COMMUNICATIONS

WANGUMAR: A new company focused on advice and consultancy in sea cucumber aquaculture and fisheries management from the Mediterranean and northeast Atlantic regions

Mercedes González-Wangüemert[1]

In the last few years, there has been an increase in demand for sea cucumbers from Asian countries. Sea cucumbers are being exported mainly from Asian countries, such as Japan, China and Hong Kong (González-Wangüemert et al. 2018), although Mediterranean countries – such as Turkey, Greece, Spain and France – are also exporting sea cucumbers. As an example, Turkey reached a total production of 1292 t in 2019 (Dereli and Aydin 2021). The main importing countries are Hong Kong, the United States and China, although Spain (2152 t), France (363 t), and Belgium (236 t) are also importing sea cucumbers, probably to later re-export them to other countries, considering the low consumption of these species in Europe (González-Wangüemert et al. 2018).

Overexploitation is driving the risk of extinction of the most commercially valuable sea cucumber species, with 16 species now classified as "vulnerable" or "endangered" on the International Union for Conservation of Nature Red List (Conand et al. 2014). As consequence, Asian markets are looking for new target species, mainly from the Mediterranean Sea and northeast Atlantic Ocean (Gonzalez-Wangüemert et al. 2014; 2015; 2016; 2018). The most important species are *Holothuria polii* and *H. tubulosa* from the Mediterranean Sea; *Holothuria mammata*, *H. sanctori*, *H. forskali*, and *Parastichopus regalis*, inhabiting both the Mediterranean Sea and northeast Atlantic Ocean; and *Holothuria arguinensis*, with a very restricted geographical distribution, including the Portuguese coast from Berlengas to Castro Marim, South Atlantic Spanish coast, Canary Islands and northwestern African coast. In the recent years though, this species is colonising the Mediterranean Sea (González-Wangüemert and Borrero-Perez 2012).

Increasing fishing pressure on these species during the last few years and some symptoms of overexploitation of their stocks have been recorded (González-Wangüemert et al. 2015; 2018). Also, many illegal catches are being registered in different European countries due to non-existent or insufficient regulations (Fig. 1). Considering the complexity of developing a proper management plan for the European sea cucumber fishery, based on experience with tropical species, aquaculture could be a sustainable way to expand sea cucumber production, thereby decreasing fishing pressure on wild stocks. Aquaculture could be an essential tool for restocking wild populations, if necessary (Fig. 2a, Fig. 2b and Fig. 3).

Figure 1. *Holothuria arguinensis* individuals caught in southwestern Spain.

Despite the ecological and economical importance of this resource, very few experts are working on these new target species in the Mediterranean and northeast Atlantic regions. These experts are essential to carrying out consultancy actions on stock assessments, accurate species identification, regulations and rules for fishery management, and the development of aquaculture production.

WANGUMAR (Wangüemert Fisheries Management and Aquaculture SLU; www.wangumar.com) fills an empty niche with regard to marine consultancy linked to sea cucumber fishery and aquaculture in the Mediterranean and northeast Atlantic regions. This company is intending to promote the

[1] Wangüemert Fisheries Management and Aquaculture SLU, WANGUMAR, Alicante, Spain. Email: mercedes@wangumar.com or wangumemar@gmail.com

[2] www.wangumar.com/portfolio/

Figure 2. Thermal induction for reproduction of *Holothuria arguinensis* (left) and *Holothuria mammata* (right) breeders.

Figure 3. Aquaculture production of *Holothuria arguinensis* juveniles.

Figure 4. Polyculture system, including *Holothuria arguinensis* and *Ulva* spp.

sustainable exploitation of new marine resources and their use for aquaculture (for food production), and to increase economic returns from polyculture through impact mitigation with integrated multitrophic aquaculture systems, Fig. 4), and to produce bioactives for medical and pharmaceutical applications), thereby diversifying the target species, and offering new opportunities for investment in this sector. This company is based on Dr Wangüemert's 18 years of experience, working in sea cucumber fisheries and aquaculture, mainly with Mediterranean and northeast Atlantic species. This experience has been acquired through several job postings with international research centres and universities, collaborations with private companies and public organisations from different continents, leading the first European sea cucumber aquaculture company (Guatizamar S.L.), travelling, and using a wide network of contacts from different sectors and institutions.

WANGUMAR has carried out different projects on sea cucumbers (fishery, aquaculture, research and training actions)[2] To highlight the FARM project (Asociación de Empresas de Acuicultura de la Región de Murcia), which is currently being developed to assess sea cucumber stocks along the Murcia coast (southeast Spain) (Fig. 5). This project arises from GALPEMUR (Grupo de Acción Local de Pesca y Acuicultura de la Región de Murcia), a local association of fishermen and fish-farmers. This organisation has shown interest in looking for new fishery resources and new potential species for aquaculture, and is getting funding from the European Maritime and Fisheries Fund (www.wangumar.com/portfolio-items/farm-murcia/).

Initiatives like this could: improve the management of sea cucumber resources in the Mediterranean and northeast Atlantic regions, protect their stocks, and allow for better and faster development of their aquaculture production.

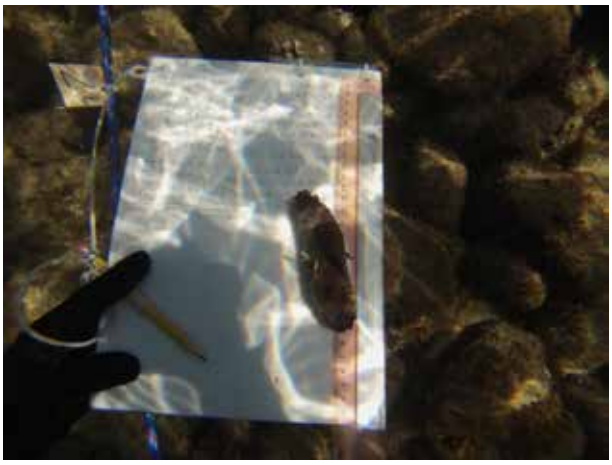

Figure 5. Sea cucumber sampling along transects under the FARM (Asociación de Empresas de Acuicultura de la Región de Murcia) project.

References

Conand C., Polidoro B., Mercier A., Gamboa R., Hamel J.F. and Purcell, S. 2014. The IUCN Red List assessment of aspidochirotid sea cucumbers and its implications. SPC Beche-de-mer Information Bulletin 34:3–7.

Dereli H. and Aydin M. 2021. Sea cucumber fishery in Turkey: Management regulations and their efficiency. Regional Studies in Marine Sciences, doi /10.1016/j.rsma.2020.101551.

González-Wangüemert M., Domínguez-Godino J. and Cánovas F. 2018. The fast development of sea cucumber fisheries in the Mediterranean and NE Atlantic waters: From a new marine resource to its over-exploitation. Ocean Coastal Management Journal 151:165–177.

González-Wangüemert M., Valente S., Henriques F., Domínguez-Godino J. and Serrão E. 2016. Setting preliminary biometric baselines for new target sea cucumbers species of the NE Atlantic and Mediterranean fisheries. Fisheries Research 179:57–66.

González-Wangüemert M., Valente S. and Aydin, M. 2015. Effects of fishery protection on biometry and genetic structure of two target sea cucumber species from the Mediterranean Sea. Hydrobiologia 743:65–74.

González-Wangüemert M., Aydin M. and Conand C. 2014. Assessment of sea cucumber populations from the Aegean Sea (Turkey): First insights to sustainable management of new fisheries. Ocean Coastal Management Journal 92:87–94.

González-Wangüemert M. and Borrero-Pérez G. 2012. A new record of Holothuria arguinensis colonizing the Mediterranean Sea. Marine Biodiversity Records 5: e105.

Sea cucumbers are now harvested in more than 80 countries

Alessandro Lovatelli

Sea cucumbers are now harvested in more than 80 countries. These high-value export commodities are often subject to illegal, unreported and unregulated fishing; therefore, identification tools for fishery and trade workers (including fisheries and customs inspectors) are required to enable proper resource management and reporting. In 2012, the Food and Agriculture Organization of the United Nations (FAO) published the first global guidebook for the identification of commercially exploited sea cucumbers, but species from some ocean regions were not included (the guide is available here: http://www.fao.org/docrep/017/i1918e/i1918e.pdf).

FAO has recently launched the collection of new and updated information that will be included in a second edition of this guide. The new edition may include information on as many as 30–40 additional species that are now fished and traded, including those from the Mediterranean Sea, western Africa and Latin America and the Caribbean. The revised edition will also update information on fisheries, market prices and the distribution of previously reported species.

With the kind financial support from the Muséum national d'Histoire naturelle (Paris –www.mnhn.fr/en), the collection of information has begun for all traded species in the Mediterranean and northeast Atlantic and western Africa, led by Dr Mercedes Wanguemert (mercedes@wangumar.com; wangumemar@gmail.com) and Dr Ed Butler (ed.butler.fish@gmail.com), respectively. FAO is funding the work in Latin America and the Caribbean through the collaboration of Dr Francisco Solís (fasolis@cmarl.unam.mx).

Collecting the information needed will be a challenge because little is actually published or easily available and, therefore, public and private sector people engaged somewhere along the sea cucumber value chains in the Mediterranean and northeast Atlantic, west Africa, Latin America and the Caribbean are kindly invited to contribute by contacting Drs Wanguemert, Butler or Solís directly within the next few months. The work has started so the earlier the better! Thank you. The overall coordination of this FAO project is under the supervision of Mr Alessandro Lovatelli (alessandro.lovatelli@fao.org) with assistance from the FishFinder Programme lead, Dr Kim Friedman (Kim.Friedman@fao.org).

PhD theses

Development of community-based mariculture of sandfish, Holothuria scabra*, in New Ireland Province, Papua New Guinea*

Cathy Hair, PhD thesis, James Cook University, Australia

Abstract

Sea cucumber, processed into its dried form of bêche-de-mer (BDM), is one of the oldest commercial marine commodities in the Pacific Islands region. High prices, low tech harvest and processing methods, strong demand in Asian markets, and well-developed supply chains make it an important economic livelihood for coastal communities in Papua New Guinea (PNG). Sea cucumber fisheries in the Pacific have historically followed boom and bust cycles and are very difficult to manage effectively to maintain sustainable yields. Depletion of sea cucumber stocks led the PNG National Fisheries Authority (NFA) to declare a nation-wide moratorium on the harvest of sea cucumber and sale of BDM from 2009 until 2017. The Tigak and Tsoi Islands in New Ireland Province, PNG, were the site of a commercial fishery for the high-value sea cucumber, sandfish (*Holothuria scabra* Jaeger), for a short period in the late 1980s before it was overfished. Despite no history of mariculture in the study area, sandfish represents a promising aquaculture candidate due to well-established hatchery production and ocean grow-out techniques. Sandfish sea ranching was proposed as a mariculture livelihood activity for Tigak and Tsoi communities; this involves releasing cultured juvenile sandfish (> 3 g) into unfenced areas of suitable habitat under community management, where they would be protected from fishing until they reach commercial size. The initial objective of this study was to assess the potential of sandfish sea ranching as a livelihood activity for Tigak and Tsoi Islands fishing communities. However, lifting of the moratorium during the study provided unexpected opportunities to assess the reopened fishery and the potential for sandfish mariculture alongside it. The focus of this study shifted as a result, to include assessment of social aspects of the sea cucumber fishery and the technical and social factors that may influence uptake of sandfish mariculture as a potential livelihood activity. Research was conducted in three collaborating partner communities; Limanak and Enuk in the Tigak Islands, and Ungakum in the Tsoi Islands.

The first two chapters draw on understandings of local culture and political economy, together with the results from the historic (pre-moratorium; 1988 to 2009), and the contemporary (post-moratorium; 2017) wild sea cucumber fishery, to examine how a livelihood based on sandfish culture could coexist with the wild fishery to increase benefits to coastal communities in PNG. Data presented in Chapter 1 confirmed that sandfish was the main target species in the early wild sea cucumber fishery but had been overfished. A history of disregard for fisheries regulations and poor-quality BDM processing was revealed. Chapter 2 presents socio-economic data on income-earning activities, household income, expenditure, BDM quality, processing, gender roles, diet and attitude toward the fishery from Enuk, Limanak and Ungakum before, during and after the sea cucumber fishery re-opening in 2017. Fishing for sea cucumber and processing BDM replaced most other livelihoods and significantly increased mean weekly household income, which was spent on store-bought foods and assets. Sandfish remained a target species but the season lasted for less than two months before the NFA BDM quota was reached and the fishery closed. These two chapters indicated there was excellent potential for cultural compatibility of sandfish sea ranching due to its value, familiarity and preference among fishers, but raised concerns regarding unsustainable practices.

Research into technical aspects of sea ranching was conducted concurrently with the social research. Results from sea pen grow-out experiments are presented in Chapter 3. Cultured juvenile sandfish (≥ 3-g mean weight) were released into 100-m^2 sea pens, located within suitable seagrass habitat at four sites near the study communities. Newly-released juveniles were provided with nil, one or seven days' cage protection to investigate if short-term predator exclusion increased survival. Cage protection did not significantly affect survival at any site but there were significant differences in overall survival and mean sandfish weight between three sites where juveniles survived. Sandfish growth and sea pen biophysical parameters were monitored at regular intervals for up to 24 months after release. Multivariate analysis of biophysical factors clearly differentiated the sea pen habitats.

One outstanding site, Limanak-1, had high survival and growth of sandfish and its habitat was characterised by higher coarse-grain fraction, seagrass epiphytes and chlorophyll-a sediment content, and low fine-grain fraction. Ungakum, a site with total mortality, had more predators and higher fine-grain fraction. Valuable qualitative data were obtained on the relationship between sandfish and habitat at the four sites. Chapter 4 presents a preliminary assessment of how geographic information systems (GIS) and remote sensing can assist in describing and predicting suitable sandfish mariculture sites. GIS is a valuable tool for aquaculture site selection but underutilised in sea cucumber mariculture. Spectral analyses of WorldView satellite imagery showed promise but were inadequate as stand-alone pre-assessment methods. However, based on these findings and the literature a three-stage GIS approach was proposed: (1) spatial multi-criteria evaluation based on parameters that influence sandfish survival and growth; (2) field data collection and liaison with stakeholders at promising sites; and (3) pilot trials with cultured juveniles at selected suitable sites, to gauge the risk of high predation and other unanticipated factors.

The success of mariculture activities involving the release of cultured marine invertebrates into the ocean is contingent on high survival and appropriate growth rates. However, physical, physiological or behavioural characteristics that differ from those of wild conspecifics, and may compromise the 'fitness' of cultured animals. These may be acquired through hatchery rearing, or as a result of stress induced by the release process. Chapter 5 investigated the influence of such factors on sandfish by comparing survival, growth and behaviour of release-size cultured juveniles to those of like-size wild conspecifics. After 85 days there was no significant difference in weight between cultured and wild sandfish juveniles. Burying behaviour of cultured and wild sandfish juveniles was observed over a 48-h period in natural habitat with or without seagrass. Cultured juveniles were found to be slower to bury in the substrate after release, less likely to be buried at most times, and more likely to be buried in substrate where seagrass was present; however, they became better synchronised with their wild counterparts after 30 h. Survival of cultured and wild sandfish was high in experiments (> 85%), but reduced burying by cultured individuals may increase the potential for predation because diel burying is the main predator avoidance strategy of sandfish juveniles. When combined with the results of Chapter 3, the findings indicate that protection of newly-released juveniles might only be advantageous where predation risk exists, and that seven days of protection may be inadequate. Minimising transportation stress and adhering to best practice release methods are key to successful ocean mariculture.

The quality of BDM from ocean-cultured (hatchery bred) sandfish was compared with that of like-size wild sandfish by processing both groups with identical methods in Chapter 6. The ratio of fresh whole to dried weight, and fresh body wall width, were significantly greater for wild individuals than cultured individuals. However, key determinants of BDM quality, including fresh gutted to dried weight ratio, dried to fresh length ratio, dried body wall width and BDM collagen content, were similar in both groups, indicating that BDM produced from ocean-cultured sandfish has similar recovery rate and quality as that from wild.

Development of mariculture livelihood activities also requires careful attention to the human dimension. Chapter 7 reports on a community trial sea ranch, in which a 5-hectare area was stocked with 5,000 cultured juvenile sandfish in order to: (1) generate data on their survival, growth and movement; and (2) to explore social aspects of community-based management and distribution of economic benefits. In 2018, during the sea cucumber fishing season, sandfish from the trial sea ranch were poached, terminating research at the site. Community attitudes and responses to the 2018 season, mariculture research and the failure of the trial sea ranch were investigated. Widesprea d community approval of the trial sea ranch and respect for the fishing prohibition were reported. However, minor poaching within the ranch escalated because community-based management proved inadequate to sanction the poachers. The trial sea ranch failed due to internal factors (i.e., weak local leadership, community disunity), exacerbated by external pressures (i.e., increased buying pressure, higher prices, limited project oversight). Poor BDM quality and ineffective fisheries management remained concerning. Results of Chapters 2 and 7 are concerning, given that sea ranching success is predicated on adoption of sustainable harvest practices, improved BDM processing and strong community-based management.

This thesis presents the first evaluation of a range of social and technical factors affecting the development of a community-based sandfish mariculture livelihood in New Ireland Province, PNG. The broad and comprehensive approach generated sound baseline data and indicated priority areas for future research. Although no data were obtained from the community-scale sea ranch experiment, other technical investigations into survival, growth, optimal habitat, BDM value and the fitness of cultured sandfish all demonstrated significant potential. These results, and ongoing research in other countries, indicate that technical bottlenecks are unlikely to constrain community sandfish sea ranching success. Unfortunately, there were social barriers to community-based sea cucumber mariculture in New Ireland Province. It was concluded that further development of this livelihood and associated socio-economic benefits will be stymied until there is effective local control of the wild sea cucumber fishery. The findings presented in this thesis contribute to further development of sandfish mariculture in New Ireland Province should the requisite socio-economic conditions be met in the future. This research will also be of value to the development of sea cucumber mariculture elsewhere in the broader Indo-Pacific region.

*Écologie, dynamique de la population et reproduction d'*Echinaster sepositus,Ophioderma longicauda *et de* Parastichopus regalis *au niveau de la côte de Mostaganem*

M. Benzait, PhD thesis, Laboratoire de Protection, Valorisation des Ressources Marine et Littoral et Systématique Moléculaire. Faculté des Sciences de la Nature et de la Vie, Université de Mostaganem, Algérie

Directeur de thèse : Soualili Dina Lila

Résumé

Notre étude a été réalisée le long de la région littorale de Mostaganem, située à l'Ouest de la côte algérienne, sur les traits de vie de quelques espèces d'échinodermes prélevées par plongée en scaphandre autonome ainsi que par la collecte des prises accessoires des petits métiers à savoir : l'astérie *Echinaster sepositus* (Retzius, 1805) du port de la Salamandre, l'ophiure *Ophioderma longicauda* (Retzius, 1789) de la plage de Stidia, et l'holothurie royale *Parastichopus regalis* (Cuvier, 1817), provenant des eaux profondes de la région de Sidi-Medjdoub et du petit port de Sidi-Lakhdar. Un échantillonnage mensuel a été réalisé pour les deux espèces *Echinaster sepositus* et *Ophioderma longicauda*. Pour l'espèce *Parastichopus regalis*, les échantillons ont été récoltés au niveau des débarquements des petits métiers des ports de Sidi-Medjdoub et de Sidi-Lakhdar.

L'étude des traits de vie de la population d'*Echinaster sepositus* a montré sur un total de 403 individus, un taux de 1.44 % d'hermaphrodisme et un taux de régénération des bras de 2.60%. Par ailleurs, l'analyse des paramètres de reproduction [suivi microscopique des stades de maturités sexuelles et des indices physiologiques (indice gonadique et indice du caeca pylorique)] a montré un cycle de reproduction annuel, caractérisé par une activité gamétogénetique des individus durant toute la période Printemps–Eté marquée par une ponte qui débute au printemps, devient massive durant l'été et s'étale jusqu'en début d'automne. La structure démographique, présente une distribution bimodale et un recrutement continu pendant toute l'année, particulièrement durant les saisons de printemps et de l'automne. La mortalité naturelle chez les femelles est de 1.113, la valeur de Z est de 1.483 et Z/K de 0.259. En revanche, chez les mâles la mortalité naturelle est de 0.935, Z de 1.883 et Z/K=0.707. Ces résultats ont montré une augmentation de la population d'*Echinaster sepositus* dans le port la Salamandre. Aussi, on a pu déterminer une croissance différente entre les mâles (avec L∞ de 98.28mm) et les femelles (avec L∞ de 88.20mm), ainsi qu'une croissance isométrique entre la longueur des bras et le poids du corps chez cette espèce.

Sur un total de 125 individus d'*Ophioderma longicauda* de la plage de Stidia, le suivi mensuel du rapport des variations morphométriques du disque, a permis de cibler les périodes de la pleine maturité sexuelle localisées aux mois d'Avril et d'Aout. Aussi, l'analyse des gonades a permis de déterminer que cette espèce est à larves planctoniques. La distribution de taille est de forme bimodale, avec un recrutement annuel continu. La mortalité naturelle est de 2.29, et le rapport Z/K de 0.329 ; Ce qui explique la fluctuation du nombre d'individus de la population de cette espèce dans la plage de Stidia. La relation diamètre du disque-poids du corps a montré une croissance isométrique entre ces deux paramètres. Par ailleurs, la relation Longueur de bras - Poids du corps d'*O. longicauda*, a montré une allométrie minorante confirmée par le test t de Student avec $P<0.05$).

L'analyse des prises accessoires des filets de pêche de la région de Sidi-Lakhdar et Sidi- Medjdoub, a révélé la présence d'une espèce d'holothurie de l'ordre des Synallactida L'analyse morphologique, endosqueletique et anatomique de cette espèce indiquent qu'il s'agit de l'holothurie royale *Parastichopus regalis* qui a été signalée pour la première fois dans les eaux de l'Ouest algérien. La population échantillonnée de cette espèce est caractérisée par une distribution bimodale et une relation allométrique minorante entre la taille du corps relaxé et le poids du corps. Par ailleurs, chez *Parastichopus regalis*, on a observé un commensalisme fréquent avec le poisson perle Carapide Carapus acus.

Publications related to holothurians, published in 2020.

By Chantal Conand

A Google Alert, using the word "holothurian", was set up for the period from January to December 2019. The same method had first been used in 2015 to produce the article "Bibliography on holothurians: Access to modern tools to follow new publications", which was published in the SPC.

Table 1. Number of documents related to holothurians published in 2020, from January 1st to December 31

	Category					
Month	General, ecology, biology	Biochemistry, microbiology	Genetics	Aquaculture	Fishery, socioeconomics	Total/month
January	9	9	1		2	21
February	9	6	4	3	4	26
March	20	7	1	2	4	34
April	5	12	1	3	2	23
May	5	7	1		2	15
June	10	11	4		4	29
July	8	9	1		2	20
August	9	12		1	3	25
September		9	3	2	3	17
October	5	8			2	15
November	6	5		2	3	16
December (partial)	2	1		2	2	7
Total	88	96	16	15	33	248
%	35	39	6	6	13	100

NOAA Central Library

Sea Cucumbers 2013-2020

Bibliography

Jamie Roberts, Librarian, NOAA Central Library
Erin Cheever, Librarian, NOAA Central Library

NCRL subject guide 2020-11
https://doi.org/10.25923/nebs-2p41
June 2020

New species from Brazil: *Chantalia conandae*

The latest issue of *Marine Biology Research* contains a paper by Luciana Martins and Camilla Souto (2020), "Taxonomy of the Brazilian Apodida (Holothuroidea), with the description of new genera in the family Chiridotidae." The authors describe a new genus and new species of a small holothurian. This genus is named in honour of Dr Chantal Conand, in recognition for her contributions to research on Holothuroidea.

This small species lives in the sediment of Ubatuba and São Sebastião, Brazil

Chantalia conandae Martins and Souto, 2020

Original text: English
Pacific Community, Fisheries Information Section, BP D5, 98848 Noumea Cedex, New Caledonia
Telephone: +687 262000; Fax: +687 263818; cfpinfo@spc.int; http://www.spc.int/coastfish