceedings of the ninth Echinoderm Conference.

Tropical Zones		
Indo- West Pacific	**ENGLISH NAME**	**GRADE**
Actinopyga echinites	Brown fish	2
Actinopyga lecanora	Stone fish	2
Actinopyga mauritiana	Surf red fish	2
Actinopyga miliaris	Black fish	2
Actinopyga palauensis	Black fish	2
Actinopyga spinea	Black fish	2
Bohadschia argus	Leopard fish	3
Bohadschia marmorata	Brown sand fish	3
Bohadschia similis		3
Bohadschia subrubra		3
Bohadschia vitiensis	Brown sand fish	3
Holothuria atra	Lolly fish	3
Holothuria edulis	Pink fish	3
Holothuria nobilis	Black teat fish	1
Holothuria fuscogilva	White teat fish	1

UNESCO – EOLSS SAMPLE CHAPTERS

Holothuria fuscopunctata	Elephant trunk fish	3
Holothuria scabra	Sand fish	1
Holothuria scabra versicolor	Golden sand fish	1
Stichopus chloronotus	Green fish	2
Stichopus variegatus	Curry fish	3
Thelenota ananas	Prickly red fish	2
Thelenota anax	Giant fish	3
EAST PACIFIC		
Isostichopus fuscus		
ATLANTIC		
Holothuria mexicana		
Isostichopus badionotus		
TEMPERATE ZONES		
WESTERN PACIFIC		
Cucumaria japonica		
Stichopus japonicus		
Stichopus mollis		
EAST PACIFIC		
Parastichopus californicus		
Parastichopus parvimensis		
ATLANTIC		
Cucumaria frondosa		

Table 1. Main commercial holothurian species, by zones and by grade.

-
-
-

TO ACCESS ALL THE **30 PAGES** OF THIS CHAPTER,
Visit: http://www.eolss.net/Eolss-sampleAllChapter.aspx

Bibliography

Carpenter K, and Volker N. (1998). *FAO Species Identification Guide. The Marine Living Resources Of The Western Central Pacific.* Vol. 2, 1396 pps. *Cephalopods, Crustaceans, Holothurians And Sharks.* [The part on holothurians presents the commercial species in the most diverse area worldwide.]

Conand C. (1990). *The Fishery Resources Of Pacific Island Countries. Part 2: Holothurians*. No 272, **2**, 143 pp. F.A.O. Fisheries Technical Paper, Rome. [This is the first comprehensive study on tropical sea cucumbers.]

Conand C. (1993). Reproductive biology of the characteristic holothurians from the major communities of the New Caledonia lagoon. *Marine Biology* **116**, 439–450. [This work provides data on different parameters of the reproductive ecology.]

Conand C. (1997). *Are Holothurian Fisheries For Export Sustainable*? Proc. 8th International Coral Reef Symposium, **2**, 2021–2026. [This is an overview of the fisheries up to 1994.]

Conand C. and Byrne M. (1993) A review of recent developments in the world sea cucumber fisheries. *Marine Fisheries Review* **55**, 1–13. [This is an overview of the fisheries up to 1990.]

FAO (1988–1998). *Fishery Statistics 1986 To 1996*. Vol. 1: *Catches And Landings*; Vol. 2: *Commodities*. Rome: FAO. [Yearly statistics are appearing by country and area.]

Mooi R. and Telford M. (1998) *Echinoderms*, 923 pps. San Francisco, Balkema, Rotterdam. [These proceedings contain many recent contributions on holothurians, from the symposium on fisheries and aquaculture.]

SPC (1990–1999). *"Beche-De-Mer" Information Bulletin*, (Ed. C. Conand), **1** to **11**. [These bulletins present original articles and general information on the sea cucumber biology, and fisheries.]

SPC (1994). *Sea Cucumbers and "Beche-De-Mer" of The Tropical Pacific.* Handbook 18, 51 pp. [Apart from the main species, this handbook for fishers presents processing, grading, and marketing.]

Yanagisawa T. (1998) Aspects of the biology and culture of the sea cucumber. In De Silva S., ed. *Tropical Mariculture*, pp. 291–308. London: Academic Press. [This chapter provides data and methods concerning the main temperate species.]

Biographical Sketch

Prof. Chantal Conand was born on 10 April 1943, at Cracovie (Poland); the author has French citizenship and is married with 3 children. University qualifications: Degree of Advanced Studies in Biological Oceanography, Marseille, 1965; Thesis of Advanced Studies in Biological Oceanography, Marseille, 1974; Thesis of State Doctorate in Life Sciences, Brest, 1988. Professional experience: 1966 Assistant-Teacher, Aix Marseille III University; 1970 Assistant-Teacher, Dakar (Senegal) University; 1976 Assistant-Teacher, Brest University; 1980 Detached research scientist at ORSTOM, now IRD, New Caledonia; 1984 Assistant Professor, Brest University; 1993 Assistant Professor, La Réunion University; 1995 Professor, La Réunion University. Main subjects of teaching: courses and practices in Animal Biology, Cellular biology, Ecology, and setting of new courses on Tropical Ecology. Research: in Senegal, reproductive biology of coastal pelagic fishes from Senegal; in New Caledonia, ecology, biology, and fisheries of sea cucumbers from New Caledonia and from South Pacific. At Brest, Biology and Ecology of temperate and tropical Echinoderms. At La Reunion, Coral reefs functioning, degradations and management, reef resources (holothurians). Research and administration responsibilities: Prof. Conand has been responsible of many students at different levels (Degrees, Masters). At Brest and La Reunion, my responsibilities in the Doctoral School have lead me to supervise or advise on Invertebrate Biology and Ecology, and on Fisheries. The author is Director of the "Laboratoire d'Ecologie Marine" and member of various University Councils (Biology Department, Library, Scientific Council). Member of various scientific societies. La Reunion delegate at STAC GCRMN and WIOMSA. Participation in conferences and scientific publications: participation in 26 Symposia and Seminars. Scientific publications: 5 books or chapters in a book; 26 articles in international reviews; 40 reports or newsletters; Scientific Editor of the *Beche-de-mer Information Bulletin*, published by the South Pacific Commission.

UNESCO – EOLSS SAMPLE CHAPTERS