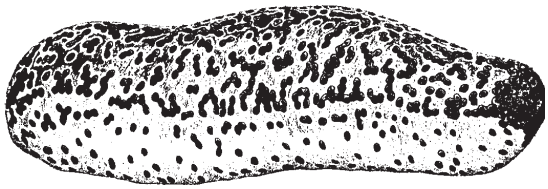
B E C H E - D E - M E R

Abstracts, Publications Workshops and Meetings



Recent publications on echinoderms

SPC handbook No.#18
Sea cucumbers and beche-de-mer of the tropical Pacific

Published and edited by the South Pacific Commission, this is a revised version of *Beche-de-mer of the South Pacific Islands,* 1974 and *Beche-de-mer of the tropical Pacific,* 1979. A colour poster showing the various species of beche-de-mer found in the Pacific (live and processed) has also been produced.

Nearshore marine resources of the South Pacific

Wright, A. and L. Hill (eds.). Institute of Pacific Studies, Suva; Forum Fisheries Agency, Honiara; International Centre for Ocean Development, Canada. 1993.

This book is a product of the Forum Fisheries Agency which has 16 Pacific Island member-countries. It presents the works of 19 authors renowned in the field of fisheries. One of the authors, Garry Preston, gives on 36 pages (pp. 371 – 407) a detailed review on the biology and the fisheries of the South Pacific holothurians, largely based on the results obtained by C.Conand while she was working at ORSTOM (New Caledonia).

Echinoderms through time

Edited by
Bruno David, Université de Bourgogne, Dijon, France
Alain Guille & Jean-Pierre Féral, Observatoire Océanologique, Banyuls / Mer, France
Michel Roux, Université de Reims, France

In: A.A.Balkema / Rotterdam / Brookfield / 1994. Proceedings of the Eighth International Echinoderm Conference, Dijon, France, 6 – 10 September 1993.

Some years ago, the International Echinoderm Conferences reached full maturity and echinoderms are now considered to be a biological and geological model that supports research studies of great importance. The extent of their contribution to various fields of research is shown by the scope of presentations at the international conferences. These proceedings contain either complete papers or abstracts of all the presentations made and posters displayed at the Eighth International Echinoderm Conference, Dijon, September 1993. Contents: General; Extinct classes; Crinoids; Asteroids; Ophiuroids; Holothuroids; Echinoids. 90 5410 5143, October 1994, 992 p.

The section on holothuroids (73 pages) includes:

Ahearn C. Family Psolidae: New distribution records from the Antarctic. p. 503.

Castro, R. L. S. The fishery of the sea cucumbers *Isostichopus fuscus* and *Parastichopus parvimensis* in Baja California, Mexico. p. 504.

CMFRI special publication number 57:
Hatchery techniques and culture of the sea-cucumber Holothuria scabra

by D. B. James, A. D. Gandhi, N. Palaniswamy & J. X. Rodrigo
Central Marine Fisheries Research Institute, Indian Council of Agricultural Research, Dr Salim Ali road, Post Box No. 1603, Tatapuram P.O., Ernakulam, Cochin 682 014, India

Preface by P. S. B. R. James, Director of CMFRI:

Hatcheries of sea-cucumbers have been established in China and Japan and more recently in Korea and Russia. At all these places only seed of *Stichopus japonicus* is produced. After the seed has been retained for two or three months, it is sea-ranched, since it is expensive to maintain in the hatcheries for long periods.

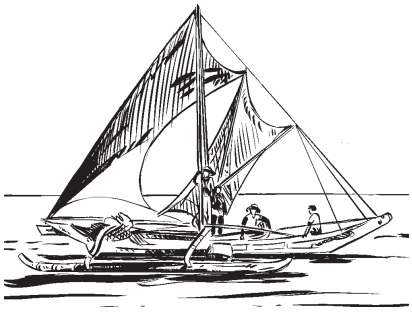
In India the beche-de-mer industry is a very ancient one. Until recently, the whole fishery was supported, by a single species, *Holothuria scabra.* As a result of this, the natural populations dwindled alarmingly. In order to enrich the natural populations, a research project on the hatchery and culture of sea cucumbers was started by the Central Marine Fisheries Research Institute (CMFRI) at Tuticorin Research Centre in 1987. Break-through was achieved in 1988 in inducing *Holothuria scabra* to spawn in the laboratory for the first time by thermal stimulation. Since then, several spawnings have taken place and seeds have been produced. In 1992 the Marine Products Export Development Authority, Cochin approved a research project worth six lakhs of rupees for three years on intensive seed production and sea-ranching

of sea cucumbers. This has given further impetus to the work.

This Special Publication is a practical guide for seed production in the hatchery and culture of *Holothuria scabra*, which is the most valuable species processed in India at present. It is well illustrated with colour photographs. We hope this special issue in the 'Transfer of Technology' series will be of interest to those who are involved in the beche-de-mer industry.

The efforts of the team headed by Dr. D. B. James in the production of seeds in the hatchery and also in the preparation of this publication is highly appreciated and I congratulate them for this achievement. I also thank Dr. K. Rengarajan for editing the publication and getting it printed in time.

The contents of this publication are:



Proceedings of the national workshop on beche-de-mer, February 1994, CMFRI, Bulletin 46

K. Rengarajan & D. B. James (eds.), Central Marine Fisheries Research Institute, Indian Council of Agricultural Research, Post Box No. 1603, Tatapuram, P.O. Ernakulam, Cochin 682 014, India

This publication contains the following technical papers:

James, P. S. B. R. & D. B. James. Management of the beche-de-mer industry in India. p.17.

James, P. S. B. R. & D. B. James. Conservation and management of sea cucumber resources of India. p. 23.

James, D. B. Holothurian resources from India and their exploitation. p.27.

Alagaraja, K. Assessment of sea cucumber resources of India. p. 32.

James, D. B. Zoogeography and systematics of holothurians used for beche-de-mer in India. p.34.

James D. B. Ecology of commercially important holothurians of India. p. 37.

Baskar, B. K. Some observations on the biology of the holothurian *Holothuria (Metriatyla) scabra* Jaeger. p. 39.

Mary Bai, M. Studies on regeneration in the holothurian *Holothuria (Metriatyla) scabra* Jaeger. p. 44.

Nagabhushanam, R., B. Ashok Kumar & R. Sarojini. Toxicity evaluation of the holothurian *Holothuria (Mertensiothuria) leucospilota* (Brandt), the effect of toxin on the prawn *Caridina rajadhari*. p.51.

Abstracts

A conservative application of a surplus production model to the sea cucumber fishery in Southeast Alaska

by Douglas A. Woodby,[1] Gordon H. Kruse[2] & Robert C. Larson[3]
Alaska Department of Fish and Game
[1]Douglas, [2]Juneau, and [3]Petersburg, Alaska

In : Management of exploited fish. Alaska Sea Grant 1993. *Proceedings of the International Symposium on Management Strategies for Exploited Fish Populations*, Alaska Sea Grant College Program, AK-SG-93-02, 1993. pp. 191 – 202.

We developed a conservative application of a surplus production model to estimate the potential annual yield for sea cucumbers, *Parastichopus californicus*. This application was motivated by a lack of information on the population biology of sea cucumbers and is conservative in at least three ways: quota reductions are made to account for potential errors in the model; only a portion of the entire population size is estimated; and the population size estimate used to set a harvest quota is at the lower boundary of the confidence interval. The maximum annual yield is estimated to be 6.4 per cent of the population surveyed. We have initiated an assessment programme to evaluate the ability of the stocks to sustain harvests as prescribed by the model. We determined that it is important to reduce sample variance from location effects; this allows detection of changes in population density that are the same size as the commercial harvests. It may also be important to consider seasonal migrations in survey design.

A review of recent development in the world sea cucumber fisheries

by Chantal Conand & Maria Byrne

In: *Marine Fisheries Review*, 1993, 55 (4)

Sea cucumbers (Holothuridae and Stichopodidae) have been harvested commercially for at least 1,000 years. The world fisheries for sea cucumbers, however, are not well documented and in general are poorly managed. Depending upon the species exploited, there are two processing procedures for the sea cucumber product. Some species are eaten raw, while most commercial species are processed into a dry product called beche-de-mer or 'trepang'. This dry product is exported to a central market such as Hong Kong and then re-exported to the consumers.

In this review, recent statistics on the world sea cucumber fisheries, collected from different services, are detailed for each major fishing area. Case studies for each fishing area are also presented. Recent major changes in the Indo-Pacific fishery include the participation of new producer countries, the shift in the species being exploited, and an increase in the Chinese market. The expansion of the largely monospecific temperate North Pacific fisheries is also described.

Statistics from Hong Kong, Singapore, Taiwan, and the Food and Agriculture Organization provide valuable information on the producer and importer countries. Particular attention is paid to the reciprocal trade of beche-de-mer between Hong Kong and Singapore. An evaluation of world sea cucumber landings and beche-de-mer production is presented. Recent developments include an expansion of the Hong Kong market due to increased demand by China, the importance of Indonesia as a major world producer and an increase in the fisheries of tropical Pacific nations. This increase is best documented for New Caledonia and Fiji. Ways to improve the access and the reliability of statistics for the sea cucumber fishery are discussed, as is the potential for management of artisanal fisheries.

The three following abstracts were published in: Proceedings of the Seventh International Coral Reef Symposium. *Guam. 1992. Vol.2*

Feeding behaviour of two tropical holothurians *Holothuria (Metriatyla) scabra* (Jäger 1833) and *H.(Halodeima) atra* (Jäger 1833), from Okinawa, Japan

by Winfried L. Wiedmeyer
Coral Reef Studies Laboratory, Department of Marine Sciences, University of the Ryukyus, Okinawa 903-01, Japan.

Digestive contents of *Holothuria scabra* and *H. atra* (n = 476 ind. each) were analysed on Okinawa, southern Japan from field surveys covering 24-hour periods. Specimens were collected at separate locations during the spawning and post-spawning seasons of 1991.

H. scabra fed during the night when burrowed. Small, medium and large individuals of both species had distinct feeding modes based on digestive speed, daily and seasonal feeding cycles, particle size and chemical selectivity. *H. scabra* and *H. atra* showed different feeding strategies and behaviour which were specific for seasons and habitats. *H. scabra* reworked more sediment than *H. atra*. But with respect to thickness of the sediment layers at the survey areas, the effect of reworking of *H. atra* at areas of underlying hard substrates is considered more significant.

The amount (dry weight) of daily reworked sediment, as a percentage of the drained body weight of the individuals, was 31.0 per cent and 23.4 per cent in *H. scabra* and 46.5 per cent and 45.2 per cent in *H. atra* for spawning and post-spawning seasons respectively. Daily assimilated organic matter (carbon / dry weight) as a percentage of the drained body weight of the individuals was 0.29 per cent and 0.23 per cent in *H. scabra* and 0.18 per cent and 0.13 per cent in *H. atra* for spawning and post-spawning seasons respectively. Assimilated organic matter per unit weight decreased with increasing body weight in both species, with the exception of the reproducing individuals during the spawning seasons. Assimilation efficiency for organic matter was 75 per cent higher in *H. scabra* than in *H. atra*.

Effects of typhoon-generated waves on windward and leeward assemblages of holothuroids

by A. M. Kerr
Marine Laboratory, University of Guam, UOG Station, Mangilao Guam 96923 USA

In the western Pacific, where typhoons are frequent, storm-associated waves were suspected of influencing the distributions of shallow-water holothuroids. I sampled holothuroids on a windward and leeward reef on Guam before and after Typhoon Russ. *Holothuria atra* and *Actinopyga echinites*, which live on open, unsheltered substrata, and diurnally cryptic species were greatly reduced (66.1%, 59.6% and 55.6% respectively) on the outer reef flat of the windward site. On the windward inner reef *Actinopyga echinites* and cryptic species also decreased (47.2% and 14.3%). No species decreased on the leeward outer and inner reefs. Rheophilic taxa along the reef margins at both sites were also unaffected by the typhoon. These data, the frequency of typhoons in the region (1 every 3.5 years on average) and the hypothesised longevity of many species (5 – 15 yrs) suggest that cyclonic storms may be important in structuring populations of holothuroids, particularly exposed, epibenthic forms, on windward reefs in the western Pacific.

Internal micro-tag identification systems for teleosts, holothurians and decapods

By R. M. Buckley[1] and M. C. Gomez-Buckley[2]
[1] Washington Department of Fisheries, 115 GAB AX-11 Olympia, WA 98502, USA
[2] University of Las Palmas, Fac. Cien. del Mar, 35017 Las Palmas de Gran Canaria, Spain

Successful extrinsic identification of organisms in ecological studies enables validation of biocenosis assumptions, estimation of population parameters, and assessment of migrations at relevant spatial and temporal scales. The magnetic, binary-coded wire tag (CWT), alpha/numeric-coded visible implant (VI) tag and fluorescent polymer (FP) tag, are bio-compatible internal micro-tags that (1) allow individual or batch recognition, (2) have low rates of loss (3) do not invalidate biological normality, and (4) enable practical long-term recovery of information. Retention of CWT in juveniles of five temperate reef and three subtropical nearshore fishes was 95 – 100 per cent up to 365 d; retention of VI tags in seven species was 0–85 per cent up to 365d. Retention of FP tags in juveniles of two temperate reef fishes was 94 per cent at 70 d. Pilot study retention of FP tags in one sea cucumber and two shrimp species was 100 per cent up to 50 d. FP tags in juvenile *Sebastes* sp. have been recovered *in situ* during visual transects using ultra-violet dive lights.

Role of the detritivorous macrobenthos in coastal ecosystems: study of the holothuroid *Holothuria tubulosa*, common species of the *Posidonia* Mediterranean seagrass beds.

Ph. D. thesis presented by Pierre Coulon at the Université Libre de Bruxelles (October 1994, in French). Laboratoire de Biologie Marine, CP160/15, 50 av. F.D. Roosevelt, 1050 Bruxelles, Belgium.

The comprehension of the 'detritus food chain' functioning in marine ecosystems is very often limited to its microbial aspect, neglecting the potential role of detritus-feeding macro-organisms. The lack of basic information (population dynamics, feeding behaviour, nutrition processes, growth) about the biology of detritus feeders—even the most conspicuous species—is one of the reasons they are generally not considered in general schemes of marine ecosystems.

The biology of the deposit-feeding holothuroid *Holothuria tubulosa*, one of the most common species in the Mediterranean, has been investigated at both the population and the organism level.

The population studied inhabits a continuous *Posidonia oceanica* seagrass meadow off Ischia Island (Gulf of Naples, Italy). The mean size of *H. tubulosa* collected in the meadow increased regularly with sampling depth (1.85, 4.88 and 11.36 g body-wall dry weight at 5, 20 and 33 m depth, respectively).

The size-frequency histograms established monthly at the 3 depths considered are always unimodal and do not permit recognition of any peak of recruits. However, annual fluctuations of population density suggest that a significant fraction of the holothuroid population is renewed each year. Actually, 50 per cent, 25 per cent and 5 per cent of the *H.tubulosa* collected at 5, 20 and 33 m depths respectively

during the sexual-maturity season do not develop a visible gonad and are thus supposed to be newly recruited juveniles.

These juveniles are not biometrically different from the older, sexually mature individuals of corresponding depths. This emphasises the fact that individual size is not a good indicator of holothuroid age. Furthermore, it suggests that *H.tubulosa* may grow at a fast pace until they reach a critical size, depending on local, depth-related, environmental constraints.

Energy income (gut absorption) and outcomes (respiration, gonadic production and nitrogenous excretion) were measured, in winter and in summer, on *H.tubulosa* individuals living in the shallow (5m), intermediary (20 m) and deep meadow (33m).

The energy available for somatic production was subsequently calculated to equilibrate the energy balance. The daily potential growth of an individual of a given size at a given depth may then be estimated after transformation of energy to biomass (1 g body-wall dry weight = 10.16 kj).

The results obtained show that *H.tubulosa* potential growth is very low or nil during winter but can be very fast in summer. A theoretical growth curve was calculated for a juvenile *H.tubulosa* of 0.19 g dw (the smallest individual ever collected) recruited in the shallow meadow and migrating toward the deep meadow border during its first year of life (the year has been arbitrarily divided into six months' 'winter' and six months' 'summer') (see Figure 1).

The curve shows that our 'theoretical juvenile' could reach 11.57 g body-wall dw after 11 months of post-metamorphic growth. That large size (equivalent to 230 g total fresh weight) is remarquably similar to the mean size of large individuals living at the deep meadow border (11.36g dw).

However, it should be emphazised that our calculation does not figure the actual growth of *H. tubulosa* individuals in the *Posidonia* meadow, but only the maximal potential growth of migrating juveniles.

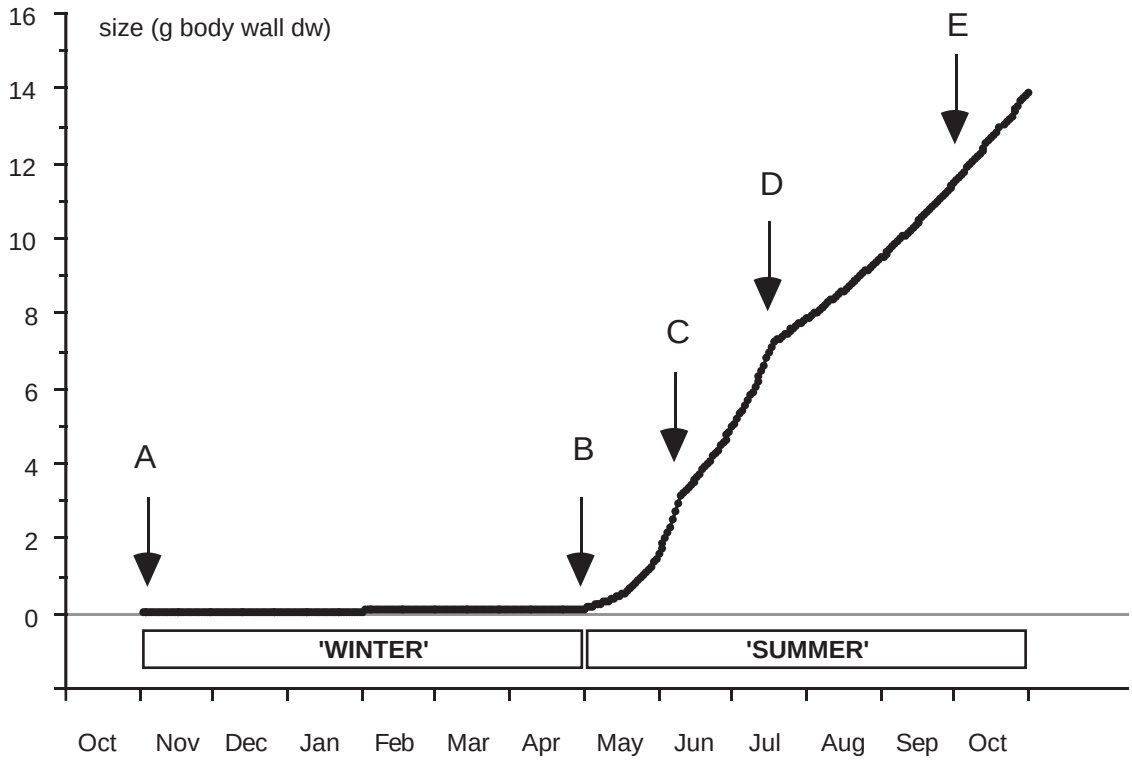


Figure 1. Theoretical growth curve of *H. tubulosa* during its first year of life

A–B	**:**	**Slow growth period in the shallow meadow (winter)**
B–C	**:**	**Fast growth period in the shallow meadow (summer)**
C–D	**:**	**Fast growth period in the intermediary meadow (summer)**
D–E	**:**	**Fast growth period in the deep meadow (summer)**
E	**:**	**The mean size of *H. tubulosa* of the deep meadow is reached**

Biology of small juveniles of the tropical holothurian *Actinopyga echinites*: growth, mortality and habitat preferences

by W. L. Wiedemeyer

In: *Marine Biology* (1994) 120: 81 – 93

Several morphological, physiological and ecological experiments on the general biology of small juveniles (drained body weight = 0.09 to 17.34 g) of *Actinopyga echinites* (Jäger 1833) (Echinodermata, Holothuroidea) were conducted between August 1991 and July 1992 at Bise reef flat, Okinawa, southern Japan. Supplementary experiments were carried out at the laboratory. The experiments were designed with a view to potential stock enhancement projects of *A. echinites* and other commercially exploited tropical sea cucumbers of the coral reef zone. During the enclosure experiments, the average percentage of drained body weight to fresh body weight of the juveniles was 48.3 per cent. The specimens displayed a growth rate of 1500 per cent during the 11-month period. Their drained body weight increased from 0.87 to 12.82 g.

The juveniles' internal and skeletal morphology differed considerably from the morphology of adult *A. echinites*. Two new types of skeletal spicules were discovered. Individual growth of all spicule types monitored differed notably, and shrinkage was observed for the two newly discovered types. Relative frequency of the spicule types within the skeletons changed with increasing body weights of the individuals.

The juveniles of *A. echinites* displayed a strong habitat preference for plate-like substrate types such as eroded limestone or dead coral plates. Skeletons of *Acropora* spp. were accepted at a much lower rate. Weight-frequency distributions of the specimens on varying substrate types and between various times of the day showed significant differences. Cryptic behaviour of the juveniles was observed at all times of the day.

Natural mortality of the holothurians, excluding predation and minor dislodgement effects, was low, at 0.6 per cent per month. When predation effects were introduced to the experiments, mortality reached a rate of 0.3 per cent per month. The average percentage of predation effects within the natural mortality total was 76.8 per cent.

Juvenile *A. echinites* exhibited a maximum short-distance migration speed of 9 cm / h. This was two orders of magnitude slower than the speed observed in adults (900 cm / h) when differences in total body length were taken into consideration. The holothurians had two activity peaks during the four-hour periods monitored, around sunrise and sunset.

Reproduction and growth of *Holothuria atra* (Echinodermata: Holothuroidea) at two contrasting sites in southern Taiwan

by S. M. Chao, C. P. Chen & P. S. Alexander

In: *Marine Biology* (1994) 119: 565 – 570

Reproductive periods and growth of two populations of *Holothuria atra* Jäger distinctly different in body size at two sites of southern Taiwan were determined. Individuals examined in the present study were collected between March 1990 and February 1992. At Nanwan (21°57' N, 120 ° 45' E), large individuals (351 to 1400 g wet wt) spawned from June to September. At Wanlitung (22° N, 120° 42' E) a small proportion of frequently dividing individuals (<190 g wet wt) had mature gonads in May, June and September, but histological examination revealed no sign of spawning. Sexual recruits, defined as small individuals <5 g wet wt without sign of regeneration, were not found at either site during this 2-year study.

After the peak of fission at Wanlitung, 40 per cent of the population showed signs of external regeneration. At Nanwan, small individuals transferred from Wanlitung grew from 6 g (n = 6) to 166 ± 8g within 8 months and from 48 ± 4 g (n = 50) to 324 ± 16 g within 1 year, with a 6.8-fold biomass increase in 1 year. At Wanlitung, the monthly average body weight of *H. atra* was between 33 and 62 g, apparently due to frequent fission, and the biomass increased only 2.9 fold in 1 year. In southern Taiwan, sexual reproduction of *H. atra* occurs in large individuals. Asexual reproduction in small individuals is the chief mechanism for population maintenance and increase, but it may decrease sexual reproductive potential.

Association of the commensal scaleworm *Gastrolepidia clavigera* (Polychatea: Polynoidae) with holothurians (Holothurioidea: Holothuriidae, Stichopodidae) near the coast of South Vietnam

by Temir A. Britayev & Elena A. Zamishliak
A. N. Severtzov Institute of Ecological and Evolutionary Problems, Russian Academy of Sciences, Lenin Avenue 33, 117071 Moscow, Russia

The Indo-West Pacific commensal scaleworm *Gastrolepidia clavigera* (Schmarda, 1861) is here recorded for the first time from the shallow waters of Vietnam (Nha Trang city). It is associated with the sea cucumbers *Stichopus chloronotus* (Brandt), *S. variegatus* (Semper), *Holothuria atra* (Jäger), *H. leucospilota* (Brandt) and *Actinopyga echinites* (Jäger). The last two species are reported as hosts for the first time. The worms were usually attached to the host surface near the oral or cloacal openings and their coloration was in close accordance with that of the hosts. Swollen white tips of dorsal cirri and head appendages of worms associated with *H. atra* mimic its sand-grain-covered papillae.

Commensal worms show two main types of trauma: large traumas of the posterior body end, probably caused by predators, and small ones (damage of parapodia, dorsal cirri and head appendages), probably a result of intraspecific aggressive interactions. Each host harboured 1–3 worms. About half of the infested hosts (51.4%) harboured a pair of worms, one male and one female. The frequency of occurrence of *G. clavigera* on hosts varied from 31.9 per cent on *A. echinites* to 80.0 per cent on *S. variegatus*. Infested sea cucumbers were larger than non-infested ones.

A positive correlation between size of males and females from every pair was found; a correlation between size of holothurian hosts and size of their commensals was not observed. The relationship between *G. clavigera* and its hosts is evaluated as commensalism.

Shallow-water holothuroids (Echinodermata) of Kosrae, Eastern Caroline Islands

by Alexander M. Kerr

In: *Pacific Science* (1994), vol. 48, no. 2: 161 – 174

Line transects and qualitative surveys were used to determine species composition and abundance distributions of holothuroids on the fringing coral reefs of Kosrae, Federated States of Micronesia. On the reef flats, in a total sample area of 2982 m^2, 9,383 holothuroids, comprising 13 species, were recorded. An additional 13 species were recorded off the transects between depths of 0 and 30 m. Species richness varied considerably between sites and physiographic zones and was significantly correlated with reef-flat width. *Holothuria (Halodeima) atra* (Jäger) was the most abundant species recorded, composing 92.1 per cent of the holothuroids on the transects. Other species were considerably less abundant: *H. (Playperona) difficilis* (Semper), *H. (Thymiosycia) hilla* (Försskal), *Afrocucumis africana* (Semper), and *Actinopyga mauritiana* (Quoy & Gaimard) made up 6.1, 0.8, 0.3 and 0.2 per cent of the enumerated taxa, respectively. Each of the other species composed ≤0.1 per cent of the fauna. Kosrae had very low densities of most commercially valuable holothuroids; only two marketable species, *Actinopyga mauritiana* and *H.(Metriatyla) scabra* (Jäger) were found there in relative abundance. Twenty-eight species of holothuroids are now reported from Kosrae.

Application of menthol as an anesthetizer for body size measuring of sea-cucumber juveniles

by Hiroyuki Hatanaka & Kenichi Tanimura

In: *Suisanzoshoku* 1994 – H6: 221 – 225

It is difficult to obtain stable body length values of the sea cucumber *Stichopus japonicus*. Menthol was applied as an anaesthetiser to keep the body shape of sea cucumbers in stable condition during size measurement. Basic menthol solution was made by mixing 0.5 g of menthol in 1 l of seawater.

A series of menthol solutions (100. 80. 60. 40%) was prepared by diluting the basic solution with sea water. The body length of the organisms placed in the anaesthetic solution was measured at ten-second intervals, until the length became stable.

All the anaesthetised sea cucumber juveniles came back to their natural shapes—not expanding or contracting—without any mortality for many months. Based on the changing pattern of body length in an anaesthetiser and recovery, the 80 per cent menthol solution gives the best anesthetic conditions for measuring the body length of sea-cucumber juveniles.

Distribution of Japanese common sea cucumber *Stichopus japonicus* in Saroma Lagoon

by Seiji Goshima, Yoshihiro Fujiyoshi, Nahomu Ide, Ruth U. Gamboa & Shigeru Nakao

In: *Suisanzoshoku*, 1994 – H6: 261 – 266

The distribution pattern of the Japanese common sea cucumber *Stichopus japonicus* was studied to obtain essential information for fishery management in Saroma Lagoon, where fishing of the sea cucumber has been prohibited since 1989 because of depleting resources. Distribution of the sea cucumber was surveyed by dredge and diving at various locations within the lagoon. The sea cucumbers were distributed mainly on oyster *(Crassostrea gigas)* reefs located at depths of 8–10m, while almost no sea cucumber was found in flat mud, muddy sand or sand bottoms. The reefs composed of dead oyster shells have a mean diameter of 16 m and mean height of 2m. Many other megabenthos organisms, such as sea urchins, starfishes, tunicates and mussels, were commonly distributed on the reefs, making up a peculiar benthos community. These results suggest a strong correlation between sea cucumbers and oyster reefs. The possible interactions between them are discussed from the viewpoint of suitable environmental conditions and food supply.

Several inducers initiated settlement and metamorphosis of Doliolaria larvae of sea cucumber *Stichopus japonicus*

by Shiro Ito, Itsuro Kawahar, Izumi Aoto & Kazutsugu Hirayama

In: *Suisanzoshoku*, 1994 – H6: 299 – 306

Settlement and metamorphosis of planktonic larvae of the sea cucumber *Stichopus japonicus* at the Doliolaria stage was induced by culturing them with several kinds of inducers. The inducing effects of these were examined by counting the number of individuals which metamorphosed to juveniles after being transferred to the petri dishes containing different kinds of inducers. Inducing effect was observed with several kinds of brown algae (*Sargassum patens, Sargassum ringgolianum, Hizikia fusiformis, Myagropsis myagoides, Colpomenia sinuosa)* but their effects were extremely low compared to that of attaching diatoms.

An attaching diatom community propagating on the 'Nami-ita' plate showed high inducing effect if

diatoms collected from the natural coast area were used as the starting material. Natural diatoms with higher density showed higher inducing effect. However, diatoms showed no effect if a single species, such as *Achnanthes biceps*, *Navicula ramosissima* or *Nitzschia* sp., which had been isolated and cultured under artificial conditions, was used as the starting material. To exhibit the inducing effect, contact between Doliolaria larvae and an inducer such as attaching diatoms is necessary.

K^+ did not show any inducing effect on the sea cucumber larvae in spite of its effect on sea urchin larvae. The 'Nami-ita' plate for settlement of the larvae should be set vertically, not horizontally, so that the juveniles can scatter uniformly over the plate.

Larval stage of sea cucumber *Stichopus japonicus* suitable for inducement to settlement and metamorphosis

by Shiro Ito, Itsuro Kawahara & Kazutsugu Hirayama

In: *Suisanzoshoku*, 1994 – H6: 287 – 297

Optimal water temperature and salinity for settlement and metamorphosis of the larvae of two types (green and red) of the sea cucumber *Stichopus japonicus* were investigated on an experimental scale. From the developmental stages of post-Auricularia and Doliolaria, metamorphosis was induced and the larvae settled by transferring them to petri dishes having diatoms attached at the bottom.

The low levels of temperature and salinity at which complete metamorphosis can take place without any influence from environmental factors were lower for the Doliolaria stage than for the post-Auricularia stage in both types of sea cucumber. The proportion of individuals metamorphosed completely into juveniles was higher at the Doliolaria stage than at the post-Auricularia stage. These results suggest that the process of settlement and metamorphosis in the larvae was induced after they had grown up to the Doliolaria stage through the post-Auricularia stage. The exact opportunity for inducing Doliolaria larvae to metamorphose can be detected as the growth stage when the length of planktonic larvae reduced to about 500 µm after they had initially grown to a maximum length of about 900 µm.

These experiments successfully achieved seedling production of sea cucumber from the culture of planktonic larvae in the order of 105 individuals.

Histochemical detection on the ontogenic development of digestive enzymes in the intestine of a juvenile sea cucumber *Stichopus japonicus*

by Motohiro Shimizu, Ikuko Mikami & Kazuhiro Takahashi

In: *Bulletin of the Faculty of Fisheries* 1994, 45 (1): 1 – 8. Hokkaido University

Activities of digestive enzymes such as peptidase and lipase were histochemically detected in intestines of adult and cultured juvenile sea cucumbers *Stichopus japonicus*, in the determination of ontogenic development of the digestive activity for proteins and lipids. The intestines of specimens larger than 0.008 g body weight were dividable into three parts (anterior, mid- and posterior intestines), while those of specimens smaller than 0.004 g body weight were undifferentiated, having a thin layer of flattened epithelial cells. Although adult specimens had well-developed villi in all intestines, young specimens showed some variations among the three intestines in villus-development; villi of the anterior and mid-intestines developed somewhat earlier than that of the posterior intestine.

Peptidase activity was conspicuous in the digestive epithelium throughout all intestines in specimens larger than 0.9 g body weight, but there were some variations among the three intestines in specimens smaller than about 0.2 g body weight; the activity

developed earlier in the anterior intestine than in other intestines. However even in flattened digestive epithelia of specimens smaller than 0.004 g body weight, the peptidase activity was confirmed to exist. Lipase activity was observed to be intense in the anterior and mid-intestines in all specimens examined, but it developed somewhat later in the posterior intestine.

The results obtained in the course of the present study suggest that small juvenile *S. japonicus* already have the digestive enzymes for proteins and lipids, and that their activities advance as the villus formation progresses.

Stiffness changes of holothurian dermis induced by mechanical vibration

by Rie Shibayama, Takakazu Kobayashi, Hiroaki Wada, Hiroko Ushitani, Jun Inoue, Toshimitsu Kawakami & Haruo Sugi
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In: *Zoological Science* 1994, 11: 511 – 515.

The effect of mechnical vibration on the stiffness of catch connective tissue in the dermis of a sea cucumber *Stichopus japonicus* was studied using the dermis strip preparation held between a force transducer and a vibrator. During the application of vibration (peak-to-peak amplitude, 2– 10%; 2 – 20 Hz), the stiffness of fresh, stiffened preparations increased by 40 – 200 per cent, and then stayed constant or slowly decreased. After the stiffness reached a maximum, pause of vibration (5 – 20 min) had no effect on the steady level of stiffness, except that the stiffness initially showed a higher value on re-application of vibration. The stiffness of non-fresh, softened preparations showed a much more marked transient increase during the period of vibration. Electrical stimulation either increased or decreased the stiffness by 10 – 20 per cent in some preparations examined. The vibration-induced stiffness changes were not affected appreciably by Ca^{2+}-free, high-Ca^{2+} (100 mM) and high-K^{+} (100 mM) solutions, acetylcholine (10^{-3} M), and low temperatures (1° – 2°C). These results are discussed in connection with nervous control of the dermis stiffness.

Reproductive cycle of the tropical holothurian *Holothuria leucospilota* in Nha Trang Bay (Southern Vietnam)

by Nguyen Viet Nam & T. A. Britayev
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In: *Biologiya morya*, Vladivostok, 1992, No. 5 – 6: 70 – 77.

The reproductive cycle of a shallow-water tropical holothurian *Holothuria leucospilota* (Brandt) was investigated. The material was collected monthly in Nha Trang Bay from June 1982 to May 1984. Analysis of the seasonal changes in gonad state was conducted, using wax sections of gonads, and the dynamics of the gonadal index were studied. No evidence of hermaphroditism was recorded. The average male / female ratio was about 0.87, however, this characteristic varied significantly depending on the season and the site of sampling. It was found that *H. leucospilota* spawns twice a year: in spring (February–March) and in summer (June–August). The spring spawning is rather short and synchronised, while the summer one is more prolonged. However, the relative number of individuals participating in summer spawning is higher. The average diameter of prespawning oocytes is 112.8 µm, that of released oocytes is up to 144 µm. Asexual reproduction was not observed. The characteristics of the reproductive strategy of *H. leucospilota* are compared with those of some other tropical species of the same genus.

Holothurian resources in the sea of South Vietnam

by Dao Tan Ho, Institute of Oceanology, Nha Trang

from the Symposium of Marine Science in Vietnam (3rd), Hanoï, 1991: 112 –118.

So far 53 species of holothurians have been found in the sea of South Vietnam. In the coastal region of Phu Yen-Khanh Hoa provinces, holothurians were the dominant animals of the benthic community. They consisted mainly of species of commercial value such as: *Actinopyga echinites, A. mauritiana, Holothuria scabra, Microthele nobilis*. Holothurians are also abundant in Phu Quoc Island.

Echinoderm conferences

The **8th International Echinoderm Conference** was held at Dijon, France, (September 1993)—see Information Bulletin #6 (April 1994). The proceedings are now published and available : A.A. Balkema, P.O. Box 1675, Rotterdam, Netherlands. Price: Hfl.230 / USD135.

The **International Workshop on Biotic and Abiotic Interactions during Larval and Adult Stages of Marine Benthic Invertebrates** was held at Villefranche-sur-mer, France, 19 – 24 Sep. 94.

The three main themes were:

- role of reproduction on the life cycle;
- biotic and abiotic factors regulating the life cycle;
- the effect of interactions in structuring a community.

The presentations and the discussions were largely focused on echinoderms.

The contributions will be published in the journal *Oceanologica Acta*.

The **4th European Echinoderms Colloquium** will be held in London, 9 – 12 April 1995, at the Natural History Museum. For information contact A. Smith, Department of Paleontology, Cromwell Road, London SW7 5BD, UK.

The **9th International Echinoderm Conference** will be held in San Francisco, in 1996. For information contact Dr R. Mooi, Department of Invertebrate Zoology, California Academy of Sciences, Golden Gate Park, CA 94118–4599 San Francisco.

Welcome to new members

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