



Abstracts & publications

beche-de-mer

Publication

Restocking and stock enhancement of marine invertebrate fisheries

J.D. Bell, P.C. Rothlisberg P.C, J.L. Munro, N.R. Loneragan, W.J. Nash, R.D. Ward and N.L. Andrew

Source: *Advances in Marine Biology* 49, 370 p.

Many of the world's fisheries are in trouble — they no longer yield the catches, and potential profits, they once did. The main problems are overfishing and destruction of important habitats. Overfishing means catching too many of the spawning adult fish, and too many of the juvenile fish before they become adults. The habitats that support fisheries have been damaged by pollution and other careless use of coastal land. Destructive fishing methods like trawling and blast fishing have also changed fish habitats so that they now support fewer fish.

Governments are responding to the fisheries crisis by raising awareness of the problems, and by legislating to restore and protect fisheries habitats and reduce fishing effort. But they are also intrigued by the possibility of using the recent gains in aquaculture technology to speed up the restoration of stocks.

Through aquaculture, it is now possible to produce juveniles of many marine species in hatcheries. Release of cultured juveniles is an appealing way to increase the stock because people can see fish going into the water and conclude that there will be more fish to catch.

But hatchery releases can be a two-edged sword. It can be very expensive to produce juveniles in hatcheries, which can mean that not enough juveniles are released to make a real difference to the stock. Bad hatchery practices can also produce "unfit" juveniles that have a different genetic make-up, and transfer diseases, to wild fish. Another potential downside is that fishermen may not worry so much about overfishing if they think that a restocking program will repair any damage that they do. As a result, many believe that money spent on hatchery releases would be better spent on other types of management, such as better policing of catch limits, minimum legal sizes and closed areas.

The counterpoints are that some fisheries have been so badly overfished that it will take decades for them to recover to the point where people can harvest the animals again. In such cases, releasing cultured juveniles could "fast-track" the build-up of the spawning adults needed to replenish the fishery. Releasing cultured juveniles for this purpose is called "restocking".

In other cases, although there are enough spawning adults some areas of good habitat still fail to produce many fish even when fishing is well-regulated. This can occur, for example, because the tiny juveniles are swept away by currents as they migrate to nursery habitats, such as mangroves and seagrasses. When this happens, there will be few fish to harvest once they grow up. Putting juveniles into a habitat where they sometimes fail to arrive naturally is called "stock enhancement".

This book summarises what has been learned about restocking and stock enhancement for valuable shellfish (clams, scallops, abalone, conch, trochus, shrimps, lobsters, sea urchins and sea cucumbers). The research that has been done to overcome the disadvantages of restocking and stock enhancement is weighed carefully. Clear guidance is then given to managers about the steps to follow to decide whether use of hatchery-reared juveniles can add value to the other methods they use to restore fisheries.

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Summary

The restocking of sea cucumbers in the Pacific Islands

S.C. Battaglene and J.D. Bell

Source: p. 109–128. In: Bartley D.M. and Leber, K.M. (eds.). Marine ranching. FAO Fisheries Technical Paper. No. 429. Rome, FAO. 213 p. (2004).

Restocking with hatchery-reared juveniles has great potential to help Pacific Islands break the long-term “boom and bust” cycle of the beche-de-mer fishery. The main benefit of restocking is that it provides a way to “fast-track” the restoration of stocks to the point where they can be managed for sustainable yields.

There are four steps to delivering the benefits promised by restocking: (1) development of methods for the mass-production of juveniles, (2) learning how to release the cultured sea cucumbers in the wild so that they survive in high proportions, (3) protecting the released sea cucumbers until stocks are replenished and (4) managing the restored stocks to obtain sustainable harvests of first-grade beche-de-mer (i.e., large individuals). The same technology used for restocking can then be applied to supplement the yields of restored stocks by releasing cultured juveniles in stock enhancement programmes to overcome recruitment limitation. This would allow the production of sea cucumbers to approach the carrying capacity of the habitat.

Although the way to restore and manage the fishery for sea cucumbers in the Pacific is now apparent, only some of the technology and procedures needed to achieve these goals are currently in place. Furthermore, the research has been confined largely to just one species, sandfish (*Holothuria scabra*). The major challenges remaining for restocking of sandfish are: learning how to scale-up the rearing techniques to produce the hundreds of thousands of juveniles needed to have an impact on the abundance of stocks; developing effective strategies for releasing cultured juveniles in the wild; and assessing the economic viability of restocking. In all three cases, however, there is cause for optimism. If research underway to investigate the potential for co-culture of sandfish and shrimp is successful, the mass-production of juvenile sandfish may be possible as a by-crop of shrimp farming. Otherwise, it should be possible to mass-produce sandfish in dedicated ponds, albeit at greater cost. There is no obvious impediment to the development of release strategies, nor are there any apparent reasons why releases cannot be done in a responsible way. For example, guidelines are in place for the management of broodstock to maintain genetic diversity, the risk of introducing diseases to conspecifics and other species appears to be low, and the fact that sandfish are low in the food chain means that there should be little or no impact on other fisheries species. Preliminary estimates also indicate that restocking should be economically viable in terms of returns to artisanal fishermen, although we hasten to point out that such an evaluation cannot be done thoroughly until the necessary research has been completed.

The key to harnessing the potential benefits of restocking sandfish is support from regional/international research organizations, fishing communities, governments and development agencies. The regional/international research organizations need to complete the development of cost-effective methods for restocking sandfish so that this tool is ready for application throughout the Pacific. The fishing communities need to be prepared to forego catches until the stocks are rebuilt, and then to comply with the advice and/or regulations designed to ensure that yields of high value can be obtained each year.

Governments must provide the framework for this process by implementing a moratorium on the export of sandfish until the stocks recover, applying a total export quota based on sustainable yields when the fishery is reopened and ensuring that there is compliance with these laws. Finally, as most governments in the Pacific do not have the financial or human resources to produce the very large numbers of juveniles required to replenish stocks, support is needed from development agencies for restocking programmes. They could also assist by contributing to the costs of developing the measures needed for sustainable management of the restored fishery.

Overall, the prospects for restocking sandfish look particularly promising and every effort should be made to bring this potential management tool to the attention of fishing communities, governments and development agencies so that they stand ready to support and implement restocking programmes as soon as the full suite of methods required becomes available.

Abstracts

Restocking the sea cucumber *Holothuria scabra*: Sizing no-take zones through individual-based movement modelling

S.W. Purcell and D.S. Kirby

Source: Fisheries Research 80:53–61 (2006)

The valuable sea cucumber *Holothuria scabra*, known as “sandfish”, has potential for restocking. However, there is little information available to determine the size of the no-take zones (NTZs) needed to protect the released animals so that they can form nucleus breeding populations. To do this, we measured short-term movement paths of released juvenile (1–105 g) and wild adult (130–690 g) sandfish in a seagrass bed in New Caledonia. We then developed an individual-based model (IBM) to predict long-term dispersal of sandfish released as juveniles (1–16 g) at 1 individual m⁻² within a 1-ha area, drawing on distributions of speed and directionality and the relationship between speed and animal weight from field data. Movement was non-random at the sampling scale used, since animals tended to turn <90° at each 2-h time step. We examined high- and low-growth scenarios by applying 50% and 25% of the modelled growth rates of sandfish held in earthen ponds (where they are known to grow faster). The dispersal of released sandfish was predicted to be limited in the first 2 years, then markedly faster thereafter. After 10 years, 6–12% of surviving animals were predicted to remain in the original 1-ha release site. To protect surviving sandfish as nucleus breeding populations for 10 years, and accepting 10% spillover, square NTZs would need to be 19–40 ha. The findings are useful for the management of restocking and pre-defining the size of sites for recapture surveys. Our model allows user-specified values for future releases and should be applicable for other sedentary marine invertebrates where basic data on movement and growth are available.

Efficacy of chemical and physical tags for large-scale release of an exploited holothurian

S.W. Purcell, B.F. Blockmans and W.J. Nash

Source: Journal of Experimental Marine Biology and Ecology 334:283–293 (2006)

Hatchery-produced juveniles need to be distinguished from wild conspecifics in order to evaluate the success of restocking experiments and stock enhancement. The commercially valuable sea cucumber *Holothuria scabra*, or “sandfish”, has potential for stock enhancement but cheap, long-lasting tags have not yet been developed. We evaluated five non-genetic tags against several criteria: cost, ease of application, retention rate, and ease of detection. In a 1-month trial, T-bar tags and visible elastomer implants proved unsuitable on hatchery-produced sandfish juveniles. Coded-wire tags and two fluorochromes, tetracycline and calcein, showed more promise, so retention rates of these tags were tested on juveniles held in an earthen seawater pond for 1 year. Sixty per cent of juveniles retained at least one of two coded-wire tags for 1 year. Under UV illumination, spicules from the body wall of sandfish immersed in solutions of tetracycline are yellow, whereas calcein-stained spicules are green. From months 1 to 12 after immersion, the average percentage of stained spicules declined from 40% to 8% with tetracycline and 54% to 5% with calcein. After 1 year stained spicules were detected in all immersed animals, i.e. mark retention was 100%. Stained spicules from the ventral body wall of juveniles were generally in greater proportions, and fluoresced brighter, than those from the dorsal body wall. Spicule density exceeded 7000 spicules per mm² of body wall in juveniles of 2–13 g, and decreased with sandfish weight. Fluorescence provides a simple diagnostic tool for identifying marked individuals and the sampling is non-destructive. Several mm² of outer body wall is ample for tag identification. Immersion-staining with fluorochromes is preferred to coded-wire tags and provided a cheap and reliable batch-mark for distinguishing released and wild sandfish.

Experimental evaluation of co-culture of juvenile sea cucumbers, *Holothuria scabra* (Jaeger), with juvenile blue shrimp, *Litopenaeus stylirostris* (Stimpson)

S.W. Purcell, J. Patrois and N. Fraisse

Source: Aquaculture Research 37:515–522 (2006)

The co-culture of juvenile sea cucumber *Holothuria scabra* (Jaeger), or “sandfish”, with juvenile blue shrimp *Litopenaeus stylirostris* (Stimpson) was tested by growing groups in co-culture and monoculture for 3 weeks

in tanks with enriched sand substratum. Feed was supplied on trays, accessible only to shrimp. Survival of shrimp and sandfish was high in all treatments (73–100%). Growth of shrimp did not differ between monoculture and co-culture, but sandfish grew significantly slower in co-culture ($P = 0.03$), although their sand burying and surface foraging were apparently unaffected by shrimp ($P = 0.76$). However, shrimp increased the levels of total ammonia-N in tanks, which related inversely with sandfish growth ($P = 0.04$). Conversely, sandfish did not appear to lower the water quality for shrimp culture. While sandfish bioturbate sediments and eat organic deposits, the juveniles did not significantly reduce the organic content of sand in tanks. Co-culturing juveniles of the two species in earthen ponds appears feasible, with no detriment to shrimp production, presenting a cost-effective method for growing sandfish to larger sizes for restocking. These findings underpin further studies to test the viability of commercial co-culture of sandfish with blue shrimp at later stages in the production cycle of shrimp.

Effect of invasive tagging on the activity of *Holothuria whitmaei* [Echinodermata: Holothuroidea]: A suitable mark-recapture method for short-term field studies of holothurian behaviour

G. Shiell

Source: Marine and Freshwater Behaviour and Physiology 39(2):153–162 (2006)

Although mark-recapture techniques are commonly used to obtain ecological data, tagging of soft-bodied holothurians has proven difficult, and the degree to which invasive tags may confound the behaviour of holothurians remains unclear. In this study, diurnal patterns of activity were monitored in the commercial sea cucumber *Holothuria whitmaei* (black teatfish) after marking the tegument superficially with a number measuring 30 x 20 mm (to a depth of ≤ 2 mm). Rates of activity in marked specimens increased significantly in the initial hours following marking, and remained higher than those of unmarked control animals for up to three days following the procedure. These results suggest (a) that behaviour in holothurians may initially be compromised by marking the tegument and (b) that improved measures of activity may be obtained following a suitable recovery period. This is a useful finding given the need for improved knowledge of commercial holothurian biology, including diurnal and seasonal patterns of behaviour.

The influence of diets containing dried bivalve feces and/or powdered algae on growth and energy distribution in sea cucumber *Apostichopus japonicus* (Selenka) (Echinodermata: Holothuroidea)

X. Yuan, H. Yang, Y. Zhou, Y. Mao, T. Zhang and Y. Liu

Source: Aquaculture 256(1–4):457–467. (2006).

In recent years, bivalve feces and powdered algae have been used as the food sources of holothurians in China. In this study, growth and energy budget for sea cucumber *Apostichopus japonicus* (Selenka) with initial wet body weights of 32.5 ± 1.0 g (mean \pm SE, $n = 45$) when fed with five different granule diets containing dried bivalve feces and/or powdered algae in water temperature 13.2–19.8°C and salinity 30–32 ppt were quantified in order to investigate how diets influence growth and energy distribution and to find out the proper diet for land-based intensive culture of this species. Results showed that diets affected the food ingestion, feces production, food conversion efficiency and apparent digestive ratios, hence the growth and energy budget. Sea cucumbers fed with dried feces of bivalve showed poorer energy absorption, assimilation and growth than individuals fed with other four diets; this could be because feces-drying process removed much of the benefits. Dried bivalve feces alone, therefore, were not a suitable diet for sea cucumbers in intensive cultivation. The mixed diets of feces and powdered algae showed promising results for cultivation of sub-adult *Apostichopus japonicus*, while animals fed with powdered algae alone, could not obtain the best growth. According to SGR of tested animals, a formula of 75% feces and 25% powdered algae is the best diet for culture of this species. Extruded diets were used in the present experiment to overcome shortcomings of the traditional powdered feeds, however, it seems a conflict exists between drying bivalve feces to form extruded diets and feeding sea cucumbers with fresh feces, which contain beneficial bacteria. Compared with other echinoderms, in holothurians the energy deposited in growth is lower and the energy loss in feces accounts for the majority of the ingested energy. Such detailed information could be helpful in further development of more appropriate diets for culture of holothurians.

Effects of body size and water temperature on food consumption and growth in the sea cucumber *Apostichopus japonicus* (Selenka) with special reference to aestivation

H. Yang, X. Yuan, Y. Zhou, Y. Mao, T. Zhang and Y. Liu

Source: Aquaculture Research 36(11):1085–1092 (2005)

To investigate the effects of body size and water temperature on feeding and growth in the sea cucumber *Apostichopus japonicus* (Selenka), the maximum rate of food consumption in terms of energy (C_{maxE} ; J day⁻¹) and the specific growth rate in terms of energy (SGRe; % day⁻¹) in animals of three body sizes (mean ± SE) — large (134.0 ± 3.5 g), medium (73.6 ± 2.2 g) and small (36.5 ± 1.2 g) — were determined at water temperatures of 10, 15, 20, 25 and 30° C. Maximum rate of food consumption in terms of energy increased and SGRe decreased with increasing body weight at 10, 15 and 20° C. This trend, however, was not apparent at 25 and 30° C, which could be influenced by aestivation. High water temperatures (above 20° C) were disadvantageous to feeding and growth of this animal; SGRe of *A. japonicus* during aestivation was negative. The optimum temperatures for food consumption and for growth were similar and were between 14 and 15° C, and body size seemed to have a slight effect on the optimal temperature for food consumption or growth. Because aestivation of *A. japonicus* was temperature dependent, the present paper also documented the threshold temperatures to aestivation as indicated by feeding cessation. Deduced from daily food consumption of individuals, the threshold temperature to aestivation for large and medium animals (73.3–139.3 g) was 24.5–25.5° C, while that for small animals (28.9–40.7 g) it was between 25.5 and 30.5° C. These values are higher than previous reports; differences in sign of aestivation, experimental condition and dwelling district of test animals could be the reasons.

Feeding and growth on bivalve biodeposits by the deposit feeder *Stichopus japonicus* Selenka (Echinodermata: Holothuroidea) co-cultured in lantern nets

Y. Zhou, H. Yang, S. Liu, X. Yuan, Y. Mao, Y. Liu, X. Xu and F. Zhang

Source: Aquaculture 256(1–4):510–520. (2006).

Suspension aquaculture of filter-feeding bivalves has been developing rapidly in coastal waters in the world, especially in China. Previous studies have demonstrated that dense populations of filter-feeding bivalves in shallow water can produce a large amount of faeces and pseudofaeces (biodeposits) that may lead to negative impacts on the benthic environment. To determine whether the deposit feeder *Stichopus* (*Apostichopus*) *japonicus* Selenka can feed on bivalve biodeposits and whether the sea cucumber can be co-cultured with bivalves in suspended lantern nets, three experiments were conducted, two in tanks in the laboratory and one in the field. In a 3-month flow-through experiment, results showed that sea cucumbers grew well with specific growth rate (SGR) reaching 1.38% d⁻¹, when cultured in the bottom of tanks (10 m³ water volume) where scallops were cultured in suspension in lantern nets. Moreover, results of another laboratory experiment demonstrated that sea cucumbers could survive well on bivalve biodeposits, with a feeding rate of 1.82 ± 0.13 g dry biodeposits ind⁻¹ d⁻¹, absorption efficiency of organic matter in biodeposits of 17.2% ± 5.5%, and average SGR of 1.60% d⁻¹. Our longer-term field experiments in two coastal bays (Sishili Bay and Jiaozhou Bay, northern China) showed that *S. japonicus* co-cultured with bivalves also grew well at growth rates (0.09–0.31 g wet weight ind⁻¹ d⁻¹) depending on individual size. The results suggest that bivalve lantern nets can provide a good habitat for sea cucumbers; and the co-culture of bivalve molluscs with sea cucumbers may provide an additional valuable crop with no additional inputs.

Role of microtubules and centrosomes in the eccentric relocation of the germinal vesicle upon meiosis reinitiation in sea-cucumber oocytes

A. Miyazaki, K.H. Kato and S. Nemoto

Source: Developmental Biology 280(1):237–47 (2005)

In the oocytes of many animals, the germinal vesicle (GV) relocates from the center to the periphery of the oocyte upon meiosis reinitiation, which is a prerequisite to the formation of meiotic spindles beneath the cell surface in order for meiosis to succeed. In the present study, we have investigated nuclear positioning using sea-cucumber oocytes. Upon meiosis reinitiation, the GV relocates to the cell periphery beneath a surface protuberance. After GV breakdown, polar bodies were extruded from the top of the protuberance, which we therefore called the animal pole process. The GV relocation was inhibited by nocodazole but not by cytochalasin. Immunofluorescent staining and electron microscopy of microtubular arrays revealed that:

(i) in immature oocytes, two centrosomes were situated beneath the animal pole process far apart from the GV, anchoring to the cortex via astral microtubules; (ii) upon meiosis reinitiation, microtubular bundles were newly formed between the centrosomes and the GV; and (iii) the microtubular bundles became short as GV migration proceeded. These observations suggest that microtubules and centrosomes participate in GV relocation. A very large mass of annulate lamellae, having a 20-microm diameter, was found in the vegetal pole of the oocytes.

Isolation and characterization of twenty microsatellite loci in Japanese sea cucumber (*Stichopus japonicus*)

M. Kanno, Q. Li and A. Kijima

Source: Marine Biotechnology 7(3):179–183 (2005)

Twenty microsatellite markers were first developed from the Japanese sea cucumber *Stichopus japonicus* using an enrichment protocol. Of the 20 microsatellite loci, 19 loci were polymorphic in the population examined. At these polymorphic loci, the number of alleles per locus varied from 2 to 15, and the observed heterozygosities ranged from 0.03 to 0.97, which is considerably higher than those previously found for allozymes. The high variability of the microsatellite markers identified in this study will make them excellent tools for genetic analyses of *S. japonicus*.

A review of pygal-furrowed Synallactidae (Echinodermata:Holothuroidea), with new species from the Antarctic, Atlantic and Pacific oceans

M. O'Loughlin and C. Ahearn

Source: Memoirs of Museum Victoria 62(2):147–179.

<http://www.museum.vic.gov.au/memoirs/index.asp>

We review the genera and species of pygal-furrowed Synallactidae and describe new species from the collections of the United States National Museum of Natural History (Smithsonian Institution). *Meseres* Ludwig is reviewed and placed incertae sedis. *Molpadiodemias* Heding and *Pseudostichopus* Théel are rediagnosed. *Platystichopus* Heding is declared a junior synonym of *Molpadiodemias*. *Filithuria* Koehler and Vaney and *Peristichopus* Djakonov are declared junior synonyms of *Pseudostichopus*. Lectotypes are designated for: *Meseres involutus* Sluiter, *M. macdonaldi* Ludwig, *M. peripatus* Sluiter, *Pseudostichopus globigerinae* Hérouard, *P. mollis* Théel, *P. pustulosus* Sluiter, *P. trachus* Sluiter, *P. villosus* Théel. A neotype is designated for *Pseudostichopus nudus* Ohshima.

Except for the type species, *Meseres macdonaldi* Ludwig, and *Meseres (?) torvus* (Théel), all species previously referred to *Meseres* are reassigned to *Molpadiodemias* or *Pseudostichopus*. *Meseres (?) torvus* (Théel) is retained in its original combination. Eleven new synallactid species are described: *Molpadiodemias constrictus*, *M. crinitus*, *M. epibiotus*, *M. helios*, *M. morbillus*, *M. neovillosus*, *M. pediculus*, *M. porphyrus*, *M. translucens*, *M. ustulatus* and *Pseudostichopus tuberosus*. *Molpadiodemias constrictus* is fissiparous. *Pseudostichopus villosus* var. *violaceus* Théel is raised to species status; *Pseudostichopus alatus* Imaoka, *P. trachus* Sluiter and *P. nudus* Ohshima are junior synonyms of *Pseudostichopus mollis* Théel; *Pseudostichopus globigerinae* Hérouard and *P. dilatorbis* Imaoka are junior synonyms of *Meseres* (= *Molpadiodemias*) *involutus* Sluiter; *Pseudostichopus propinquus* Fisher and *P. lapidus* Hérouard are junior synonyms of *Meseres* (= *Pseudostichopus*) *peripatus* Sluiter; and *Pseudostichopus arenosus* Ohshima and *P. molpadioides* Ohshima are junior synonyms of *Meseres* (= *Pseudostichopus*) *hyalegerus* Sluiter.

New combinations are: *Molpadiodemias atlanticus* (Perrier), *M. depressus* (Hérouard), *M. involutus* (Sluiter), *M. pustulosus* (Sluiter), *M. villosus* (Théel), *Pseudostichopus elegans* (Koehler and Vaney), *P. hyalegerus* (Sluiter), *P. papillatus* (Djakonov), *P. peripatus* (Sluiter) and *P. spiculiferus* (O'Loughlin). Other species discussed are: *Molpadiodemias violaceus* (Théel), *Pseudostichopus aemulatus* Solís-Marín and Billett, *P. echinatus* Thandar, *P. mollis* Théel, *P. occultatus* Marenzeller, and *P. profundus* Djakonov. A key is provided for the species of *Molpadiodemias* and *Pseudostichopus*. Tables are provided of genera and subgenera with current systematic status, and species with original and current combinations.

A new Indo-West Pacific species of *Actinopyga* (Holothuroidea:Aspidochirotida: Holothuriidae)

Y. Samyn, D. Vandenspiegel and C. Massin

Source: Magnolia Press Zootaxa 1138:53–68 (2006) and <http://www.mapress.com/zootaxa/>

Actinopyga is one of the five genera commonly recognised in the family Holothuriidae. This small genus has sixteen species currently considered valid. The present paper describes a new Indo-West Pacific species, *Actinopyga caerulea*, of which the most striking character is its bluish coloration. The ossicle assemblage of the new species resembles mostly that of *A. bannwarthi* Panning, 1944 and *A. flammea* Cherbonnier, 1979.

New host and geographical distribution for the pearlfish *Carapus mourlani* (Carapidae) with a discussion on its biology

E. Parmentier, A. Mercier and J.-F. Hamel

Source: Copeia 1:122–128 (2006)

Specimens of the pearlfish *Carapus mourlani* (Carapidae) were observed for the first time in association with the sea cucumber *Isostichopus fuscus* (Holothuroidea: Echinodermata) along the coast of Ecuador. Out of 4345 sea cucumbers collected from various depths between 5 and 60 m, 12 harbored a pearlfish either in the coelomic cavity, the respiratory tree or the digestive tract, yielding a prevalence of ca. 0.28%. The presence of *C. mourlani* appeared to be detrimental to the holothurian host in some cases. Side effects resulting from coelomic cavity infections included less advanced gonad maturity (reduced gonadal tubule diameter and length, lower ratio of mature oocytes) and a significant proportion of necrotic and shriveled gonadal tubules, devoid of gametes. Aside from discussing this evidence, the present paper briefly describes the biology of the pearlfish, its relationship with the host and its daily activity cycle.

Note on the association between *Plakobranthus ocellatus* (Mollusca, Gastropoda, Opisthobranchia) and *Holothuria atra* (Echinodermata, Holothuroidea)

A. Mercier and J.-F. Hamel

Source: Les Cahiers de Biologie Marine 46:399–402 (2005)

This paper presents evidence of a commensal association between an opisthobranch (*Plakobranthus ocellatus*) and a sea cucumber (*Holothuria atra*). Field observations revealed that occurrences of *P. ocellatus* specimens and egg filaments were much more frequent on the body wall of *H. atra* than on that of two other holothurian species living in the same habitat. Roughly 95% of *H. atra* were colonized by *P. ocellatus* during the night, which corresponds to the active period of *H. atra* and the resting period of *P. ocellatus*. The proportion decreased to ca. 21% in the daytime when the sea cucumbers are resting and most opisthobranchs are foraging. Laboratory trials confirmed the daily pattern of association and the fact that *P. ocellatus* lay their eggs on the body wall of *H. atra*. Furthermore, multiple-choice experiments showed that ca. 71% of *P. ocellatus* favoured *H. atra*, whereas only ca. 9% colonised other species of sea cucumber. Because *H. atra* is known to exude toxic chemicals that deter several species of invertebrates and fishes, the opisthobranch may use the sea cucumber as a refuge against predators and as a secure spawning ground.

Transportation methods for restocking of juvenile sea cucumber, *Holothuria scabra*

S.W. Purcell, B.F. Blockmans, N.N.S. Agudo

Source: Aquaculture 251:238–244 (2006)

Holothurians role in the marine sediments reworking processes

M. Dar

Source: Sedimentology of Egypt 12:173–183 (2004)

Synallactes laguardai, a new species of sea cucumber from South Africa (Echinodermata: Holothuroidea: Aspidochirotida: Synallactidae)

F.A. Solís-Marín.

Source: Proceedings of the Biological Society of Washington 118(3):570–575 (2005).

A simple enzymatic method for examining calcite ossicles of Echinodermata

C.G. Tiago, A.D. Brites, and G.Y. Kawauchi

Source: Journal of Microscopy 218(3):240–246 (2005)

Regional sea cucumber project: Proceedings of the start-up workshop, Mombasa, Kenya, 26–29 January 2006

N. Muthiga and C. Conand (eds)

Source: <http://www.wiomsa.org/default.asp?groupid=2004121144037123>

A few recent publications on echinoderms in Spanish

Los equinodermos de las islas Lobos de Afuera (Lambayeque, Perú)

Y. Hooker, F.A. Solís Marín and M. Lellish.

Source: Revista Peruana de Biología 12(1):77–82 (2005)

Catálogo de los equinodermos (Echinodermata: Crinoidea, Echinoidea, Holothuroidea) nerítico-bentónicos del Archipiélago Cubano

R. Valle García, F.A. Solís-Marín, M. Abreu Pérez, A. Laguarda-Figueras y A. Durán-González

Source: Revista de Biología Tropical 53 (Supl. 3):9–28 (2005)

Equinodermos (Echinodermata) de la zona marina económica exclusiva del Golfo de México

A. Durán-González, A. Laguarda-Figueras, F.A. Solís-Marín, B.E. Buitrón Sánchez, C.A. Gust y J. Torres-Vega

Source: Revista de Biología Tropical, 53 (Supl. 3):53–68 (2005)

Equinoideos (Echinodermata: Echinoidea) del Golfo de México

A. Laguarda-Figueras, A.I. Gutiérrez-Castro, F.A. Solís-Marín, A. Durán-González y J. Torres-Vega

Source: Revista de Biología Tropical 53 (Supl. 3):69–108 (2005)

Equinodermos (Echinodermata) del Caribe Mexicano

A. Laguarda-Figueras, F.A. Solís-Marín, A. de La Luz Durán-González, C. Ahearn, B. Estela Buitrón Sánchez y J. Torres-Vega

Source: Revista de Biología Tropical, 53 (Supl. 3):109–122 (2005)

Equinodermos (Echinodermata) del Golfo de California, México

F.A. Solís-Marín, A. Laguarda-Figueras, A. de La Luz Durán-González, C. Ahearn Gust y J. Torres Vega

Source: Revista de Biología Tropical 53 (Supl. 3):123–137 (2005)

PhD and Masters theses

Habitats and macroinvertebrate fauna of the reef-top of Rarotonga, Cook Islands: implications for fisheries and conservation management

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Throughout the Pacific, many species of echinoderms and molluscs have cultural value and are harvested extensively in subsistence fisheries. Many of these species are sedentary and often associated with distinct reef-top habitats. Despite the significance of reef habitats and their fauna for fisheries, and biodiversity etc., little information has been available on the distribution of habitats and their influence on the reef-top fauna in the Cook Islands. This thesis developed a novel approach to assess the status of the shallow-water reef-tops of Rarotonga, Cook Islands, to provide critical information to fisheries and conservation managers. The approach used remote sensing (aerial photography with ground truthing) to map the spatial arrangement and extent of the entire reef-top habitats accurately, and historical wind data and coastline shape to determine the windward and leeward sides of the island. The benthic habitat maps and degree of wind exposure were used to design and undertake a stratified sampling programme to assess the distribution and abundance of the epibenthic macroinvertebrate fauna of the reef-top. I quantified the distribution and abundance of the epibenthic macroinvertebrates and how they varied with habitat, assessed the effectiveness of a traditional *ra'ui* (marine protected area) for conserving stocks of *Trochus niloticus* and other invertebrates, and investigated the reproductive biology and impacts of traditional gonad harvesting on *Holothuria leucospilota*.

There were four major habitat types (rubble/rock, sand/coral matrix, algal rim and sand) identified, the most extensive being rubble/rock (45%) and sand/coral matrix (35%). The degree of exposure to winds was found to correlate with the reef development and habitat distribution.

The assemblage composition of each major habitat type differed significantly from every other habitat. The rubble/rock habitat had the greatest substratum heterogeneity and structural complexity, and the highest number of species and individuals. The overall abundance of the fauna was dominated by holothurians (68%) and echinoids (30%), while *Trochus niloticus* and *Tridacna maxima* accounted for the remaining 2% of the total invertebrate assemblage. Clear habitat partitioning was also found for adult and juvenile *Trochus niloticus* and *Tridacna maxima*.

In the traditional fishery for *Holothuria leucospilota*, the mature gonads of males are harvested by making an incision in the body wall of the animal, removing the gonads and then returning the animal to the reef to allow regeneration. Monthly collections of *H. leucospilota* were used to describe the reproductive biology of this species. Gametogenesis and spawning were synchronous between the sexes and spawning occurred annually during summer, when water temperature and photoperiod were at their highest. Although the incision in the body wall and gonad removal had no impact on the survival of *H. leucospilota* in experimental cages, their body weight, and general sheltering and feeding behaviours were affected. Gonads took at least 41 days to start regenerating, suggesting a considerable delay in the spawning of fished individuals.

In 1998, five Rarotongan communities re-introduced the traditional *ra'ui* system of resource management, prohibiting all fishing and gathering from their reefs. The performance of the Nikao *ra'ui*, which had been put in place to allow trochus stocks to increase, was investigated. Comparisons of macroinvertebrate assemblage composition and species density were made between three fishing treatments, i.e. fished areas adjacent to the *ra'ui*, within the *ra'ui* after two years of protection, and in the *ra'ui* after it had been lifted for three weeks to allow a commercial trochus harvest. Analysis of variance on the count data for the twelve most abundant species, and non-metric multi-dimensional scaling indicated that there were no differences in the microhabitat or the invertebrate assemblage composition between the three fishing treatments. However, there were significant differences between the rubble/rock and sand/coral matrix habitat types. The results on the effectiveness of the Nikao *ra'ui* are equivocal, due to the small sample size and the variability between samples, which was highlighted by the wide confidence intervals.

This study highlights the importance of habitat to the macroinvertebrate fauna of the reef-top and the need for accurate habitat maps to increase the cost-effectiveness of future resource surveys, to provide information to management, and for the design of marine protected areas. The mapping and survey methods must

be reliable and repeatable in terms of the limitations of time, and the availability of expertise, funding and resources. The results provide important information for fisheries and conservation managers of Rarotonga and other Pacific Islands to better design rigorous sampling programmes for monitoring the status of reef-top resources, and for evaluating and planning marine protected areas.

Matter and energy transfers in soft-bottom sediments of an anthropogenic reef complex (La Réunion Island, Indian Ocean)

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Source: PhD La Reunion University 6/06/2006

Coral reefs are very productive ecosystems. Soft-sediments generally play a role in storing place, in transforming and in producing of matter, and therefore could play a key role in reefs. The goal of this study was to evaluate the role of soft-bottoms compartment during the transfer of matter and energy in the reefs of Reunion Island. Three main lines of research were developed: the physicochemical characterisation of studied sites, the metabolism of soft-bottoms and, the characterisation of biological component by the study of macrofauna and holothurians. A limited disturbance was detected by physicochemical data although locally enrichments of freshwater by nutrients were measured. At the reef scale, the soft-sediments were found heterotrophic (net production = 31.6, respiration $R = 109.6$, gross production $P_g = 77.9$ mmolC $m^{-2} d^{-1}$ et $P_g/R = 0.7$). Opposite to the two holothurians (*Holothuria atra* and *H. leucospilota*), macrofauna did not constitute a major group in the food web (134 taxa, with a mean of 32.86 ind. $0.2 m^{-2}$ et 0.059 g (dry weight) $0.2 m^{-2}$) compared to echinoderm biomass that could reach 7.92 g (dry weight) m^{-2} . At the station scale, spatial heterogeneity of metabolism was in agreement with the physicochemical characteristics of environment reflecting the double influence of ocean and land. The most productive and heterotrophic stations were located in the back-reef where the oceanic influence was the lowest. Finally, macrofauna was under hydrodynamic influence although holothurians are growing in the most productive area. The soft-bottoms played a key role in filtrating organic matter provided from the back-reef. This mechanism was deeply influenced by the high hydrodynamism, which modulated the loss of mater and energy of the reef. These losses were however limited by the action of holothurians (high density 3 ind. m^{-2}), which store organic matter such as biomass and probably enhanced local production. To conclude soft-bottoms were responsible of recycling, which was reinforced by holothurians that limited the loss of matter and energy due to hydrodynamism.

Reproduction sexuée de *Holothuria leucospilota* à La Réunion

S. Kohler (supervised by C. Conand and S. Gaudron)

Source: Mémoire de Maîtrise de biologie des populations et écosystèmes. Université de La Réunion. 25 p. + annexes (2006)

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