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BECHE-DE-MER

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NOTE FROM THE CO-ORDINATOR

Membership of the S.I.G. on Beche-de-mer has increased since the last issue, reflecting the interest and expansion of the group in and outside the South Pacific region. Thanks are due to the members who have contributed articles, letters or various information in the diverse range of disciplines dealing with sea cucumbers.

The reproductive biology of holothurians remains an important focus of scientific research, necessary for fishery management or aquaculture experiments. Spawning observed in the field is poorly documented and a request for information on spawning is included in this issue (page 4), with the hope to put together and then circulate the information.

In the last issue, the first part of the summary of a Japanese handbook on *Stichopus japonicus* described the biology and the rearing of larvae and juveniles. It is continued in this issue (page 5) with data on the fishery and its management, and on earlier Japanese regeneration experiments on this species.

Attempts to tag holothurians have used various tags which are retained for more or less time according to the species tegument and tag used. Results of an internal micro-tag experiment started in Papua New Guinea seem promising (page 9).

The beche-de-mer fishery industry in Fiji shows boom-bust cycles which raise resource problems described here (page 13). Options for management and for dealing with socio-economic problems are presented. Opinions and comments from other experiences will be welcome.

Chantal Conand

Inside this issue

PIMRIS is a joint project of 4 international organisations concerned with fisheries and marine resource development in the Pacific Islands region. The project is executed by the South Pacific Commission (SPC), the South Pacific Forum Fisheries Agency (FFA), the University of the South Pacific's Pacific Information Centre (USP-PIC), and the South Pacific Applied Geoscience Commission (SOPAC). Funding is provided by the International Centre for Ocean Development (ICOD) and the Government of France. This bulletin is produced by SPC as part of its commitment to PIMRIS. The aim of PIMRIS is to improve the availability of information on marine resources to users in the region, so as to support their rational development and management. PIMRIS activities include: the active collection, cataloguing and archiving of technical documents, especially ephemera ("grey literature"); evaluation, repackaging and dissemination of information; provision of literature searches, question-and-answer services and bibliographic support; and assistance with the development of in-country reference collections and databases on marine resources.

PIMRIS

Pacific Islands Marine Resources Information System

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

I N F O

Bohadschia argus

Developments in beche-de-mer production in Indonesia during the last decade

by A. Tuwo and C. Conand,
Université de Bretagne Occidentale,
Brest, France

Although Indonesia is now the main world beche-de-mer (or teripang in Indonesia) producer and exporter, the fishery is still poorly documented. The holothurian fishery in Indonesia is mostly intended for the processing of beche-de-mer for export, although the Chinese minority consume it and some Indonesian fishermen also appreciate it.

Available statistics from the last decade are presented in Table 1 and show the recent trends. Indonesian export statistics from the Trade Department are divided into total exports and exports to the main world beche-de-mer markets, Hong-Kong, Singapore and Taiwan (1). Import data from these markets, Hong Kong (2) and Taiwan (3) and FAO data on catch and export are complementary sources of information. According to the national statistics, annual production has multiplied by five between 1981 and 1987. Since 1987, it has stayed around 4,700 t per year. This corresponds to around 50,000 t captured (to take into account the weight loss which occurs during processing). From FAO export data and from the pooled imports from Hong Kong and Taiwan, peak production seems to have taken place in 1988, as in other countries. The major part of the production is exported to Hong Kong. Taiwan imports seem to be decreasing at present. In Singapore's import statistics, beche-de-mer is not always specified in shipments of dried sea food, as is the case with the imports from Indonesia.

In Indonesia, as in the other tropical Indo-Pacific countries, various large species of holothurians are fished. These artisanal fisheries are scattered throughout the different islands : Lampung, Java, Nusatenngara, Sulawesi, Maluku, Irian Jaya. Two types of fishing practices are undertaken.

With small boats, a few fishermen (3 or 4) go to the reef, for daily harvest, without diving equipment. The processing is done when they return.

With larger boats, around ten fishermen go far away, often with their family, for one or even several months. They use diving gear (compressed air) and sell the processed product in the nearest town. Around ten species of sea cucumbers are processed by the traditional Indonesian methods, which may include two unusual features : soaking in salt before boiling (Figure 1) and incisions in the body wall for larger species before boiling (Figure 2). These practices give an unusual appearance to the processed product and probably result in lower quality. Improvement of the processing methods would provide higher quality products and more cash income for the fishermen.

Table 1. Beche-de-mer production in Indonesia, from different sources (in tonnes)

Source	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
National statistics exports (1)										
Total exports	878	840	1,518	2,160	3,890	3,670	4,605	4,755	4,888	4,679
Exports to Hong-Kong, Singapore and Taiwan	658	608	1,232	1,266	3,185	2,342	2,877	3,644	3,040	3,438
Hong Kong imports (2)	295	393	599	1,046	2,421	2,472	2,173	3,131	1,785	2,143
Taiwan imports (3)	–	–	370	331	389	348	505	502	202	144
Total (2+3)	–	–	969	1,377	2,810	2,820	2,678	3,633	1,987	2,287
FAO: catch	285	275	232	456	351	478	512	590	590	–
exports	545	623	1,274	1,318	3,123	2,362	2,517	3,480	–	–

Culture of *Holothuria scabra* (sandfish) in enclosures is practised in South-East Sulawesi. Small individuals, around 6 cm, are collected on their grounds (muddy sands) and transplanted to net enclosures (around 150 m^2), at a density of 5 to 10 per m^2. After six months, they have grown to around 20 cm and are ready to be harvested for processing. These low-cost cultures have also been practised in India. Detailed studies on the growth of the species, in and outside the enclosures, are still needed, as well as price analyses.

Figure 1. Soaking of various sea cucumber species in salt before boiling (Sulawesi, Indonesia)

Figure 2. Boiling a large prickly redfish (Sulawesi)

Request for information on spawning behaviour of tropical holothurians

by M. Byrne [1] and C. Conand [2],
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Substantial advances have been made recently in knowledge of the reproduction and development of holothurians (Franklin, 1980; Conand, 1981,1990; Shelley, 1981; Harriot, 1982,1985; Ong Che and Gomez, 1985; Costelloe, 1985; Smiley and Cloney, 1985; Cameron and Fankboner, 1986,1989; Smiley, 1986,1988; McEuen, 1988; Sewell and Berquist, 1990). Although these publications include studies on tropical holothurians (Franklin, 1980; Conand, 1981,1990; Shelley, 1981; Harriot, 1982,1985; Ong Che and Gomez, 1985), most research has concentrated on the reproduction of temperate species (Smiley and Cloney, 1985; Cameron and Fankboner, 1986,1989; Costelloe, 1985; Smiley, 1986,1988; McEuen, 1988; Sewell and Berquist, 1990).

A recent review on the spawning behaviour of north-east Pacific holothurians by McEuen (1988) provides a substantial database for the region and also includes a survey of available information on spawning in tropical holothurians.

This review is particularly useful for the north-east Pacific in that it provides predictive information on the reproductive cycle and potential appearance of larvae in the plankton for species whose reproductive cycle has not been documented. It also includes information on the possible suite of environmental cues that trigger spawning by holothurians.

A similar review on spawning of tropical holothurians, especially one based on observations from countries with beche-de-mer fisheries, would be of great value in providing data on reproductive activity of commercial species, especially those species for which there is no information.

In conversation with several colleagues working in the tropics it was evident that they, and other workers, have encountered spawning holothurians during field research or other activities. These observations could be used as an initial database on reproduction and spawning in tropical holothurians. Over the next few months we would like to put together as much information as possible on spawning of tropical holothurians. If any of our readers have observed spawning in the field, please send us the details.

We need as much of the following information as possible:

1. What species was involved?
2. How many individuals were spawning? If more than one individual was spawning, how close were the spawning individuals to each other?
3. How many individuals were not spawning?
4. When were the observations made?
5. What was the locality?
6. Describe the spawning behaviour.
7. What were the environmental parameters i.e:
   (a) Time of day: dawn, daytime, dusk, night-time?
   (b) What stage of the lunar cycle: first quarter, full moon, last quarter?
   (c) What was the state of the tide: low, mid, high?
   (d) What was the depth: on the sea floor, on top of coral, etc.?
8. Were any other echinoderms spawning?

Please send your observations to: M. Byrne, Histology F-13, University of Sydney, NSW 2006, Australia, or to: C. Conand, Laboratoire d'Océanographie Biologique, UBO, Brest, France.

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A Handbook on the Japanese Sea Cucumber - Its Biology, Propagation and Utilisation (K.Y. Arakawa, 1990)

translated by M. Izumi, South Pacific Commission, Noumea, New Caledonia

In the last issue of the Beche-de-mer Information Bulletin *(No 3, November 1991) a summary of the general biology of* Stichopus japonicus, *experiments on seed collection and culture of larvae and juveniles, as described in the above publication, was given. The Appendix is summarised below.*

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4. Appendix

4.1 **Propagation**

4.1.1 Resource preservation and management

Prohibition of sea cucumber fishing in certain seasons or areas under local fishing regulations is very effective in terms of resource management, as well as protecting areas for juvenile release and seedlings.

4.1.1.1 Prohibited fishing area

An example of the effectiveness of prohibited fishing areas comes from Oura Bay, Saga Prefecture in Kyushu. Stones were scattered over the sea-bottom in an area of 700 m^2 and 1,700 juveniles were released. Fishing was prohibited for two years in an area of 1,500 m^2 which included the area of release. At the end of the prohibition period, 90 fishing boats made a total catch of 1,600 kg, approximately 30 times higher than previous catches.

In another example, in Migayi Prefecture in 1938 (also in an area where stones had been scattered over the sea-bed), fishing of adult sea cucumber was prohibited for three years in an area of 1,938 m^2. After the prohibition was lifted, catches increased by 2.5 to 3.7 times.

4.1.1.2 Prohibited fishing season

Most local regulations provide for prohibited fishing seasons between March and November, since there is a spawning season from March to July and a season of high water temperatures from August to September. The local prohibited fishing seasons are shown in Figure 1.

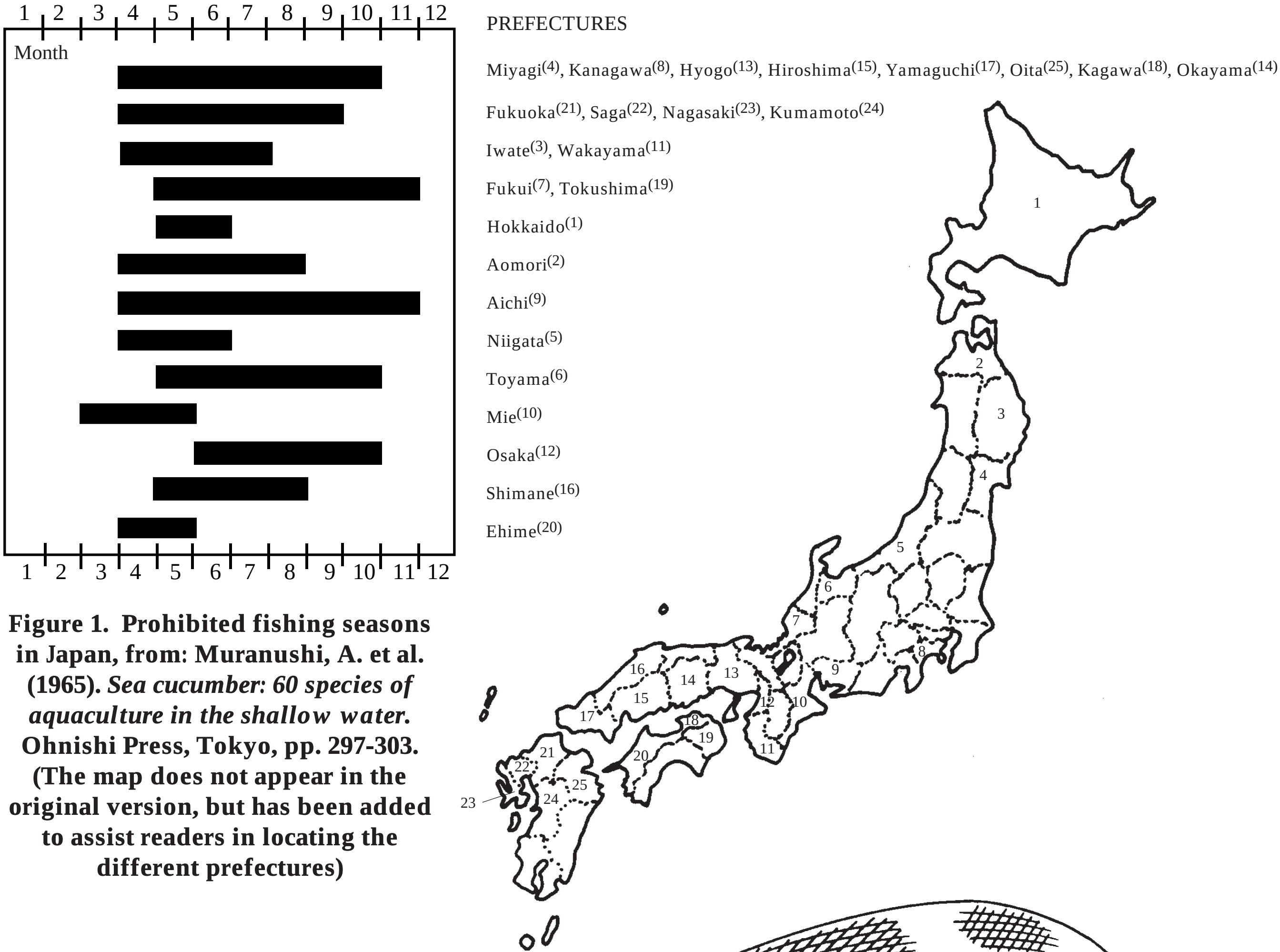

Figure 1. Prohibited fishing seasons in Japan, from: Muranushi, A. et al. (1965). *Sea cucumber: 60 species of aquaculture in the shallow water.* Ohnishi Press, Tokyo, pp. 297-303. (The map does not appear in the original version, but has been added to assist readers in locating the different prefectures)

4.1.2 Traditional fishing gear and methods

Fishing gear and methods including small bottom trawl nets for sandy bottoms, spears, hooks and scoop nets for reefs and diving gear have been developed with local originality, as shown in the table on page 7 and figures 2–4.

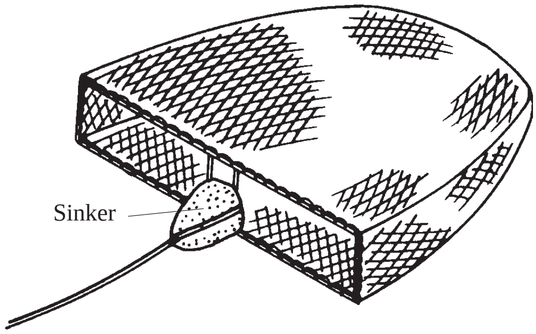

Figure 2. Beam trawl net

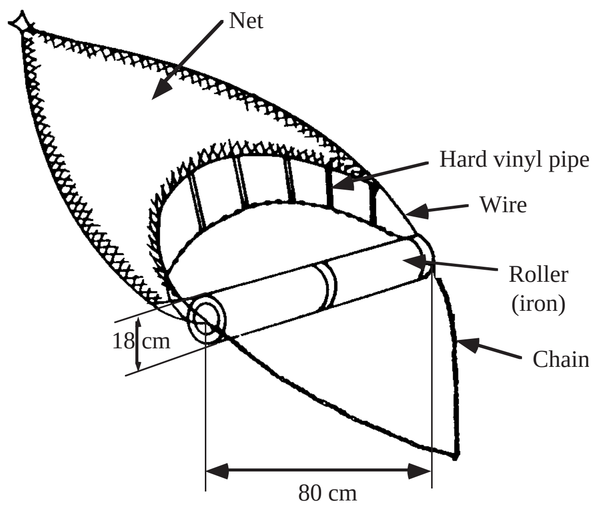

Figure 3. Roller-pulling net

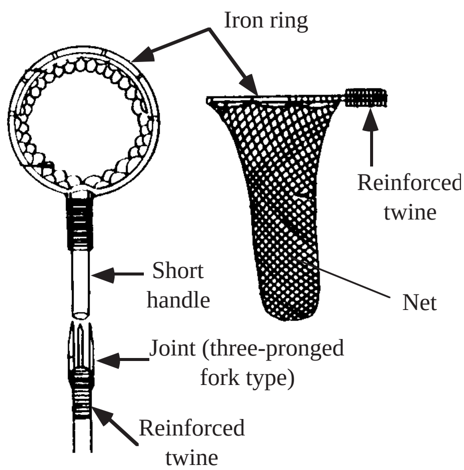

Figure 4. Scoop net

In many prefectures, there are local restrictions or prohibitions on certain types of fishing operations and fishing gear (see table below).

Prefectures	Gear
Kumamoto	Single type of beam trawl net (koketa-ami ichijyo-gata) (Figure 2)
Aichi	Parallel type of beam trawl net (koketa-ami nijyo-gata)
Aomori, Yamaguchi, Nagasaki, etc...	Bottom trawl net (sokobiki-ami)
Hokkaido, Miyagi, Aichi, Ishikawa, etc...	Beam trawl net (ketahiki-ami or keta-ami)
Hokkaido, Aomori	Japanese eight foot net (hassaku or hassaku-ami)
Aichi, Mie, Shimane, Saga, etc...	Trawl net (hiki-ami)
Okayama	Roller-pulling net (roller-kogi) (Figure 3)
Others	(uchise-ami, teguri-ami, funa-biki, mutsu-ami, etc...)

4.1.3 Regeneration experiments

In regeneration experiments at the Souya Fisheries Cooperative in Hokkaido, Japan, since 1984, approximately 2,000 pieces of 1,300 sea cucumbers' bodies cut in sections were released. The survival rate of tail and head parts was confirmed as about 60% and about 25% respectively after 3 months. On average, they recovered about 80% of their weight.

4.1.3.1 Regeneration of body parts

It was reported that the regeneration rate of cut sea cucumber was 80 to 90% in about 100 breeding days. The result of the regeneration experiments is shown in the following table.

Cutting position	No. of sea cucumber	No. surviving after 5 days	7 days	24 days	32 days	Survival rate after 32 days
	12 (12)	7 (6)	7 (6)	6 (4)	6 (1)	50.0 (8.3)
	12 (12)	12 (12)	11 (10)	9 (4)	8 (2)	66.7 (16.7)
	12	9	9	5	5	41.7
	12	12	12	9	8	67.7
	12	5	5	2	0	0
	12	12	12	10	10	83.3

( ) = red-coloured *Stichopus japonicus* (Aka)

Cited from: Che, S. (1963). *Research on sea cucumber - behavior, biology and propagation of* Stichopus japonicus. Kaibun-do, Tokyo, 226 pages.

4.1.3.2 Regeneration of viscera

A fishing village in Aichi Prefecture, Japan, has a traditional method of removing sea cucumber viscera without killing them. The following process is required:

— Keep collected sea cucumber in a sea-cage for half a day so that they emit all faeces from their intestines;

— Divide sea cucumbers into lots of 10 and place each lot in tray;

— Remove intestines from one or two sea cucumbers, then squeeze the juice from the intestines;

— Put juice into each tray containing about 10 sea cucumbers;

— All sea cucumbers will discharge their intestines from their anus.

If a sea cucumber of more than marketable size has eviscerated its intestines, the fresh tegument and salted viscera are sold separately. Smaller sea cucumbers are returned to the sea to regenerate for a month, and the intestines only sold.

4.2 **Statistics**

4.2.1 Total catch of sea cucumber in Japan from 1978 to 1987

Year	Catch (tons)
1978	10,143
1979	9,381
1980	8,970
1981	8,098
1982	8,437
1983	8,295
1984	7,624
1985	7,862
1986	7,248
1987	7,133

Cited from: *Annual statistical report of fisheries and aquaculture production for 1987*, Department of Statistics and Information, Ministry of Agriculture, Forestry and Fisheries.

4.2.2 Sea cucumber catch in major prefectures in 1987

Prefecture	Catch (tons)
Hokkaido	1,723
Aomori	364
Mie	246
Ishikawa	711
Nagasaki	657
Hyogo	413
Hiroshima	442
Yamaguchi	717
Ehime	259
Oita	417

Cited from: *Annual statistical report of fisheries and aquaculture production for 1987*. Department of Statistics and Information, Ministry of Agriculture, Forestry and Fisheries

4.2.3 Deliveries and sales of fresh sea cucumber, Tokyo Central Wholesale Market (Tsukiji)

4.2.3.1 Total deliveries and sales of sea cucumber

Year	Deliveries (kg)	Unit price (yen/kg)	Total sales (yen)
1978	926,262	536	496,517,850
1979	799,309	647	517,531,164
1980	837,080	707	591,639,060
1981	810,328	709	574,328,277
1982	695,655	768	534,469,103
1983	713,724	817	583,455,585
1984	772,736	769	594,364,040
1985	726,067	751	545,390,865
1986	784,064	757	570,343,588
1987	704,951	753	531,095,020
1988	697,539	850	592,818,633

Cited from: *Annual report for 1988*, Tokyo Metropolitan Central Wholesale Market

4.2.3.2 Total deliveries and sales of salted entrails of sea cucumber

Year	Deliveries (kg)	Unit price (yen/kg)	Total sales (yen)
1978	12,905	6,694	86,384,030
1979	12,079	7,088	85,611,755
1980	9,789	9,050	88,593,050
1981	13,893	8,718	121,125,350
1982	11,893	7,839	93,224,380
1983	56,947	2,156	122,784,268
1984	9,296	6,999	65,064,400
1985	10,241	6,099	62,464,800
1986	9,851	6,435	63,395,405
1987	8,044	7,289	58,629,410
1988	9,750	11,952	116,529,805

Cited from: *Annual report for 1988*, Tokyo Metropolitan Central Wholesale Market

4.2.4 Trade statistics

4.2.4.1 Imports to Japan of frozen sea cucumber

Country	Weight (kg)	Amount (yen)
USA	20,458	32,806,000
Canada	17,120	20,115,000
Korea	10,078	19,988,000
Fiji	6,128	4,182,000
China	169	1,265,000
Total	47,656	78,356,000

Cited from: *Fisheries trade statistics for 1988*, Fisheries Agency of Japan

4.2.4.2 Imports to Japan of salted or dried sea cucumber

Country	Weight (kg)	Amount (yen)
Korea	18,210	93,925,000
Maldives	2,250	4,606,000
USA	1,803	3,402,000
China	315	1,811,000
Singapore	1,212	1,261,000
Total	23,790	105,005,000

Cited from: *Fisheries trade statistics for 1988*, Fisheries Agency of Japan

First results of an internal tag retention experiment on sea cucumber

by P. Lokani,
Fisheries Research Station,
Kavieng, Papua New Guinea

Introduction

Tagging is an established method of studying growth, mortality, and migration in fish. While tagging is applicable to the study of holothurians, a number of problems have been encountered (see Shelley, 1982; Conand, 1983 and Conand, 1991). External tags have been rejected and have caused extensive necrosis (see Shelley, 1982 and Conand, 1983). Tags tested to date include Super-Plastic tags, Vital stain, plastic tags, gun-inserted tag and freeze branding (Shelley, 1982), Swiftachment fasteners (Dennison tagging gun), self-adhesive numbered labels and floy tags (Conand, 1983). Conand (1983, 1991) records floy tags and fasteners retained on the body wall of sea cucumbers for more than one year. Shelley (1982) records Dennison tags retained on the body wall of sea cucumbers for more than six months.

This note outlines the interim result of a tag retention experiment which started in early January 1992 and continues. The main objective of the experiment is to test the ability of holothurians to retain a coded wire micro-tag in the body wall over a period of time. The experiment is being carried out by the Kavieng Fisheries Research Station of the Papua New Guinea Department of Fisheries and Marine Resources with financial support from the South Pacific Commission Inshore Fisheries Research Project. SPC also arranged for a number of micro-tags and a simple tag injector were supplied by North West Marine Technology (NWMT), based in the United States, for this experiment.

Methods

Three species of commercial holothurian, white teatfish (*Holothuria fuscogilva*), prickly redfish (*Thelenota ananas*) and deepwater redfish (*Actinopyga echinites*) were injected with micro tags. Once injected the tags can only be seen by X-ray or a tag detector. This type of tag has mainly been used for tagging fish.

Four body sites were selected in the white teatfish and prickly redfish and three sites in the deepwater redfish (Figure 1). One tag each was injected about 2 cm from the anus and from the mouth, on the dorsal side of the animal, and approximately on the fourth teat on the right facing the anal teat in the white teatfish and facing the anus in the prickly redfish. Deepwater redfish were tagged about 1 cm

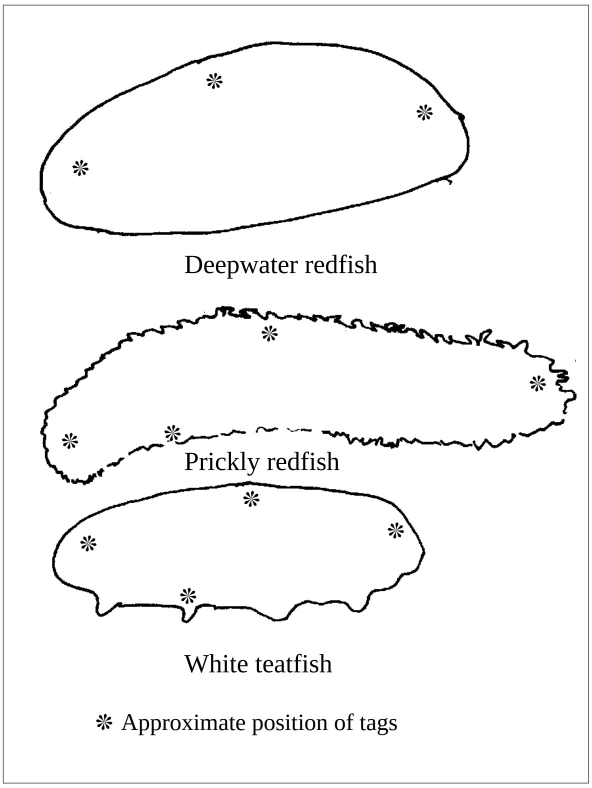

Figure 1. Body sites for the three species of sea cucumbers

from the anal teeth and mouth and in the mid-dorsal section as in the white teatfish and prickly redfish. Five specimens each of the three species were tagged.

The tagged animals were X-rayed after tagging (Figure 2) to confirm that the tags were indeed imbedded in the body wall. One or two animals were put in a bucket of water and transported to the X-ray theatre in a bucket of sea-water. After tagging and X-raying the animals were placed inside 2x 1 m enclosures constructed of arc-mesh wire covered with chicken wire (Figure 3). Each prickly redfish was placed in a separate enclosure while other enclosures each contained one white teatfish and one deepwater redfish. The enclosures for the white teatfish and deepwater redfish were placed at a depth of 2m on a turtle sea grass bed. Enclosures for prickly redfish were placed in a sand bed at 4 m.

After the first day of tagging the animals were X-rayedevery day for the first three days, then every week for three weeks for the white teatfish and the deepwater redfish and for two weeks for the prickly redfish. Prickly redfish were X-rayed

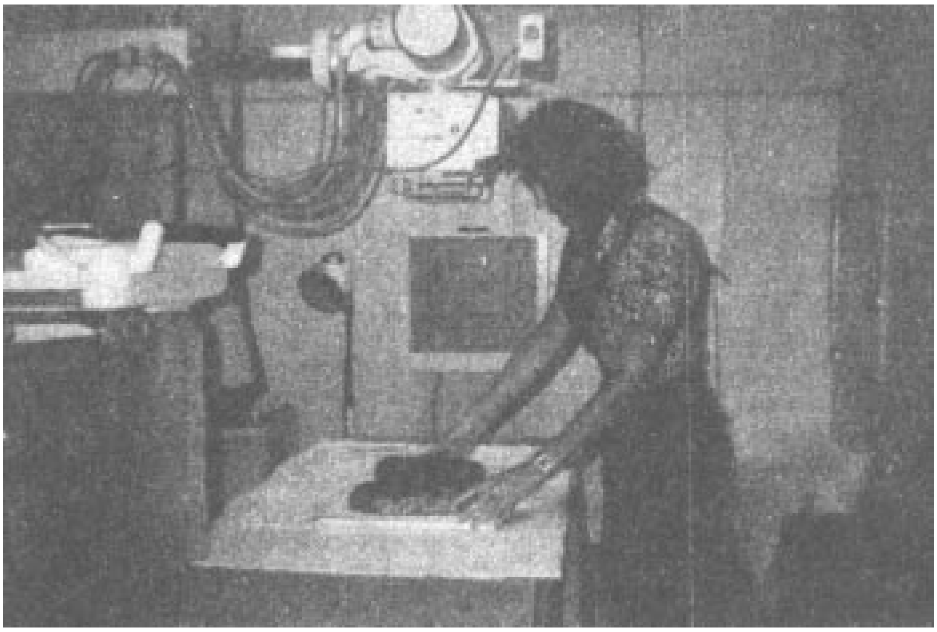

Figure 2. The tagged animals are X-rayed to confirm that the tags have been absorbed by the body.

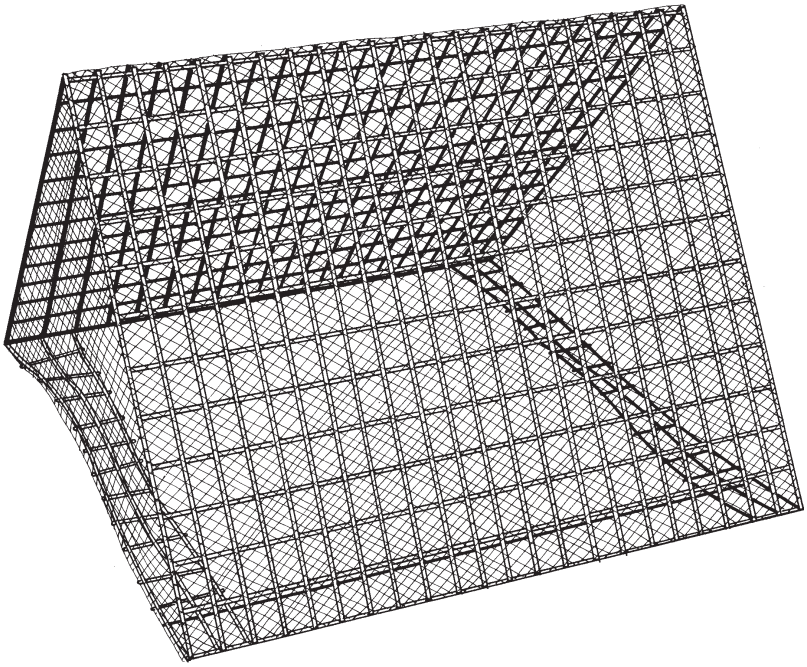

Figure 3. Enclosures constructed of arc-mesh wire covered with chicken wire

again in the sixth and ninth weeks after tagging, and the white teatfish and the deepwater redfish X-rayed in the seventh and eight weeks.

There was no control group of untagged sea cucumbers as the primary concern of the experiment was tag retention in the body wall.

Results

Tags retained in the body wall

The table (next page) shows the percentage of tags retained over time by body site for each species. Two prickly redfish and two deepwater redfish died during the course of this experiment. One deepwater redfish probably escaped.

Percentage of tags retained per tagging site, by species

	Week	1	2	3	4	5	6	7	8	9
White teatfish	Anal teeth	100	100	100	-	-	-	60	60	-
	Dorsal body	100	100	100	-	-	-	60	60	-
	Teat	100	100	100	-	-	-	40	20	-
	Mouth	100	100	100	-	-	-	60	40	-
Prickly redfish	Anal teeth	100	100	-	-	-	100	-	-	30
	Dorsal body	100	100	-	-	-	60	-	-	30
	Teat	100	100	-	-	-	100	-	-	0
	Mouth	100	100	-	-	-	100	-	-	100
Deepwater redfish	Anal teeth	100	-	-	-	-	-	50	-	50
	Dorsal body	100	100	100	100	100	100	100	100	100
	Mouth	100	-	-	-	-	-	50	-	-

The cause of death for prickly redfish was lesions sustained through contact with the meshes of the enclosures, probably due to insufficient availability of food. Deepwater redfish sustained some injuries from the meshes, but these were not as serious as those in prickly redfish. Deepwater redfish deaths were probably due to insufficient food.

The calculations for prickly redfish and deepwater redfish are based on the three and two animals respectively which are still alive.

All body sites tagged for all species retained 100 per cent of the tags for the first three weeks. In the sixth week the tag retention rate in the three live specimens of prickly redfish was still 100 per cent for all sites except the dorsal body which dropped to 60 per cent. By the eighth week tags injected on the teats were completely lost while the percentage of tags retained in the anal teeth and the dorsal body dropped to 30 percent. Only tags injected on the dorsal side of the mouth still remained intact at 100 per cent retention.

In the seventh week the percentage of tag retention for the white teatfish dropped to 60 per cent for all sites except the dorsal body which dropped to 40 per cent. By the eighth week tags retained in the anal teeth and dorsal body still remained at 60 per cent. The percentage of tags in the mouth dropped to 40 per cent, and in the teat to 20 per cent.

Effects of the tags

No obvious physical symptoms due to the injection of the tags were observed. No lesions or ulcers developed in the body sites injected. None of the animals eviscerated their guts after tag injection or during transport and X-raying. It is anticipated that a control group will be set up in other enclosures once more tags become available. The effects of frequent X-raying need also to be investigated.

Discussion

Keeping the animals in the enclosures restricts their movements and therefore limits their food supply. This, in turn, may affect the ability of the animal to retain the tags in the body wall, because of thinning of the body wall.

There also appears to be a difference in the ability of the body sites of the holothurians to retain or eject tags. By the ninth week all tags near the mouth of prickly redfish were still intact while all tags in the teat were all lost and only 30 per cent of the tags were still intact near the anal teeth and dorsal body.

Shelley (1982) conducted tagging trials in tanks with some tagging in the field, while Conand (1983, 1991) also conducted tagging trials in an aquarium and in the field. Both authors stress that the environment cannot be recreated accurately in an aquarium and that this will influence tag loss. Conand (1983) hypothesises that the high percentage of tag loss in the aquarium after 18 weeks was caused by reduced feeding.

The environment for the present experiment was not precisely the same as the natural one. The site was chosen because of proximity to the X-ray Unit. Enclosing the animals makes it easier to observe and X-ray the same animals every time. The primary suspected cause of tag loss in this experiment is the limited food supply in the enclosed area, which leads to very reduced feeding.

Prickly redfish and deepwater redfish sustained injury which resulted in ulcers and death from the mesh of the chicken wire. Meshed enclosures are not suitable for this type of experiment.

The correct exposure of the X-ray film is important. Very often a tag will be hard to see if the film is over-exposed. It was observed that some tags which did not appear on one film appeared on later shots of the same animal. If tags are not observed in the animal during the first "take" a second or third shot of the animal should be made.

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Queensland's beche-de-mer fishery

by Dr. J. Beumer,
Queensland Department of Primary Industries,
Brisbane, Australia

Interest in the commercial harvesting of beche-de-mer species for food and medicinal purposes was renewed several years ago. Harvesting commenced along the East Coast of Queensland as well as in the Torres Strait.

For management purposes the East Coast and Torres Strait are considered as separate entities, although jurisdiction for commercial harvesting of beche-de-mer lies within the Queensland Department of Primary Industries which administers the Queensland Fisheries Act. The following Table contrasts the management methods currently operating for the two harvesting areas.

East Coast	Torres Strait
Permit to individual	Permit to Island Community Council
Industry quota	-
Individual quota	-
Limit of 10 divers	-
Collection only from areas covered by water at low tide	-
Quarterly returns	Quarterly returns
No species restrictions	No species restrictions
No size limits	No size limits
Collection by hand only	Collection by hand only

The present annual industry quota for the East Coast is 500 t (wet weight). Individual quotas allocated are between 15 and 75 t. Additional quota may be requested during the tenure of the permit. Additional allocation is made on the basis of total reported industry collection at time of application for quota increase. All permits are tenured for 12 months and for the fiscal year (July to June). Repeat permits may be granted, subject to satisfactory performance criteria. The maximum annual industry catch reported to date is 130 t.

There are difficulties with the processing of beche-de-mer, particularly in areas away from the larger coastal centres. Export standards for beche-de-mer are set by the Australian Department of Primary Industry and Energy, Exports Section. A joint project between the industry and the Queensland Department of Primary Industries is exploring methods of processing to satisfy export standards. The Northern Territory, which has also recently re-established a beche-de-mer fishery, will participate in this project. It will assess processing techniques and determine specific composition (e.g. amino acids, etc.) and storage methods. Possible interaction with FAO is being explored. Thirteen species are to be analysed. The six of major commercial potential are *Holothuria scabra, H. atra, H. nobilis, H. fuscogilva, H. echinites* and *Thelenota ananas.*

The beche-de-mer fishery is relatively small. Little information is available on stock size or specific distribution and the conservative management reflects this low level of knowledge. The only other pressure on beche-de-mer stocks is from the marine aquarium trade which has a high demand for the more colourful species*. There has also been interest recently in the use of powdered beche-de-mer as a slow-release fertilizer for use by the plant nursery trade.

Note from the editor: most of the species have toxins and holothurians generally bring about mortality of other aquarium fauna.

Resource aspects of the Fiji beche-de-mer industry

by T. Adams, Fisheries Division, Suva, Fiji*

Introduction

Around 10 of the holothurian species found in Fiji are of varying degrees of commercial importance These are white teatfish (**sucuwalu**), black teatfish (**loaloa**), sandfish (**dairo**), blackfish (**driloli**), surf redfish (**tarasea**), stonefish, greenfish, curryfish, lollyfish (**loliloli**) and brown sandfish (**vula**). **Dairo** and, to a lesser extent, **vula** are the only species consumed by Fijians. The rest are export commodities valued as a food-flavouring and medicinal item by ethnic Chinese peoples.

Beche-de-mer was the second most significant factor after sandalwood in attracting Europeans to Fiji in the first half of the last century. Also known as trepang, it was a comparatively high-value, non-perishable commodity and was extremely useful as a trade item with China. Merchant sailing vessels, most of them of United States origin, would set up beche-de-mer collection and drying stations in Fiji, trading firearms for a hold full of dried trepang. The trepang would be traded on Chinese markets, often through Manila, for silks and other useful Chinese products, and the ships would return to their own countries to complete the cycle.

Like sandalwood before it, the natural resource of beche-de-mer was virtually wiped out in the early 1800s, and by the time the resource had recovered to fishable levels the market demand had dropped and other commodities had become trading items.

Until recently, 20th-century markets for beche-de-mer were found only in expatriate Chinese communities and the island outposts of Taiwan and Hong Kong. This market was easily supplied by production from the Philippines, Japan and Indonesia, and production in Fiji was limited to small quantities of the higher value species, mainly the teatfish (**sucuwalu** and **loaloa**). The Fisheries Division, with the help of the South Pacific Commission, spent considerable effort on developing this industry in the period 1978–1985, but never made much headway. Teatfish are deeper-water species preferring smaller-island habitats and were never of a high enough export value to mitigate the difficulties of intensively collecting them.

However, in the mid-1980s, trade started to open up again with mainland China, particularly from Hong Kong, and it was discovered by traders that beche-de-mer was a very useful barter item to overcome problems in currency transactions. The market opened up very rapidly and a whole range of species – even the lower value species – became valuable. These lower-value species were mainly found in shallow, inshore areas around the main islands and, whilst they were easy to collect in large quantities, they were also easy to over-exploit.

Beche-de-mer exports from Fiji boomed in 1985. The annual level of exports of dried beche-de-mer had never been more than 50 t/yr for the past hundred years, but rapidly climbed to over 700 t in 1988. The real figure was probably nearer 1,000 t, since a considerable amount appeared to go through Customs classified as "Miscellaneous molluscs". Bearing in mind that beche-de-mer shrink to one-tenth of their fresh weight during processing, a total of 10,000 t of beche-de-mer was probably harvested from Fiji reefs in 1988. This was easily Fiji's biggest single fishery, in terms of tonnage, and the export value (extrapolating the figures quoted by Customs) would have been around F$4 million (F$4 per kg). The average value quoted by Customs rose to F$5 per kg in 1989, F$9.50 in 1990 and was F$8.22 per kg in 1991. In the first three quarters of 1991, 285.4t were exported; the figure is likely to rise to 380 t by the end of the year, for a total (Customs-quoted) value of F$3 million.

The Fisheries Division, and several exporters we have talked to, expects the volume of exports to tail off much further in the future, due to increasing resource-availability problems. Although the level of exports has remained around 400 t for the past three years, it seems that this level is only being maintained by exploiting new or more distant reefs, and by exploiting different and lower-value species. In 1988, the vast majority of the trade was in blackfish (**driloli**) but more recently there have been increasing quantities of other species such as greenfish, redfish and stonefish. In other words, this graph is the sum of what is probably a series of sharper peaks and declines for individual species.

Problems

1. Resource problems

There were fears in 1987/88 that the huge increase in production of beche-de-mer (1000% in three

*Tim now works for the South Pacific Commission within the Inshore Fisheries Research Project as Senior Inshore Fisheries Scientist years) would lead to devastating effects on the natural resource. Beche-de-mer, like most other tropical sedentary resource fisheries, tends to have a 'boom and bust' cycle of exploitation. A new market demand or a rise in price stimulates investment in the fishery. It becomes overharvested after a certain period, but new investment still continues, based on the previous year's prospects, and the fishery collapses. It is some time before the natural resource regenerates sufficiently for the cycle to start all over again, and this regeneration time is even longer when investors are unable to abandon infrastructures and are forced to keep eating into the "resource capital" (the remaining natural broodstock) to try and service their investments. This cycle has been noted for many fisheries, including the Fiji beche-de-mer fishery itself in the last century, and the trochus and beche-de-mer fisheries in New Caledonia before World War II.

This boom-bust cycle can only be avoided by very comprehensive regulatory measures – measures which are far beyond the current capacity of the Fiji Fisheries Division, particularly in a policy climate of deregulation and cutbacks in civil service expenditure. However, measures can be taken to minimise the problem.

As a first approach to controlling inevitable over-exploitation, Cabinet approved a 3in minimum size limit on the export of beche-de-mer in 1988. The major export species had become blackfish (**driloli**). **Driloli** is the smallest commercially important species. Individuals reach sexual maturity at a size of about 5in. Experiments and observation showed that a 5-in individual would shrink to 2.5in when processed, so the 3in minimum size for exported beche-de-mer was designed to ensure that individuals of the major exported species would have a chance to release eggs before being liable to harvesting. There was no hope of sustaining exports at 1988 levels and the main aim of this regulation was to slow down the rate of the predicted resource "crash". Without resource protection, exports would continue at a high level for a couple of years and then fall to virtually zero. With protection, the resource could be harvested for a longer period, even if at a lower level.

This strategy was effective for a while, as can be seen from the drop in exports after the law came into force in 1989 (although a large part of this drop was probably also due to a decline in total abundance of the resource). However, enforcement is a problem, particularly as there is no legal requirement for exporters to notify the Fisheries Division of shipments and the size limit is only enforceable at the point of export. Increasing quantities of undersized product came back into the market in 1990 and at the end of the year Cabinet approved a further amendment enabling the Fisheries Division to enforce the size limit in the factory. Still, enforcement of this regulation across the board is difficult under the limited resources available to the Fisheries Division (which has 26% of its posts vacant). Stricter guidelines for the inspection of export shipments have now been introduced.

It was hoped in 1988 that this measure might stabilise the fishery at levels of indefinite sustainability (which would probably be in the region of 100–200t per year) but subsequent experience has shown that this hope is very unlikely to be realised. Too much of the original standing stock has already been harvested to sustain full yearly regeneration.

It may be wiser from the national point of view to accept the "boom and bust" cycle of the fishery and to maximise export earnings by allowing harvesting to continue for a further period, followed by a complete closure of the fishery for several years to allow full regeneration. This would allow a further cycle of maximum earnings rather than a continuous very low level of return.

If exploitation is to continue at present levels of effort, the most likely scenario is that beche-de-mer fishing will dwindle to unprofitability. However, if fishing still continues, even at low levels (likely if the world price continues to rise), beche-de-mer stocks will never get the 'breathing space' to regenerate to former levels. Without a moratorium or ban, Fiji might expect exports to drop to less than 50t a year for the next 10 years (500t total). With a five-year moratorium, followed by five years of fishing, we might expect the same level of exports as over the past five years (over 3,000t total), for that 10-year period.

2. Socio-economic problems

(a) **Dairo**, *Holothuria scabra*

One potential problem that was identified early was the likelihood that **dairo** resources would be quickly wiped out. **Dairo** is one of the highest-value species for the export market, but is the one species that is consumed locally. It is an important subsistence food-source in times of hardship and following cyclones. There was the added worry that **dairo** is more exacting to process than other species, due to its chalky coating, and there was every likelihood that a lot of product would be rejected and wasted. A ban on the export of **dairo** was approved by Cabinet in 1988, although an exemption clause in the Fisheries Regulations allowed the Minister for Primary Industries to allow exports in special cases.

The intention was to allow exports of **dairo** only by companies with a good reputation and proven ability to produce an acceptable product and only in cases where the owners of customary fishing rights were completely willing to exploit their **dairo** stocks. It would thus be up to the traditional owners to decide whether they wanted to trade off cash in hand against the loss of future subsistence fisheries.

The Fisheries Division has no wish to meddle unduly in the rights of customary fishing rights owners to manage the resources under their control, but it is noticeable that **dairo** levels have dropped remarkably on many reefs, and that it is increasingly difficult to find **dairo** being sold in municipal markets.

(b) Foreign vs. local exporters

Another problem has been the vast number of companies wishing to enter the business. In 1986 there were just three exporters of beche-de-mer. By 1988 there were 24, with more applying all the time. Many of these new companies were foreign-dominated and, whilst they provided a multitude of outlets for village fishermen and competition on prices, there was no way that the beche-de-ner resource could support this many companies for long at profitable levels for all.

In 1989, the Beche-de-mer Exporter's Association was formed. The idea was that membership of the Association would be limited to reputable companies – companies with an established stake in the future of Fiji – excluding the agents of overseas companies who came into the country with a pocketful of money, travelling round the districts buying from the processing stations set up by locally-based companies. By agreement with Customs, exports of beche-de-mer would only be allowed to those exporters holding an export permit from the Fisheries Division and the Division would only give permits to members of the Association.

Whilst a good idea in principle (the Trade Advisor to the Forum Fisheries Agency hailed it as one of the most progressive developments in the South Pacific fisheries sector for years), the Association generated considerable controversy and the Ministry had to withdraw the export licensing linkage in December 1990. The main problem was the perception by non-members that a "cartel" was controlling the industry for their own profit, and that there was no chance for new companies, particularly Fijian companies, to get involved in the export side of the fishery.

However, the Association appears to have been of considerable benefit. For a time it managed to reduce the total number of exporters to 12 established companies: a reasonable figure that permitted free competition on prices to the benefit of fishermen, but allowed those companies more freedom to invest in village fishing operations (loans and grants of boats, equipment and fuel, as well as processing gear) without worry about commercial "poachers". During 1989 / 90 there was a noticeable rise in the standard of processing and hence in the reputation and value of Fiji's exports, According to Customs, this was accompanied by a marked rise in the per-kilo value of Fiji's beche-de-mer exports over the period 1988-90. Also according to Customs-declared prices, that value has since fallen again.

However, it might equally be said that the rise in per-kilo value was due to a rise in world market prices, and that the recent fall has been due to the greater percentage of lower-value species being processed.

Conclusion

Beche-de-mer will not become extinct in Fiji. They are too adept at hiding under rocks, and of too low a value individually to make it worthwhile to collect every last one. They do not face the fate that threatened the **vasua dina** before exports were banned in 1988 and that is still threatening the turtle. But the people who make a living out of this fishery face economic hardship if stocks fall below commercially fishable levels.

The beche-de-mer fishery has been of considerable economic benefit to rural fishermen over the past five years. The peak years of the fishery, in 1987 and 1988, coincided with the peak of Fiji's economic troubles, and many rural areas were able to survive on the proceeds of their beche-de-mer fishing. Fisheries Division records show that many fishermen were able to pay off the Fiji Development Bank (FDB) loans on their fishing boats in record time during this period, although, regrettably, the diversion of effort into beche-de-mer fishing was one of the main factors in the failure of the seaweed farming industry to get established and in people being unable to repay FDB seaweed loans.

Fortunately, the beche-de-mer fishery has not taken rural people out of their traditional context. They are not totally dependent on this part-time fishery and will slip back into their normal activities as the fishery declines. It is a different story for the exporters. Many of the new seafood companies set up over the past five years have based most of their operations on beche-de-mer and face a very uncertain future if their mainstay disappears. There are not very many marine resources, apart from tuna and outer-island reef-fish, left to exploit, since most of the higher-value, easy-to-collect resources are low in numbers.

After the controversy generated by the trade protectionism inherent in the Beche-de-mer Exporters Association, the Fisheries Division will not become willingly involved again in trade regulatory measures. Such measures can only be imposed effectively through harmonised Government policy, and implemented by an appropriate Government agency. The Fisheries Division will continue to advise Fiji Trade and Investment Bureau (FTIB) and other trade bodies that further investment, particularly foreign investment, in beche-de-mer exporting is undesirable. However, the Division has concentrated its resources on more appropriate measures, particularly the protection of immature beche-de-mer, and measures designed both to reduce the rate of the likely forthcoming collapse and to speed the eventual regeneration of the resource.

One helpful measure would be for owners of traditional fishing rights to prohibit beche-de-mer fishing in certain reserve areas. The Fisheries Division has no legal powers to set up such reserves, but the Fisheries Act allows ample scope for resource custodians to endorse fishing permits accordingly, and to ban fishing for a particular species in a particular area under their control. Such areas would provide a protected breeding ground for "broodstock" beche-de-mer, whose spawn would help to replenish surrounding areas and enhance the fishable stock. Recent research shows that some species of beche-de-mer tend to spawn together in synchrony, and a cloud of larvae drift down-current to settle on a suitable reef. Protected areas would thus be best placed upstream in the prevailing current. The Fisheries Division hopes to perform more research on this phenomenon, but local knowledge and common sense are likely to be just as useful as scientific research in this case.

It is extremely unlikely that reseeding reefs with artificially cultured beche-de-mer will ever make an impact on the problem. An enormous amount of basic research still has to be done on tropical beche-de-mer species, both to culture them and to determine which areas should be reseeded. Attempts will be made to gain this knowledge, and to request the resources necessary to do that research, but it would be far more efficient and cost-effective to protect that part of the natural resource that we still have and to encourage natural regeneration.

Beche-de-mer poster for Papua New Guinea

Source: SPC Fisheries Newsletter #60 (January – March 1992)

In support of the Papua New Guinea Department of Fisheries and Marine Resources' research work on beche-de-mer, carried out by Paul Lokani at the Kavieng Fisheries Laboratory, SPC is providing technical and financial support for the preparation of a poster on beche-de-mer species.

Although compiled in response to a request from PNG, the final version of the poster is likely to be of interest to fisheries officers, traders and those involved in marine resource education in all Pacific Island countries, especially those with large beche-de-mer fisheries.

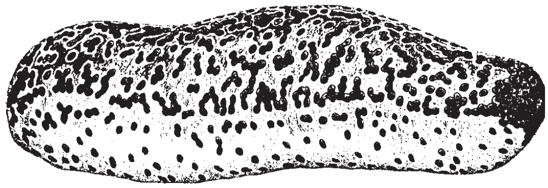
The poster will be principally aimed at fisheries inspectors and other fisheries officers, and is intended to help them identify beche-de-mer correctly down to species level, in order to improve export statistics on this group of animals. At the present time, there is much mixing and most beche-de-mer exports are not classified by species. This makes it difficult for fisheries research staff, who are expected to provide advice to the government on management of the fishery, to understand how heavily the various different sea cucumber species are being exploited.

Because inspection of beche-de-mer happens after processing, the poster will mainly feature photographs of the various types of finished product, although for each species treated, pictures of the live or fresh animal will also be shown. As well as distinguishing the various beche-de-mer types, the poster will also show examples of differences in quality to help inspectors check on grading and on the approximate relative values of export consignments.

Earlier in the year Detlef Blumel, Graphic Arts Officer at SPC's Regional Media Centre in Suva, Fiji, spent some time working with SPC scientist Garry Preston, visiting beche-de-mer traders in Fiji to photograph as many types and grades of beche-de-mer as possible. These were pasted up into a mock-up and forwarded to Papua New Guinea for comment. Feedback from PNG has been received and will be incorporated into the final version of the poster.

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

CORRESPONDENCE



New species of holothurian found in Guam?

Alexander M. Kerr (Marine Laboratory, University of Guam, U.O.G. Station, Mangilao, Guam 96923) wrote the following letter to Garry Preston (South Pacific Commission) and Chantal Conand.

'...Myself and several others have been doing nocturnal reefal surveys for new echinoderm records to Guam. We have made several expected and a few interesting finds (one asteroid, two echinoids and six holothuroids) which are scheduled to appear in the December 1992 volume of Micronesica.

We have not, however, been able to identify a species of holothuroid. During an otherwise uneventful fishing trip (we caught one fish), Paul Gates mentioned that you work with holothuroids. I am hoping that you may be able to help identify this puzzling specimen or know someone who can.

The holothuroid is 15-22 cm relaxed length and is a dark purplish-brown. The tentacles of the specimen shown in the enclosed picture are purple and number 20 (Note from editor: the photo was not of good enough quality to be published – the original will be kept by the SPC Fisheries Information Officer and will be available on request to members). *The spicules appear to belong to a* Holothuria (Thymiocysia) *sp. Notice the small knobs scattered along the longitudinal axis of the otherwise smooth buttons. We photographed the animal during the day on an algal substrate, however, it is strictly nocturnal and has been found active only on live colonies of the massive coral* Porites rus. *The tegument is thick, much like* H. (T.) impatiens, *but is smooth. It emits an amazing quantity of long, very thin cuvierian tubules when disturbed. Like* H. (Microthele) nobilis, *abrading the tegument reveals a lighter colour beneath. If it is indeed a species of* Thymiocysia, *could it be* H. (T.) remollescens? *I do not have access to Lampert's original description (in Semper 1885) nor to H.L. Clark's (1946) description.*

For your convenience, I have enclosed a self-addressed postcard. If you recognise the holothuroid and have any information concerning it, know someone who might, and/or would like to receive a specimen (relaxed in MgSO4, then preserved in 70% ethanol), I would be very pleased to acknowledge your reply. I would also be glad to send you specimens of other Guam echinoderms should you so desire. I am quite interested in holothuroid ecology and plan as a master's thesis to do several field experiments assessing their community structure and community-level effects on other reefal organisms. I would be interested in receiving materials on holothuroids that you have published and have available at S.P.C.'

Reply from Chantal Conand

'...Thank you for your letter and questions about a species of Holothuria. *Although it is only from a photograph and a few observations, it corresponds exactly to the species I have not identified and referred to as* Holothuria *sp. 1 in my thesis. I have also given a photograph, a few details on morphology (p.29) and ecology (p.92). I have found it at 8 sites all around New Caledonia. The cuvierian tubules and the "smooth" tegument are really characteristic. '*

Royal Hawaiian Sea Farms involved in research on sea cucumbers

Dale Sarver, from Hawaii (Royal Hawaiian Sea Farms Inc., PO Box 3167, Kailua-Kona, Hawaii 96745) sent letters to Garry Preston, SPC and to Chantal Conand to explain what kind of activities are carried out by Royal Hawaiian Sea Farms in Kailua-Kona, Hawaii. Extracts from these letters are reproduced below.

1. Letter to Gary Preston

'...Royal Hawaiian Sea Farms is a small company producing a variety of edible seaweed, seawater raised tilapia, and on occasion shrimp. We produce over one tonne of Gracilaria *every week which is our main crop. It is sold locally and on the US mainland.*

In addition to aquaculture production RHSF trades in a variety of prepared and dried seaweeds and live lobsters and will soon start selling prepared seaweed products.

RHSF carries out research on other potential marine products in an effort to diversify and provide a wider range of products. One such potential product is sea cucumbers. Stichopus horrens *has a very strong ethnic market in the islands. It is usually pickled and served in a variety of Japanese styles. The animals are found intertidally at night, and the fishing pressure has reduced the population significantly.*

We have obtained a Small Business Innovation Research grant through the Department of Agriculture which has also attracted matching State funds. The project is to develop maturation and larval culture techniques which might lead to commercial production. Although little is known of this species it appears to be seasonal like most other cucumbers. Attempts are being made to initiate out of season maturation and spawning through manipulation of various environmental factors. We are modelling our approach on methods proved to be successful with S. japonicus *in Asia. RHSF is arranging to obtain broodstock of this species in order to attempt commercial production, and to use as a model for our work on the local species.*

Work has just started but there are indications that there are some mature individuals even in the off season. We will keep you informed on our progress. Comments and advice are welcome.

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2. Letter to Chantal Conand

'...Thank you for your letter and enclosed reprints on sea cucumber biology.

Our luck with the Stichopus horrens *has been very good. I have been able to stimulate out of season spawning by manipulating several physical and chemical parameters. In addition we have succeeded in rearing the larvae of juveniles, although the numbers have been very low. I am currently trying to improve on the techniques and hopefully we can get enough through to work with.*

The program we are working under specifies we try culture techniques for S. japonicus *also. I have been having a very hard time locating a source of these animals. Do you have any suggestions as to where I could obtain some live specimens? Broodstock size would be best but even small juveniles would be helpful. There has been no response from my approach to some of the Prefectures involved in the early research. Possibly a biological supply company would be a good way if you know of any. Any advice would be appreciated.'*

Sea cucumber culture in Japan

Hideyuki Tanaka, Project Manager with the South Pacific Aquaculture Development Programme, sent the following correspondence, regarding sea cucumber culture, to Being Yeeting, Senior Fisheries Officer, Fisheries Division Kiribati.

'...In response to your fax inquiry on sea-cucumber culture, unfortunately there is not too much development in tropical sea-cucumber culture at present even in resource management, though University of Guam has started research on its ecology and seed production since 1988.

However, sea-cucumber resource management and culture have been commonly practiced in Japan and China. Seed production technique is already established in Japan for developing sea-cucumber ranching and culture. There are, I think, six or seven, or more large scaled hatcheries in Japan. In recent, we sent a staff of Fiji Fisheries Division to one-month training course on sea-cucumber and tropical scallop cultures in China. A copy of training report prepared by the participant will be sent to you together with some other papers. There are currently strong interests in sea-cucumber culture in the South-east Asian countries, and I have heard some country has started experiment of sea-cucumber stocking-culture in fishpen.

In Japan sea-cucumber culture is practiced by intensive methods, such as by cages or baskets, which are at present not technically applicable and very costly in the region. Given to slow growth of sea-cucumber, China and Japan *are at present making more efforts in restocking of juveniles with setting up nursery or grow-out grounds rather than culturing. I also would like to propose to look into resource enhancement by management method in the tropical situation rather than culture method. What we need as the best in the tropic, I think, is to develop the method of juvenile aggregation and protect those juveniles until market size.*

I have several examples of successful practices in resource enhancement, but sorry those information available with me are limited only from Japan. There have been many trials in Japan since the 18 Century, the following are some major successful records:

1.In two localities in Aichi Province in 1894, stones were dropped into sea bottom for increasing stock. Both trials resulted in very successfully.

2. In 1932, Nagasaki Fisheries Experimental Station confirmed effect of bundles of twigs placed to shallow bottom as good seed (juvenile) collectors. Saga Fish. Exp. St. also obtained a good result of juvenile aggregation by placing bundles of lumbers with weight. It was also found that this trial created a place of estivation for adult sea-cucumber.

3.In Hyogo Province during 1932-34, one sea-cucumber fishing ground was divided into three zones, and one zone was dropped with stones and restocked with wild juveniles in the first year, another zone in the second year and the last zone in the third year. Each zone was harvested after two years alternatively (e.g. each zone was harvested at every two years) and at the same time catch of sea-cucumber less than 50 g was restricted. In three years later, production became 27 times of initial stocking.

4. In Ohura Bay of Saga Province in 1934, 915 m^3 of stones were dropped at one location and restocked with 1,700 kg of mature sea-cucumbers, and in the next year 359 m^3 stones were also dropped at another location. Some 1,600 kg of sea-cucumber were harvested only for 4 days period after two years fishing moratorium. Production was increased 9 times bigger in weight and 13 times much in value compared to before. Given this successful result, fishermen built a monument for advising this success in history.

5.Since around 1935 in Nanao Bay, Ishikawa Province, fishermen started construction of sea-cucumber shelters by sinking lumbers and old boats together with stones. Since 1953 shelters were constructed at considerable scale in the bay by stones dropping. In 1977-78 a large scaled nursery ground was constructed at two locations, which aimed at 25-26 t of additional annual catch at each location.

6. In Miyagi Province in 1938, a shelter was constructed by sinking old boats and dropping stones, and restocked with 1,200 liters of young sea-cucumbers. After one year moratorium, production increased to 2.5-3.7 times bigger in catch and 5-6 times higher in value compared to the previous catches.

7.In Ohura Bay, Nagasaki, in 1978-79, long-lined seed collectors attached with oyster shells collected seed successfully. Some 69,000 and 341,000 juveniles were collected each year by this method.

8.Similarly, in Senzaki Bay, Yamaguchi Province in 1980-81, suspended seed collectors made of pearl culture baskets inside which hold oyster shells and cedar leaves, collected 1,064 and 53,200 juveniles yearly. Those seed were used for restocking.

9.In Okayama Province in 1988, a young-fishermen group experimentally collected about 10,000 juveniles of which size was 1,4 g in body weight, by pearl culture baskets with oyster shells. All seed were aimed at restocking rather than culturing.

As conclusion, the following practices might be suggested as feasible conservation measures for sea-cucumber resources.

— moratorium for long terms;

— rotation of fishing grounds;

—restriction of catching season;

—size regulation;

—construction of juvenile aggregation areas;

—construction of sea-cucumber shelters and restocking of adults or juveniles;

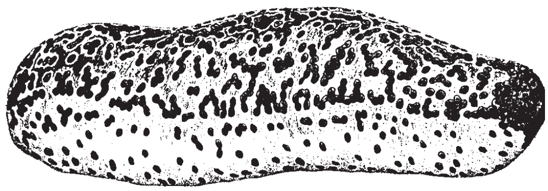
—collection of wild seed and restocking.

Regarding restriction of catching season in Japan, each province has a different closed fishing season, but these are all between March to November. March to July is a spawning season, August to September is an estivation period due to high temperature, and October is a recovering period from the estivation. In the period August to October, sea-cucumber is less commercial value due to poor quality. On the other hand, there is a difficulty for tropical sea-cucumber to establish such closed fishing season because of lacking of basic information on life cycle, growth, maturity, etc.; on tropical species. What is the maturing size for each commercially important species? When is the spawning season for each species? How do they grow? Is there an estivation period for tropical species like the temperate species?

Our project has encouraged to develop these basic research in the region during the project period, and tried to do it even by ourselves. However, this was not realised due to lack of manpower in both country and project office. Research institutes or universities in the region didn't pick up these regionally important research, except the University of Guam. I hope the USP or Atoll Research Unit might be in a position to carry out such research. I really feel the necessity of setting up a sub-regional research station/group on sea-cucumber study in the region.

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

Abstracts, Publications Workshops and Meetings



The new references listed below will be held in the SPC library and will be available on request.

If there are documents that you feel should be added to the database, please send us a copy, or, if this not possible, a photocopy of the cover page. Documents do not need to be formal publications– many of those held in the database are not — and we are keen to archive as much 'grey literature' (internal reports, correspondence, unpublished data, etc...) as possible.

Thanks in advance for your help.

Conand, C. and C. De Ridder (1990). Reproduction asexuée par scission chez Holothuria atra (Holothuroidea) dans des populations de platiers récifaux. *Echinoderm Research*, De Ridder, Dubois, Lahaye & Jangoux (eds), 1990 Balkema, Rotterdam (an abstract in English is shown below).

Holothuria atra *is the most common aspidochirotid holothurian on tropical Indo-Pacific reef-flats. Transverse fission followed by regeneration has been studied in populations from New Caledonia and Papua New Guinea. Fission has been observed in the field in all sizes of individuals at a mean rate of 1% of the population sampled in New Caledonia. From direct observations and from the sizes of recently divided individuals regenerating the oral or anal end, the position of the split has been located in the anterior 45%. From the observed fission and regeneration rates in the population, it is inferred that external regeneration (disappearance of fission signs) takes about two months. Asexual and sexual reproduction appears to be seasonal. But whereas fission mainly occurs during the cool season, sexual reproduction (from gonad studies) takes place during the warm season. Fission is probably triggered by emersion, during low tides, through dessication and thermal stress. It is hypothesised that the low water time of the spring tides can explain the seasonality of the fission as this phase of the tide occurs in these localities near the middle of the day in the cool season (and during the night in the warm season).*

Conand, C. (1991). Long-term movements and mortality of some tropical sea-cucumbers monitored by tagging and recapture. *Biology of Echinodermata*, Yanagisawa, Yasumasu, Oguro, Suzuki & Motokawa (eds), 1991 Balkema, Rotterdam (an abstract is shown below).

In addition to assisting studies of growth and mortality of a population, tagging experiments followed by a series of recaptures are useful in following animal movements. Tagging experiments have been conducted on seven aspidochirotid holothurians from different lagoon and reef habitats of the lagoon of New Caledonia. On reef-flats, where high-density populations are observed, the position of tagged individuals was located inside quadrats marked out by pegs and orientated. In deeper stations, where population densities are usually lower, the quadrats were larger and were not delimited with precision. Recaptures were generally made each three months. Recapture rates are highly variable, depending on the species, and their progressive decline is mostly due to the loss of tags. For the reef-flat species Actinopyga echinites *and* A. mauritiana, *the movements of some tagged individuals were followed over one year. Their mobility was rather limited as many individuals were found within the inner quadrat after six months. The average direction of movement has been determined for these two species. It is apparently random for* A. echinites *and oriented towards the reef crest for* A. mauritiana.

Massin, C. and D.J.W. Lane (1991). Description of a New Species of Sea Cucumber (Stichopodidae, Holothuroidea, Echinodermata) from the Eastern Indo-Malayan Archipelago: *Thelenota rubralineata* n. sp. *Micronesica* 24 (1): 57-64, 1991 (an abstract is shown opposite).

Thelenota rubralineata *n. sp. is described from specimens off Indonesia and Papua New Guinea. This colourful shallow water species is compared with* T. anax *and* T. ananas. *A short note is given on its behaviour.*

The papers cited below were published on the occasion of the Third European Conference on Echinoderms in Lecce, Italy, from 9 to 12 September 1991. These papers will be available in the SPC library soon.

Immunocytochemical detection of bromo-deoxyurine in proliferating cells of regenerating Cuvierian tubules of *Holothuria forskali* (Echinodermata); 81–86.
by D. VandenSpiegel, D. Nonclercq & G. Toubeau

Cuvierian organs in the holothuroid genus *Actinopyga* (abstract); 131
by D. VandenSpiegel & M. Jangoux

Brooding and marsupium structure in the cucumariid holothuroid *Neconus incubans* (Echinodermata); 121–124.
by V. Alvà & M. Jangoux

Evolution récente des exploitations mondiales d'holothuries (abstract); 171–172.
by C. Conand

Holothurians' response to attack by the tonnid gastropod *Tonna galea* (poster); 204
by A. Toscano, F. Bentivegna & P. Cirino

Cellular and molecular basis of encapsulation in sea cucumber hosts; 209
by C. Canicattì

Phenoloxydase and lipidic pigments in enriched *Holothuria polii* coelomocyte populations; 217
by S. Sammarco & C. Canicattì

Dopamine in *Holothuria polii* coelomocytes; 221.
by P. Cretì, L. Scalera-Liaci & C. Canicattì

On the association between the crab *Hapalonotus reticulatus* and the holothuroid *Holothuria (Metriatyla) scabra* (poster); 242.
by D. VandenSpiegel & A. Ovaer

Upcoming conference

The 8th International Echinoderm Conference will be held at the University of Burgundy, Dijon, France from 5 to 10 September 1993. People who are interested in attending should contact:

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Welcome to new members

by J.P. Gaudechoux,
South Pacific Commission,
Noumea, New Caledonia

The SPC Beche-de-mer Special Interest Group is growing. We have received additional completed questionnaires from the individuals listed below. The previous lists of members are available in the first three issues of *SPC Beche-de-mer Bulletin*.

If you are on the list and your name and address are wrong, please send us a correction. If you are not on the list and would like to be, fill in the form enclosed with the bulletin or write to us for a new one.

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