# Abstracts and new publications...

### Sea cucumber fisheries: Global analysis of stocks, management measures and drivers of overfishing

*S.W. Purcell, A. Mercier, C. Conand, J.-F. Hamel, A. Lovatelli, V. Toral-Granda and S. Uthicke*

*Fish and Fisheries 14:34–59 (2013)*

Worldwide, most sea cucumber fisheries are ineffectively managed, leading to declining stocks and potentially eroding the resilience of fisheries. We analyse trends in catches, fishery status, fishing participation and regulatory measures among 77 sea cucumber fisheries through data from recent fishery reports and fishery managers. Critical gaps in fisheries biology knowledge of even commonly targeted species undermine the expected success of management strategies. Most tropical fisheries are small-scale, older and typified by numerous (> 8) species, whereas temperate fisheries are often emerging, mono-specific and industrialised. Fisher participation data indicated about 3 million sea cucumber fishers worldwide. Fisher participation rates were significantly related to the average annual yield. PERMANOVA analysis showed that over-exploited and depleted fisheries employed different sets of measures than fisheries with healthier stocks, and a non-metric multidimensional scaling ordination illustrated that a broad set of regulatory measures typified sustainable fisheries. SIMPER and regression tree analyses identified that the dissimilarity was most related to enforcement capacity, number of species harvested, fleet (vessel) controls, limited entry controls and rotational closures. The national Human Development Index was significantly lower in countries with over-exploited and depleted fisheries. Where possible, managers should limit the number of fishers and vessel size and establish short lists of permissible commercial species in multispecies fisheries. Our findings emphasise an imperative to support the enforcement capacity in low-income countries, in which risk of biodiversity loss is exceptionally high. Solutions for greater resilience of sea cucumber stocks must be embedded within those for poverty reduction and alternative livelihood options.

### Commercially important sea cucumbers of the world

*S.W. Purcell, Y. Samyn and C. Conand*

*FAO Species Catalogue for Fishery Purposes No. 6. Rome: Food and Agriculture Organization. 150 p. (2012)*
*http://www.fao.org/docrep/017/i1918e/i1918e00.htm*

Sea cucumbers are exploited and traded in more than 70 countries worldwide. This book provides identification information on 58 species of sea cucumbers that are commonly exploited in artisanal and industrial fisheries around the world. Not all exploited species are included. It is intended for fishery managers, scientists, trade officers and industry workers. This book gives key information to enable species to be distinguished from each other, both in the live and processed (dried) forms. Where available for each species, the following information has been included: nomenclature together with FAO names and known common names used in different countries and regions; scientific illustrations of the body and ossicles; descriptions of ossicles present in different body parts; a colour photograph of live and dried specimens; basic information on size, habitat, biology, fisheries, human consumption, market value and trade; geographic distribution maps. The volume is fully indexed and contains an introduction, a glossary, and a dedicated bibliography. Persons with a genuine need for the hard copy may request one from Mr Alessandro Lovatelli (Alessandro.Lovatelli@fao.org). Please ensure to provide your full name, position (in your organisation), name of your institute, full mailing address and contact details (including your email address) and intended use of the book (e.g. identification for research or trade).

### Sea cucumber culture, farming and sea ranching in the tropics: progress, problems and opportunities

*S.W. Purcell, C. Hair and D. Mills*

*Aquaculture 368:68–81 (2012)*

Tropical sea cucumber mariculture has potential to become a profitable industry and contribute towards natural population replenishment. Here, we synthesise the fields of progress, current impediments and research opportunities in tropical sea cucumber aquaculture arising from recent studies and an Indo-Pacific symposium. We present novel comparisons of data from hatcheries, earthen ponds and sea pens

from published and unpublished studies in various countries. Of the few tropical species to have been cultured, only the sandfish *Holothuria scabra* has been bred extensively. While risks from hatchery-produced sea cucumbers are recognised, more genetic research is needed in farming and sea-ranching programmes. Advances have been made in the culture and nursery rearing of tropical sea cucumber juveniles but few have been published. Sandfish larvae have now been grown successfully on just one microalga species, but experimental studies to optimise culture conditions are needed urgently. Disease of tropical sea cucumbers in culture is infrequent but the treatment of disease and parasites is understudied. Earthen ponds are currently most effective for nursery rearing of juvenile sandfish to a size for stocking. Growth rates and survival of sandfish in ponds to market size are also favourable, and should improve via studies on stocking density, feeding regimes and pond management. Sea pens confer ownership of released stock and can provide a means of limiting predation in natural habitats but the costs of materials, maintenance and surveillance against poaching can diminish profitability. Sea ranching has minimal material costs but needs a large leased area and may require juveniles to be marked prior to release. Retail prices of sandfish in Hong Kong increased exponentially with body size. A cost-benefit analysis illustrated that labour and utility costs in pond farming will preclude profitability of monoculture in some cases, forcing proponents to look towards co-culture or gamble with uncertain survival in sea ranching. Better governance and consultation regarding the stocking of sea cucumbers have been advocated. We conclude that well-designed experiments and meta-analyses are needed to fill critical knowledge gaps if sea cucumber mariculture is to expand in the tropics as it has in temperate Asia. Co-culture remains a burgeoning frontier despite poor success of initial studies. Sea cucumbers have superb potential to diversify mariculture industries in the tropics and potentially ameliorate the detrimental effects of mariculture on coastal ecosystems.

### Principles and science of stocking marine areas with sea cucumbers

*S.W. Purcell*

*p. 92–103. In: Hair C.A., Pickering T.D. and Mills D.J. (eds). Asia-Pacific tropical sea cucumber aquaculture. ACIAR Proceedings No. 136. Canberra: ACIAR. (2012)*
*http://aciar.gov.au/publication/PR136*

Clearly stating the goals of stocking builds an essential platform for success. The scales, methodologies, management and time frames of the interventions can then be matched to the original goals. Stock enhancement, restocking and sea ranching will involve different stocking strategies. The genetic risks to wild stocks must be minimised by preventing translocation of juvenile sea cucumbers to different locations than those where broodstock were collected, unless studies show wider genetic homogeneity of the stock. Cultured juveniles are easily marked by immersion in a fluorochrome solution (e.g. tetracycline or calcein), which provides a long-term, unequivocal means of distinguishing hatchery-produced animals from wild conspecifics. Use of open sea pens is an experimental tool that provides better estimates of early stocking success. Juvenile density can be assessed by searching through sand and mud in quadrats by hand, whereas sub-adults and adults can be surveyed visually in transects with a stratified arrangement. Proponents of sea cucumber stocking in the wild should be conservative and realistic about the expected returns; 1 in 5–10 (10–20%) of released juvenile sea cucumbers surviving to market size is a benchmark. Clear goals, use of existing technology, and realistic expectations in sea ranching and restocking of sea cucumbers will provide the foundation for success.

### Sea cucumbers collected by the Kermadec Biodiscovery Expedition 2011 (Echinodermata: Holothuroidea: *Apodida* and *Dendrochirotida*)

*P.M. O'Loughlin and D. Vandenspiegel*

*Zootaxa 3515:60–66 (2012)*

Three shallow holothuroid species are recorded for the rocky shoreline of the Kermadec Islands. The new apodid species *Chiridota kermadeca* sp. nov. is described. Two dendrochirotid species are reported, both previously found in New Zea- land: *Plesiocolochirus ignavus* (Ludwig, 1875) and *Pseudocnus sentus* (O'Loughlin and Alcock, 2000).

### The caudinid sea cucumbers of New Zealand (Echinodermata: Holothuroidea: Molpadida: Caudinidae)

*N. Davey and P.M. O'Loughlin*

*Zootaxa 3613(4):357–368 (2013)*

Five species of Caudinidae occur in New Zealand waters. Two new species are described: *Paracaudina alta* sp. nov. and *Paracaudina reductia* sp. nov. Two species reported previously are discussed: *Paracaudina chilensis* (Müller) and *Paracaudina coriacea* (Hutton). A lectotype has been established for *P. coriacea* (Hutton). *Hedingia albicans* var. *glabra* (Théel) is raised out of synonymy with *Hedingia albicans* (Théel), and the variety elevated to species status as *Hedingia glabra* (Théel). A key is provided for the New Zealand species of Caudinidae.

## PhD Dissertation

### Analysis of certain nutritional components that are essential for *Holothuria scabra* (Echinodermata, Holothuroidea): Influence of sediment quality on sea cucumber development during aquaculture and the importance of bacteria

*PhD Student: Thomas Plotieau*

*Phd Thesis. Belgium: University of Mons (2012)*

It has become clear that natural sea cucumber populations are decreasing drastically around the world due to the heavy demand of the Asian market. The disappearance of sea cucumbers not only leads to ecological problems, as they are one of the main sediment bioturbators in marine ecosystems, but also to an enormous social problem since the beche-de-mer trade is a source of income for thousands of people living in developing countries. One of the best responses to this global problem has been the development of sea cucumber farming, involving villagers in coastal zones who raise end-of-cycle specimens. At the current time, *Holothuria scabra*, a tropical Indo-Pacific species, is farmed in a semi-industrial manner in Madagascar. This species is one of the best for aquaculture in tropical settings, given its broad distribution, high market value and ability to grow in sea pens managed by coastal communities. *H. scabra* feeds by ingesting the top few millimetres of the sediment layer, which is composed of a mineral portion and an organic portion. The latter is itself composed of detritus and a large number of associated micro-organisms. Although *H. scabra* is of great interest ecologically, economically and socially, very little information is available about its nutrition. This paper concentrates on just that – more specifically, on the influence that sediment quality has on *H. scabra* development and the importance of the bacterial portion.

*H. scabra*'s growth was recorded over a four month period in two villages involved in juvenile growout in south-west Madagascar. The growth rate for sea cucumbers at the two sites did, in fact, differ greatly: at the first site, specimens had a growth rate of 1.4 g $day^{-1}$, whereas at the second site, the rate was only 0.4 g $day^{-1}$. The sediments were described so as to identify differences in organic matter and mineral matter composition that might explain this enormous difference in growth rates. The site where the highest growth rate was recorded had sediment with finer grain sizes and more abundant organic matter. In addition, the latter contained a higher percentage of autotrophic microorganisms. The protein concentrations and the number of bacteria in the sediment at the two sites did not differ significantly, but the mineral composition was very different: at the first, i.e. the one that allowed more rapid growth, the mineral composition was more diverse with a high percentage of quartz. The sediment at the other site, i.e. the one with the lower growth rate, contained more than 80% carbonates, mainly bioclastic. So, *H. scabra* growth rates were better when specimens lived on sediment with high levels of organic matter rich in autotrophic microorganisms, lower percentages of particles greater than 1 mm and a high percentage of particles under 250 $\mu$m. Terrigenous deposits in the sediment caused by runoff were not a problem for *H. scabra* growth rates.

While sediment has an impact on *H. scabra* growth, intensive farming of this sea cucumber species has an impact on the sediment. Various elements in the sediment's surface layer, which serves as feed for *H. scabra*, were tested inside and outside the farm pens of two other aquaculture sites in south-west Madagascar. These tests showed that (i) the percentage of the finest grain size (less than 250 $\mu$m) decreased by 5% to 14%, (ii) the percentage of carbonates decreased by 5%, (iii) aragonite was the type of carbonate most affected by sea cucumbers, then calcite and magnesian calcite, (iv) organic matter levels were not affected by sea cucumbers, (v) the number of bacteria decreased by up to 50% and (vi) the concentration of autotrophic microorganisms decreased by up to 22%.

Farming trials for *H. scabra* juveniles with 15N-marked organic matter components demonstrated that juveniles assimilate gram- bacteria from the genus *Vibrio* and gram+ bacteria from the genus *Clostridium*. Adding 15N-marked ammonium sulphate, one of the preferred sources of nitrogen for autotrophic microorganisms, and antibiotics showed that *H. scabra* juveniles assimilate autotrophic microorganisms. Also, 15N-marked alanine, dissolved in the water, is assimilated by sea cucumbers, and bacteria may also be an indirect way for them to assimilate this compound. *H. scabra* assimilates plant debris, such as spermatophyte debris, although it probably serves more as a medium for the development of live micro-organisms. In addition, the growth rate of juveniles raised in areas with spermatophyte debris was no greater than that of control juveniles. Juvenile growth was significantly higher than that of control juveniles when 15N-alanine, with or without antibiotics, 15N-marked ammonium sulphate or 15N-alanine-marked bacteria from the genus *Vibrio* were added on a weekly basis. Of the various compounds tested, only bacteria from the genus *Clostridium* proved harmful for juvenile development.

Some 116 bacterial phylotypes belonging to the following groups: g-proteobacteria (62%), a-proteobacteria (23%), bacteroidetes (6%), actinobacteria (2.75%), fusobacteria (1.75%), firmicutes (1.75%), cyanobacteria (1.75%) and d-proteobacteria (1%), were found in *H. scabra*'s digestive tract. The number of bacteria was significantly higher (1.5 x) in the anterior end of *H. scabra*'s digestive tract as compared to the sediment it feeds on. Then, this number decreased significantly in the digestive segment and remained stable straight through to the faeces. Some g-proteobacteria species, including bacteria from the genus *Vibrio*, are less sensitive to digestion than other groups. In addition, the first segment of the digestive tract could serve as a reservoir when certain species of bacteria such as the genus *Vibrio* may proliferate. The season has an influence on bacterial diversity in the digestive tract of *H. scabra*: in fact, during the dry season, the g-proteobacteria group was more abundant whereas, during the rainy season, it was the a-proteobacteria group. The genus *Vibrio* was the most widespread with certain well-known opportunistic pathogens such as *V. harveyi*, *V. alginolyticus* and *V. proteolyticus*, which are very common in *H. scabra*'s intestine.

In their natural setting, spermatophyte grass beds, *H. scabra* select sediment zone based on the grain size and organic matter level. Once in that zone, they assimilate compounds that come from spermatophyte, bacteria, autotrophic microorganisms such as diatoms and elements dissolved in the water. When the sediment passes through the digestive tract, the carbonate part, mainly aragonite, is dissolved. In that way, *H. scabra* frees up bioclastic and non bioclastic carbonates for other organisms in the reef ecosystem. During aquaculture, this loss in elements caused by sea cucumbers should be offset by adding feed that contains the various compounds assimilated by *H. scabra*, as shown by our work.

## Titles of the presentation of the 14th International Echinoderm Conference (Brussels, August 2012)

### Oral Communications

Reexamination of the genus *Lissothuria* (Verrill, 1867) (Echinodermata: Holothuroidea)
*Arriaga-Ochoa J.A., Solís-Marín F.A. and Laguarda-Figueras A.*

Feeding preferences of the Arlequin crab, *Lissocarcinus orbicularis* (Dana, 1852), an obligate symbiont of holothurians
*Caulier G., Van Nedervelde F., Lepoint G. and Eeckhaut I.*

Echinoderm diversity, biogeography and abundance along the shores of the Sultanate of Oman
*Claereboudt M.R. and Al-Rashdi K.M.*

The Echinoderm fauna of Europa Island (French Eparses Islands) in the Mozambique channel (South Western Indian Ocean)
*Conand C., Stöhr S., Eléaume M., Magalon H. and Chabanet P.*

Characterisation of the adhesive proteins from the Cuvierian tubules of *Holothuria forskali*
*Demeuldre M., Wattiez R., Hennebert E., Becker P. and Flammang P.*

Growth rate in *Parastichopus californicus* contained off Vancouver Island, Canada: An important wild and potential aquaculture species
*Duprey N.M.T., Hannah L., Hand C.M. and Pearce C.M.*

Reproductive biology and nocturnal behaviour of *Holothuria sanctori* (Delle Chiaje, 1823) in Canary Islands (eastern Atlantic Ocean)
*Navarro P.G., García-Sanz S. and Tuya F.*

Genetic structure and demographic history of Atlanto-Mediterraean sea cucumbers: Congruent and contrasting patterns in some *Holothuria* species
*Borrero-Pérez G.H. and González-Wangüemert M.*

Molecular systematics of the Holothuriidae (Echinodermata: Holothuroidea)
*Michoneau F. and Paulay G.*

Organ regeneration by the uptake of dissolved organic material in the holothurian *Parastichopus californicus*
*Nestler J., Brothers C.J. and Lee R.*

Some quantitative data for the holothuroids of the antarctic benthos (Echinodermata, Holothuroidea)
*Mark O'Loughlin, Niki Davey, Ty Hibberd, Susanne Lockhart and Melanie Mackenzie*

Utilization of maternal reserves during embryonic and early larval development of the New Zealand sea cucumber *Australostichopus mollis*
*Peters-Didier J. and Sewell M.A.*

Giant Mesozoic Holothurian Larvae?
*Reich M. and Stegemann T.R.*

Nutritional profile and antioxidant properties of the sea cucumber *Holothuria arguinensis*
*Roggatz C.C., Custódio L., González-Wangüemert M., Barreira L., Pereira H. and Varela J.*

Sea cucumber in recirculating systems and integrated multi-trophic aquaculture (IMTA) in Tanzania, South Africa and the United Kingdom
*Slater M.J., Beltran-Gutierrez M., Robinson G., MacDonald C.L., Ferse S.C.A., Kunzmann A., Jones C.L.W, Eeckhaut I. and Stead S.M.*

Biodiversity and biogeography of the southern African holothuroid echinoderms
*Thandar A.S.*

Comparison of methods for estimating abundance of a depleted population of sea cucumber (*Isostichopus fuscus*)
*Ulate K., Huato-Soberanis L. and Sanchez-Ortiz C.A.*

Advances in the understanding of the feeding biology of the Australasian sea cucumber, *Australostichopus mollis* (Echinodermata: Holothuroidea), and its aquaculture implications
*Zamora L., Jeffs A. and Slater M.*

**Posters**

Has the cucumber changed its spots? Cryptic *Bohadschia* species in the Malaysian Beche-de-mer fishery
*Byrne M., Conand C., Choo P.S., Rowe F.W.E. and Uthicke S.*

Preservation of bioactive saponins through the preparation of *trepang*
*Caulier G., Flammang P., Gerbaux P. and Eeckhaut I.*

Biodiversity of echinoderms on the underwater lava flows with different ages from the volcano Piton de La Fournaise (Reunion Island, Indian Ocean)
*Bollard S., Quod J.P., Boissin E., Eleaume M. and Conand C.*

Antarctic holothuroids from the Ross Sea and adjacent Islands and seamounts, with descriptions of new species based on morphological and molecular phylogeny
*Davey N., O'Loughlin M. and Van den Spiegel D.*

Protecting a wild fishery while introducing aquaculture: Adding aquaculture activities into British Columbia's healthy sea cucumber population
*Duprey N.M.T., Hand C.M. and Pearce C.M.*

Development of a promising polyculture farming involving the sea cucumber *Holothuria scabra* and the red algae *Kappaphycus alvarezii* in the South West of Madagascar
*Tsiresy G., Eeckhaut I., Lavitra T., Razanakoto I., Dubois P., Lepoint G. and Pascal B.*

Sea cucumbers: The new resource for a hungry fishery (CUMFISH project)
*González-Wangüemert M., Conand C., Uthicke S., Borrero-Pérez G., Erzini1 K., Aydin M. and Serrao E.*

Holothuroids collected by Kakichi Mitsukuri and Hiroshi Ohshima deposited in the University Museum, the University of Tokyo
*Inoue J., Ueshima R. and Fujita T.*

Asexual reproduction of the holothurian *Cladolabes schmeltzii* (Holothuroidea, Echinodermata)
*Kamenev Ya.O. and Dolmatov I.Yu.*

The littoral sea cucumber (Echinodermata: Holothuroidea) fauna of Guam re-assessed – A diversity curve that still does not asymptote
*Borrero-Perez G.H., Honey M., Kamarudin K.R., Kerr A. M., Kim S., Menez A., Michonneau F., Miller A., Ochoa J.A., Olavides R.D., Paulay G., Samyn Y., Setyastuti A., Solis-Marin F., Starmer J. and VandenSpiegel D.*

Biodiversity of Antarctic holothuroids (South Shetland Islands, BOUVET Island and WEDDELL Sea)
*Moles J., Ballesteros M. and Avila C.*

Development of gonad-stimulating substance-like peptide system during larval development in the sea cucumber, *Apostichopus japonicus*
*Ahmed H.O., Katow T. and Katow H.*

Original text: English

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