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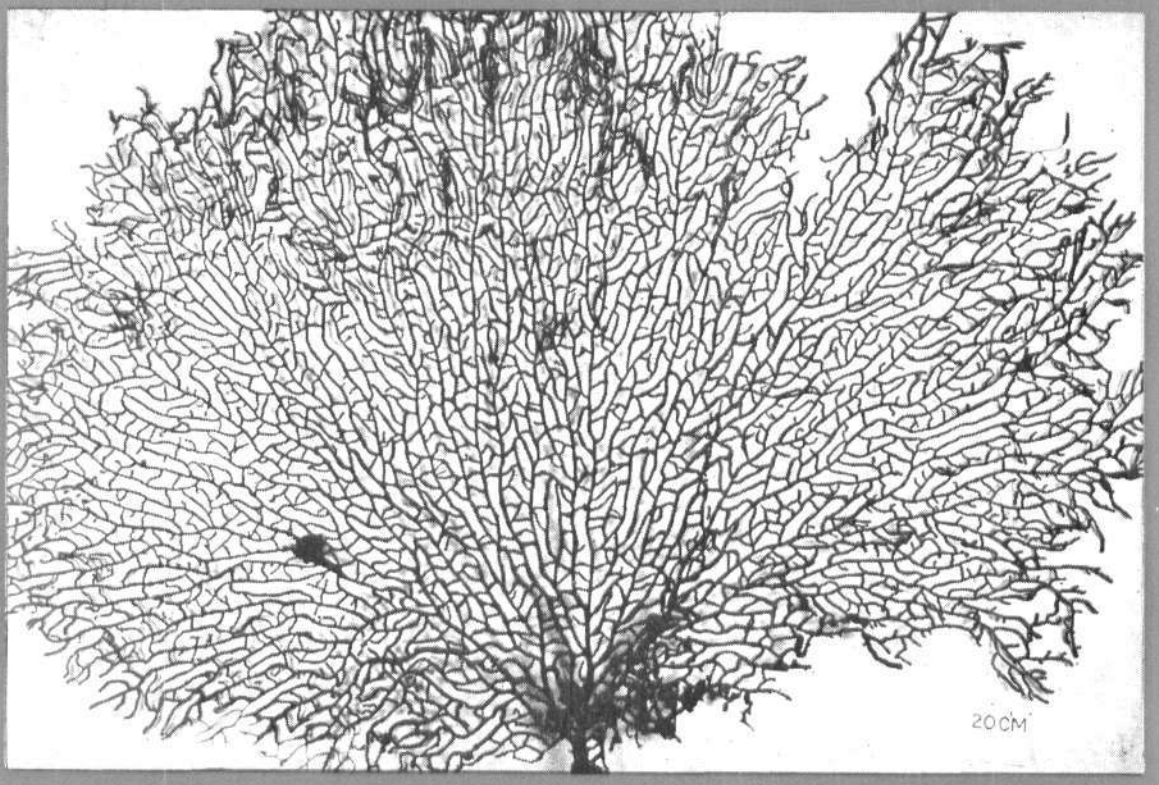

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GORGONID RESOURCES OF INDIA

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Introduction

The colourful seafans have been objects of attraction to man from time immemorial. Those who had opportunity to watch them under water with their variegate coloured polyps expanded have even considered them to be the 'flowers' of 'underwater gardens.' For these aesthetic reasons these animals have been collected all over the world, and from India too they have been exported under the head 'curio' for a long period. But the demand for this commodity was not at all specific and the revenue realised under this head was also not very attractive. However, the condition drastically changed by the beginning of 1970's and several countries started importing them in bulk from India.

Though the reason behind such large scale imports is not clear, it is inferred that the discovery of prostaglandins (PGE, PGF, PGE_2, PGF_2–alpha, PGF_2–beta and the like) in 1969 by Weinheimer and Spraggins from *Plexaura homomalla* (Esper), a Caribbean species, triggered off a world wide 'hunt' for the species or its congeners. Prostaglandins or derivatives thereof now serve as 'wonder drugs' for many-a-systemic disease in man and animal, and enamoured by their clinical possibilities several pharmaceutical firms have even stepped up their production on a commercial basis. The present demand for gorgonids of Indian waters may be said to be a part of this world wide 'hunt' for raw materials.

India stepped up commercial exploitation and export of gorgonids during 1975 and the material is now being exported to countries like France, West Germany, Belgium, U. S. A. and Netherlands, to mention a few. The quantity exported from India during 1975–'76 period was rather negligible, being a total of 552 kg valued at Rs. 9,206 averaging about Rs. 16 per kg. The average price/kg was on the increase till 1977–'78, but with the record export of 14.7 tonnes during 1978–'79 the price came down for the year to an average of Rs. 10.97 per kg.

The quantity of gorgonids exported from India since then showed a downward trend, but the price/kg was on a steady increase. For 1,008 kg exported during 1983-'84 the total revenue realised was Rs. 1.04 lakhs, averaging Rs. 103.65 per kg. The year-wise export, total value realised and the price/kg are indicated below (Table 1).

Table 1.* *Quantity, price, price/kg of gorgonids exported from India during* 1975–'83

Period	Quantity (kg)	Total value (Rs.)	Price/kg (Rs.)
1975–'76	552	9,206.00	16.67
1976–'77	2696	57,106.00	21.18
1977–'78	7013	1,71,250.00	24.41
1978–'79	14760	1,62,051.00	10.97
1979–'80	4050	1,67,053.00	41.24
1980–'81	1849	60,388.00	32.65
1981–'82	3690	2,10,260.00	56.98
1982–'83	808	51,209.00	63.37
1983–'84	1008	1,04,485.00	103.65

*Based on data obtained from M.P.E.D.A., Cochin.

Classification of commercially important gorgonids of India

Anthozoans which include seafans, corals, sea anemones *etc.*, are exclusively marine cnidaria and are divided into two subclasses based on structural differences in their symmetry. The first subclass Octocorallia, which includes soft corals, seafans, seawhips *etc.*, is colonial in habit and the polyps have eight tentacles and the body cavity also is divided into eight radial compartments. The other subclass Zooantheria (also called Hexacorallia) which includes sea anemones, black corals, stony corals *etc.*, has hexamerous symmetry that may be biradial or radiobilateral in nature.

Of the six extant orders of the subclass Octocorallia, the Alcyonacea (soft corals) and Gorgonacea (seafans, sea whips *etc.*) are widely distributed in the coastal areas of the Indo-Pacific. From the pattern of abundance it may be stated that Gorgonacea forms the largest single contributor to the total biomass along our reefs.

Members of the Order Gorgonacea Lmx. have a skeleton composed of two parts - an outer cortex ('skin' or 'rind' as it may be called) containing loosely arranged calcareous spicules, and an inner medulla with solid axis made of calcareous or horny matter with or without the addition of calcareous spicules. Based on the arrangement of the skeleton this Order may be divided into two suborders - Scleraxonia and Holaxonia. The former suborder includes species with both spicules and horny material in the medulla while in the latter there is only horny matter.

Among the commercially important gorgonids of India, species of both Scleraxonia and Holaxonia are represented, the latter being more dominant than the former. The general classification of commercially esteemed species of Indian seas is as follows:

List of species

Order Gorgonacea Lmx.
Suborder Scleraxonia Studer
Family Anthothelidae Broch
Genus *Solenocaulon* Gray
1. *Solenocaulon tortuosum* Gray
Family Subergorgiidae Gray
Genus *Subergorgia* Gray
2. *Subergorgia suberosa* (Pallas)
3. *S. reticulata* (Ellis and Solander)
Suborder Holaxonia Studer
Family Plexauridae Gray
Genus *Plexauroides* Wright and Studer
4. *Plexauroides praelonga* (Ridley)
Family Paramuriceidae Bayer
Genus *Muricella* Verrill
5. *Muricella umbraticoides* (Studer)
6. *M. complanata* Wright and Studer
Genus *Thesea* Duchassaing and Michelotti
7. *Thesea flava* Nutting
Genus *Echinomuricea* Verrill
8. *Echinomuricea indomalaccensis* Ridley
9. *E. indica* Thomson and Simpson
Genus *Echinogorgia* Kolliker
10. *Echinogorgia reticulata* (Esper)
11. *E. flora* Nutting
12. *E. complexa* Nutting
Genus *Heterogorgia* Verrill
13. *Heterogorgia flabellum* (Pallas)
Family Gorgoniidae Lmx.
Genus *Leptogorgia* Milne Edwards
14. *Leptogorgia australiensis* Ridley
Family Ellisellidae Gray
Genus *Ellisella* Gray
15. *Ellisella andamanensis* (Simpson)
16. *E. maculata* Studer
Genus *Nicella* Gray
17. *Nicella dichotoma* (Gray)
Genus *Juncella* Val.
18. *Juncella juncea* (Pallas)
Genus *Gorgonella* Val.
19. *Gorgonella umbraculum* (Ellis and Solander)
20. *G. rubra* (Thomson and Henderson)
Genus *Scirpearia* Cuvier
21. *Scirpearia filiformis* Toepl.
Family Isididae Lmx.
Subfamily Isidinae Lmx.
Genus *Isis* Lin.
22. *Isis hippuris* Lin.

The above list shows that the total number of species exported from India at present is 22 and these are referable to 7 families and 15 genera. Scleraxonian species are not many and the majority of commercial species fall under Holaxonia; the important families being Paramuriceidae and Ellisellidae with nine and seven species respectively.

Commercial classification of Indian gorgonids

Gorgonids exported from India are commercially classified under four heads or 'types': 'Black', 'Red', 'Flower' and 'Monkey tail.' The examination of export data from some places indicates that another type by name 'White' was included at some centres in the past. But this 'type' is nothing but the name given to the skeleton of undersized 'Red type' gorgonids from which the outer coloured cortex (skin) has been removed.

The commercial classification thus is based mainly on colour and body form and on generic affinity, whatsoever, is taken into consideration. The following may be given as the salient features of each 'type' and the species falling under each.

1. *'Black type':* Specimens are black or dark brown in colour and the body pattern may be mostly reticulated.

Branches divide in one plane and give rise to an ovate to obovate colony form; stalk may be short and stout. In the list of species Nos. 9, 12 and 13 fall under this type (front cover photo).

2. *'Red type':* Specimens may be pink or brick red in living condition. Body pattern resembles very much that of the above type. Nos. 2, 3, 4, 6, 8, 10 and 19 of the list of species come under this type (Fig. 1).

Fig. 1. 'Red' type gorgonid *(Subergorgia reticulata* (Ell. & So.)

Fig. 2. 'Flower' type gorgonid *(Leptogorgia australiensis* Ridley).

3. *'Flower type':* Specimens may be yellow, red, orange, white or cream in colour. Body pattern may be lamellar or bushy with free branches. Young specimens of 'Red type' may often be sorted out under this category. In the list of species Nos. 7, 11, 14, 15, 17 and 20 and also young specimens of No. 4 may be classified under this category (Fig. 2).

4. *'Monkey tail type':* Colony long and whip-like; seldom branching, if dividing, often dichotomously. Nos. 16 and 18 given in the list of species are of this type (Fig. 3).

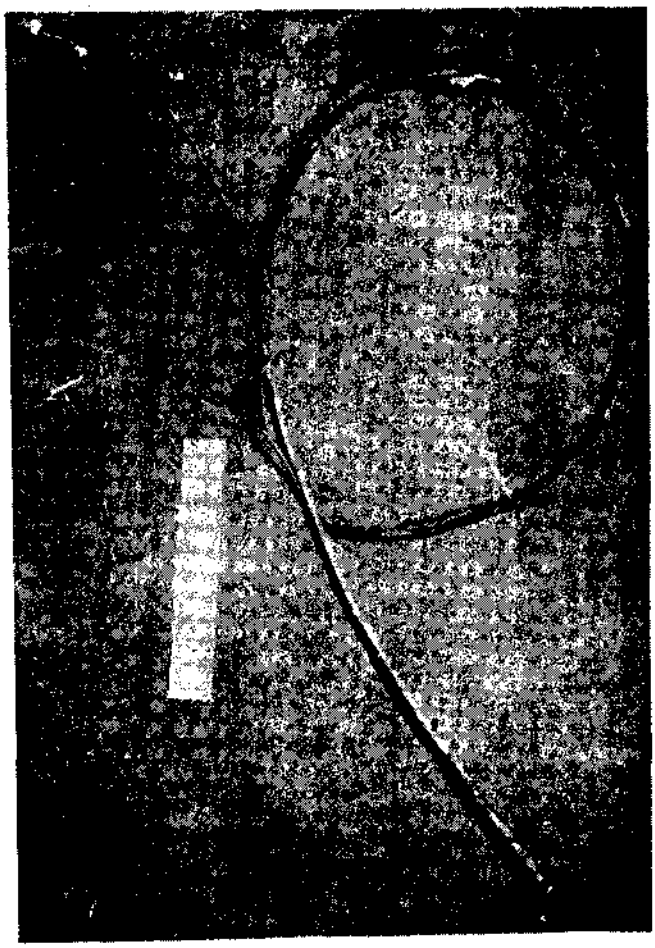

Fig. 3. 'Monkey tail' type gorgonid *(Juncella juncea* (Pallas).

Type-wise composition

In order to find out the percentage contribution of each 'type' to the fishery, the details were analysed from three centres *viz.* Tuticorin, Keelakarai and Rameswaram. This reveals that the average contribution of the 'Black type' to the fishery was 38.3%, of the 'Red

type' 25.7%, of the 'Monkey tail type' 20.3% and of the 'Flower type' 15.7%. Species that dominated in the fishery from each type were, in the order of abundance, Nos. 9 *(Echinomuricea indica)*, 13 *(Heterogorgia flabellum)* and 12 *(Echinogorgia complexa)* of the 'Black type'; Nos. 19 *(Gorgonella umbraculum)*, 3 *(Subergorgia reticulata)* and 2 *(Subergorgia suberosa)* of the 'Red type'; No.14 *(Leptogorgia australiensis)* of the 'Flower type' and Nos. 18 *(Juncella juncea)* and 15 *(Ellisella andamanensis)* of the 'Monkey tail type.' In all the three centres studied the first mentioned species from each 'type' dominated well over the others in the landings.

Distribution along the Indian coasts

Gorgonids, though distributed widely along the coasts of India, are available in fishable magnitude only in the Gulf of Mannar and hence it may be stated that the gorgonid export depends mainly on catches from the three major centres in the Gulf of Mannar, *viz.* Tuticorin, Rameswaram and Keelakarai. During the formative years (1975–'79) the merchants engaged fishermen directly for collecting gorgonids. But this condition changed subsequently in all the major centres. Fishing exclusively for gorgonids became less common and merchants started appointing their agents in different places to collect specimens from fishermen who, in turn, started gathering them as and when they dive for chank or mussel or fished with trawl nets, traps or bottom set gill nets *etc.* Such collection centres are distributed both along the southeast coast (upto Madras) and southwest coast (upto Quilon) of India.

The general distribution of the various commercially important species along the Indian coasts is quite interesting as it shows difference with regard to their number and abundance. Many species that are abundant in the Gulf of Mannar are sparse elsewhere. Species such as *Heterogorgia flabellum, Gorgonella umbraculum* and *Juncella juncea* are rather exceptional and exist in fishable magnitude in several areas along the east and west coasts of India and Andamans. *Isis hippuris*, on the other hand, has been collected only from Andamans. This species is exported for making ornaments.

From the point of view of species composition, it may be stated that the maximum number of species from each 'type' is fished from the Gulf of Mannar. The total number of species collected at each centre may be indicated as follows: Tuticorin – 14 species; Keelakarai – 10 species; Rameswaram – 10 species; Nagapattinam – 2 species; Madras – 8 species; Cape Comorin – 8 species; Muttom – 2 species; Kadiapattinam – 6 species; Colachel – 3 species; Thengapattinam – 2 species; Vizhinjam – 3 species; Quilon – 2 species and Andamans – 2 species. The distribution of species in the northern parts of both east and west coasts of India is not well known, but based on published accounts it may be stated that both 'flower' and 'red' types are available along Dwaraka, Ratnagiri and Visakhapatnam areas.

Species represented in the commercial landings from the above centres are listed below. The number given refers to the serial number of species given in the 'List of species' (*vide supra*).

1. Tuticorin: Nos. 2, 3, 4, 6, 7, 9, 10, 12, 13, 14, 17, 18, 19 and 20.
2. Keelakarai: Nos. 2, 3, 4, 9, 12, 13, 14, 15, 18 and 19.
3. Rameswaram: Nos. 2, 3, 7, 9, 10, 12, 13, 14, 18 and 19.
4. Nagapattinam: Nos. 13 and 19.
5. Madras: Nos. 3, 5, 8, 9, 10, 13, 14 and 19.
6. Cape Comorin: Nos. 1, 6, 12, 13, 14, 18, 19 and 21.
7. Muttom: Nos. 19 and 20.
8. Kadiapattinam: Nos. 6, 15, 16, 18, 19 and 20.
9. Colachel: Nos. 12, 13 and 18.
10. Thengapattinam: Nos. 13 and 19.
11. Vizhinjam: Nos. 11, 18 and 19.
12. Quilon: Nos. 13 and 19.
13. Andamans: Nos. 19 and 22.

The following species have been reported for the first time from the Indian seas: 1) *Thesea flava* Nutting, 2) *Echinomuricea indica* Thomson and Simpson, 3) *Echinogorgia flora* Nutting, 4) *E. complexa* Nutting and 5) *Heterogorgia flabellum* (Pallas).

Fishing seasons

During the northeast monsoon (October-March) the coastal areas of the Palk Bay become rough and choppy but the inshore areas of the Gulf of Mannar remain comparatively calm and hence fishing could be carried out unhindered in the Gulf of Mannar coast. By March the wind changes direction, as a result of which the inshore areas of the Gulf of Mannar become choppy and this condition prevails up to September. Such periodic reversal of monsoon winds influences the fishing activities of the region. Depending on the reversal of monsoon winds there are obviously lean and brisk periods for the gorgonid fishing also.

An added advantage with regard to the Gulf of Mannar is the occurrence of a long chain of islands extending from Tuticorin to Rameswaram Island. The total extent of this chain is about 140 km and the number of islands in the chain is 20. The sea in between these islands and the mainland is 5–15 m deep. Fishing

in the nearshore areas of the mainland as well as those parts of the islands which are in the shadow of north-east monsoon is usually attempted during October–March period. During the southwest monsoon period the condition changes altogether, *i.e.* those areas of the islands facing the southwest monsoon winds and also the nearshore areas of the mainland become rough while areas of the islands facing away from the monsoon winds become calm and favourable for fishing.

In order to find out the seasonality of gorgonid landings, month-wise data obtained from three important centres such as Tuticorin, Keelakarai and Rameswaram have been analysed. The availability of gorgonids at both Rameswaram and Keelakarai follows a set pattern with peaks during April–May and January–March, the latter being dominant. But the fishery at Tuticorin is somewhat different in that the prolonged lean period noted during July–January at the other two centres is not so well pronounced. The relatively short duration of both monsoons coupled with the presence of well protected islands in the inshore areas, may be mentioned as the reasons for the protracted fishing activity noted here.

As compared to the southeast coast, the conditions prevailing on the southwest coast of India are quite different since both monsoons are equally intense here. Along the southwest coast a regular fishery for gorgonids is nonexistant and the little quantity brought ashore by fishermen engaged in trap fishing, trawling, mussel or chank fishing is transferred to the merchant or to their agents from time to time. Besides, sometimes the fishermen also keep stray catches with them for a long period before they are sold to the merchants/ agents and hence information on the month-wise collection of gorgonids could not be ascertained in detail here.

Trend of fisheries

The species constituting each 'type' are not equally distributed among the various centres surveyed. However, the most common and heavily fished species are *Echinogorgia indica*, *Heterogorgia flabellum* (both of the 'Black type'), *Gorgonella umbraculum* ('Red type'), *Juncella juncea* ('Monkey tail type') and *Leptogorgia australiensis* ('Flower type'). At present the above said five species form the mainstay of Indian gorgonid fishery.

A perusal of Table 1 shows that gorgonid export from India started with 552 kg in 1975–'76. The price/ kg realised for this quantity was a little over Rs. 16/-. What followed in the subsequent years, judged from the standards of any exporting country, was rather spectacular, for the export by 1978–'79 reached a peak of 14.7 tonnes valued at Rs. 1.62 lakhs. But, the price realised per kg was only Rs. 10.97. Probably, this record output of Indian gorgonid affected the available stock rather adversely, and the sudden dip in the price structure noted was perhaps due to the dominance of undersized specimens in the export samples. During the ensuing years, there was, however, very clear indication of a reorientation in the gorgonid fishery in our waters partly due to the poor revenue realised during the year of record export and also due to the strict size-quantity regulations imposed by a few foreign agencies. This situation prompted the fishermen to venture into new areas in search of larger specimens. The cumulative effect of all these measures, no doubt, resulted in a major cut in the quantum of our exports from 14.7 tonnes of 1978–'79 to four tonnes during 1979–'80. But this reduction in quantity apparently produced no corresponding effect on the revenue realised, which was estimated at Rs. 1.67 lakhs, with a record price of Rs. 41.24 per kg. The quantity exported from India, since then, began to show a downward trend and by 1983–'84, it came down to 1,008 kg. But the price/kg, on the contrary, registered a steady increase and by 1983–'84 it touched a peak of Rs. 103.65/kg.

Summing up the export trend over these years it may be stated that the export of this commodity from India during first five years (1975–'79) was to the tune of 25 tonnes while the same for the next five years (1980–'84) was only 11 tonnes. But in terms of revenue the latter period realised a total of Rs. 5.9 lakhs as against Rs. 3.9 lakhs obtained in the former period. There is indication that indiscriminate fishing in conventional grounds in the early period (*i.e.* period up to 1979) has affected our coastal beds while fishing in distant beds during the subsequent years (up to 1984) for larger specimens fetched a higher price in the foreign market. But care has to be taken even now to see that these beds also are not indiscriminately exploited and depleted.

Such a possibility of selective depletion of particular gorgonids in the major centres along our coasts requires mention in this context for three reasons.

a) 'Black' and 'Red' types were the first to be exported from India.
b) The above types are more common in our waters and they enjoy almost the same bathymetric distribution. Their price structure also

is more or less the same in foreign market depending upon the size.

c) Skeleton of 'Red type' started appearing in export samples as 'White type' in some places. This indirectly influenced the exploitation of undersized 'Red type' specimens in all the important centres.

The component species constituting the four major 'types' were not subjected to fishing pressure at the same rate. Area-wise analysis indicates that in all the three major centres surveyed (*i.e.* Keelakarai, Tuticorin and Rameswaram) along the Gulf of Mannar coast, 'Black type' dominated (namely *Echinomuricea indica* and *Heterogorgia flabellum)* and was followed by the 'Red type' *(Gorgonella umbraculum)*. This clearly indicates that only three species were being exploited in large quantities and hence they are to be considered the direct victims of indiscriminate fishing.

Quantitatively speaking, the other two types, *viz.*, 'Monkey tail' and 'Flower', were exported at 20-22% level of the total and, as such, the problem of depletion has not yet reached any alarming scale for them. It is hence advisable to enhance their exploitation by increasing the effort in all centres where they are not fished in appreciable quantities at present.

Areas where fishing could be intensified

The areas where gorgonid fishing is active at present are indicated in Fig. 8 by continuous lines and virgin areas to which fishing could be extended profitably in future by interrupted lines. At centres like Dwaraka, Ratnagiri and Visakhapatnam the availability of gorgonids could be assessed only up to the 'type' level. These studies indicate that 'Flower type' is plenty at all these centres. At present no harvest of gorgonid is made from these areas and hence attempts may be initiated to exploit them in moderate quantities to supplement the landing from other centres.

To present a clear picture of the availability of various species in the proposed extended fishing areas (Fig. 8) the coast line is considered under eight zones: zones 1–4 on the east coast and 5–7 on the west coast. The Andaman group of islands is shown separately as Zone 8.

Zone 1. *Cape Comorin to Thiruchendur*

Gorgonids are occasionally collected from scattered centres like Perumanai, Periatalai, Manapad and Thiruchendur. Specimens of almost all species available at Tuticorin are distributed throughout this zone upto a distance of 4 km from the shore. It was also found during the present investigation that specimens of *Solenocaulon tortuosum* Gray are available in fishable magnitude off Cape Comorin at depths varying between 50 and 60 metres.

Zone 2. *Tuticorin to Rameswaram*

This zone, at its southern part, embraces the most extensive and heavily fished beds of India. Fishing in this part of the zone should be restricted in future as per guidelines provided in the section on 'some regulatory measures to be adopted' (*vide infra*).

The rest of this zone, that is the coastal area extending between Keelakarai and Rameswaram, includes the two major fishing centres *viz.*, Keelakarai and Rameswaram. Though a lucrative fishery existed at Keelakarai in the initial years (1975-'79), fishing became a less viable proposition in the subsequent period for want of sufficient returns. The other fishing centre, *viz.* Rameswaram depends mainly on the collections made from the various islands as also from the shallower areas off Mandapam Peninsula. At present the specimens are being collected by fishermen in their spare time. This area is rich in species like *Echinoforgia reticulata, Thesea flava, Juncella juncea, Plexauroides praelonga* and *Subergorgia suberosa.* The area between Hare Island and Pulli Island has a rich bed with a high frequency for larger specimens at a depth of 15 metres. This bed harbours species like *Echinomuricea indica, Heterogorgia flabellum, Gorgonella umbraculum* and *Juncella juncea.*

The Palk Bay side of Mandapam Peninsula and Rameswaram Island, especially the two semifossilised coral reefs called Kathuvallimuni Reef and Vellapertumuni Reef harbours a rich assemblage of gorgonids. *Leptogorgia australiensis* is rather wide spread all through these reefs. Other species such as *Echinogorgia reticulata, Subergorgia suberosa* and *Gorgonella umbraculum* are also available in moderate quantities. Exploitation of gorgonids from Devil's Point (Rameswaram Island), from areas outside the present limits, could also be attempted on an enhanced rate. Resource-wise the shallower areas extending between Devil's Point and Bathing Ghat (marked BG in map) may also provide a good area.

Zone 3. *Tondi to Point Calimere*

In this zone gorgonid exploitation is practiced as a part-time avocation only at two places – Tondi and

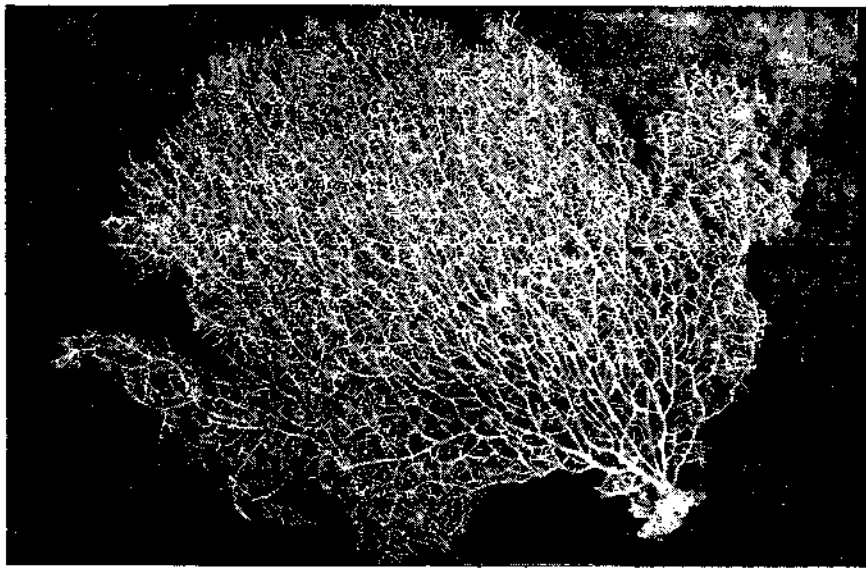

Fig. 4. The 'Black type' gorgonid *(Heterogorgia flabellum)*.

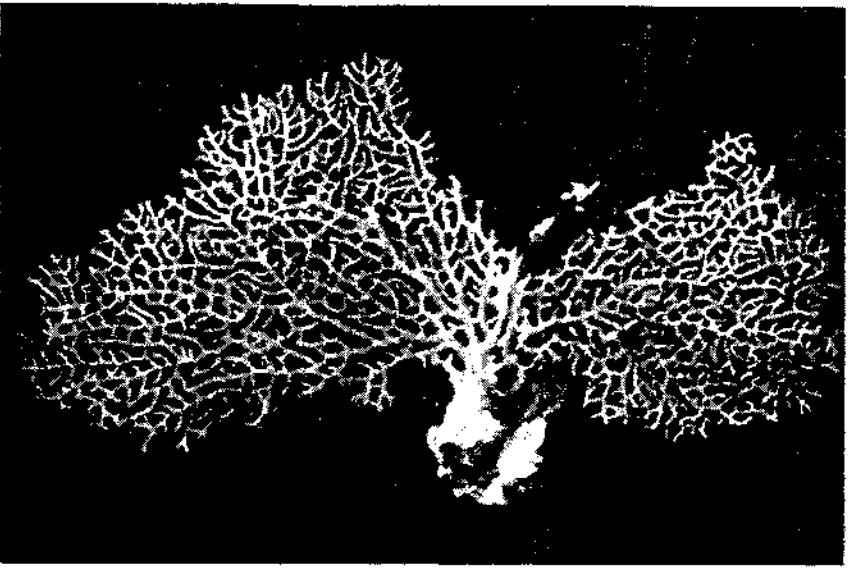

Fig. 5. The 'Red type' gorgonid *(Gorgonella umbraculum)*.

Fig. 6. The 'Red type' gorgonid *(Subergorgia suberosa)*.

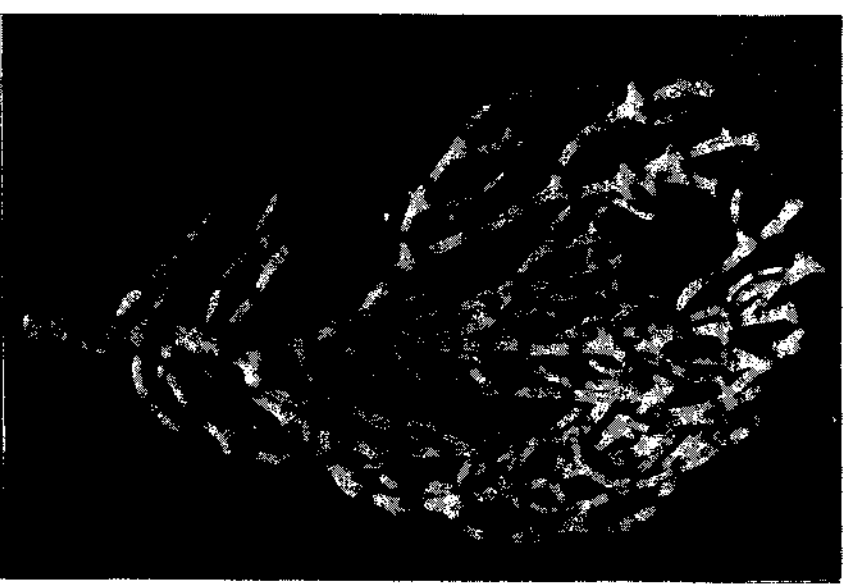

Fig. 7. *Isis hippuris*, a gorgonid used for making ornaments.

Point Calimere. Gorgonids are abundant all along this coast in shallower areas and attempts could be initiated to exploit them judiciously. A better season for their exploitation would be the pre-northeast monsoon months as the growth of specimens is likely to get retarded during the northeast monsoon period due to excessive silt fall.

Zone 4. *Visakhapatnam*

Since gorgonid exploitation is not in vogue at present, trials in this line would be desirable. 'Flower', 'Red' and 'Black' types are quite common in this zone.

Zone 5. *Okha, Dwaraka and the Gulf of Kutch*

Commercial exploitation of gorgonids has not yet been started here. In several places along this zone vast stretches of intertidal areas get exposed during low tide rendering hand picking of specimens rather easy. Places in and around Beyt Island, Adatra Reef, Chindi Reef, Balapur Bay, Mangunda Reef and areas off Dwaraka are rich in both 'Flower' and 'Monkey tail' type specimens, which are common upto a depth of 7 metres.

Zone 6. *Ratnagiri to Malvan*

'Red' and 'Flower' types are plenty in areas where the sea bottom is studded with rocks *etc.* Attempts could be initiated to exploit them on a commercial basis.

Zone 7. *Vizhinjam to Cape Comorin*

There is no organised fishery for gorgonids in this zone at present. In view of the richness, mainly in species such as *Gorgonella umbraculum, Heterogorgia flabellum, Echinogorgia complexa, Leptogorgia australiensis* and *Juncella juncea* attempts may be made to exploit them at an enhanced rate.

Zone 8. *Andamans*

Exploitation of *Gorgonella umbraculum* ('Red type') and *Isis hippuris* may be attempted.

Present status of our gorgonid beds

Since the gorgonid export from India is solely dependent on specimens fished from the Gulf of Mannar, the sign of depletion is felt much in all the fishing centres in the Gulf of Mannar. Details collected from three main centres such as Tuticorin, Keelakarai and Rameswaram clearly indicate that the depletory trend is not alike in all the three centres and this may be attributed to the distribution pattern of the various species and also on the difference in the fishing intensity effected from time to time.

The information gathered from the three major centres mentioned above throws considerable light on the problem of depletion in general. A centre-wise list of species which indicates clear cut mark of depletion, those with no signs of depletion where fishing could be carried out at the present level and those in which fishing could be intensified in future, is appended below. The notations 'B', 'R', 'F' and 'M' after each species denote 'Black', 'Red', 'Flower' and 'Monkey tail' types respectively.

Centre 1: *Tuticorin*

a) Species showing distinct depletory trend
   Echinomuricea indica (B)
   Gorgonella umbraculum (R)
   Heterogorgia flabellum (B)
   Echinogorgia complexa (B)

b) Species without any depletory trend
   Subergorgia suberosa (R)
   S. reticulata (R)
   Plexauroides praelonga (R)
   Muricella complanata (R)
   Thesea flava (F)
   Echinogorgia reticulata (R)
   Leptogorgia australiensis (F)
   Juncella juncea (M)

c) Species which could be intensively fished
   Nicella dichotoma (F)
   Gorgonella rubra (F)

Centre 2: *Keelakarai*

a) Species showing distinct depletory trend
   Echinomuricea indica (B)
   Gorgonella umbraculum (R)
   Heterogorgia flabellum (B)

b) Species without any depletory trend
   Echinogorgia complexa (B)
   Leptogorgia australiensis (F)
   Ellisella andamanensis (F)
   Juncella juncea (M)

c) Species which could be intensively fished
   Subergorgia suberosa (R)
   S. reticulata (R)
   Plexauroides praelonga (R)

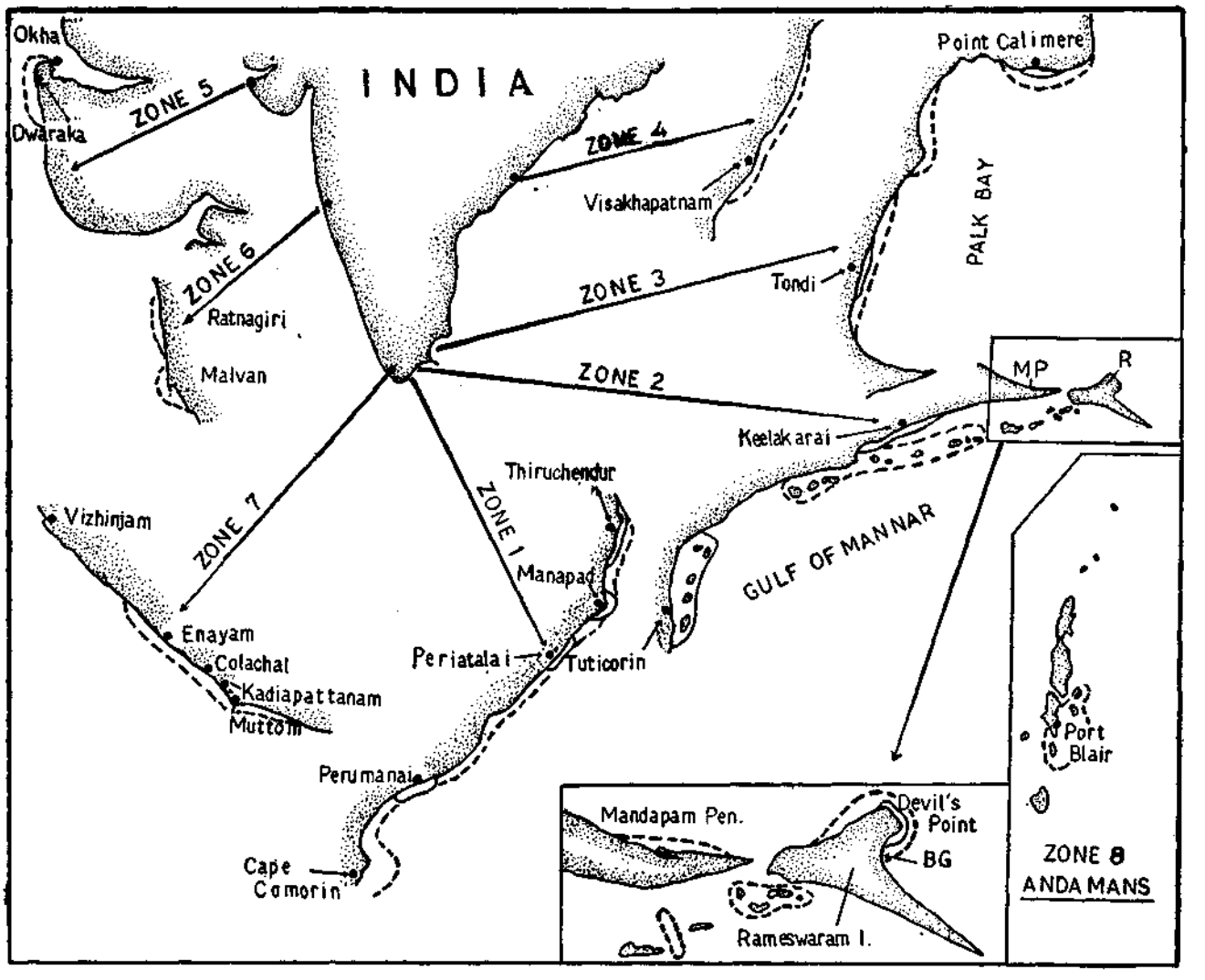

Fig. 8. Exploited and potential areas where fishing for gorgonids is going on at present are indicated by continuous lines and where fishing could be extended in future are indicated by broken lines. R - Rameswaram Island, MP - Mandapam Peninsula and BG - Bathing Ghat. Each zone is magnified and given separately.

Centre 3: *Rameswaram*

a) Species showing distinct depletory trend
Echinomuricea indica (B)
Heterogorgia flabellum (B)
Gorgonella umbraculum (R)

b) Species without any depletory trend
Subergorgia suberosa (R)
S. reticulata (R)
Thesea flava (F)
Echinogorgia complexa (B)
Juncella juncea (M)

c) Species which could be intensively fished
Echinogorgia reticulata (R)
Leptogorgia australiensis (F)

The absence of any stock assessment of gorgonids in our waters prior to the commencement of their commercial exploitation makes the assessment of damage caused to them by indiscriminate fishing rather complicated. During the present investigation it was found that the condition of many of our erstwhile rich beds in the Gulf of Mannar was alarmingly poor. Though the depletory trend is discernible only in the case of four species mentioned under Column (a) at each centre, a *ban on the collection of these four species from the Gulf of Mannar alone will not produce any desired effect, for any collection in these grounds can be claimed to come from outside the present limits.* Hence it is necessary to *extend such a ban to all new areas* indicated in Fig. 8. It is quite certain that if such a ban is imposed atleast for a *period of* 10 *years* it would lead to a drastic cut in the export of gorgonids from India as these four

species form the mainstay of our export at present. Anticipating such an eventuality alternative steps to maintain a regular supply of a minimum quantity every year/season by diversifying the fishing activities may be adopted well in advance and this should be formulated in the following lines:

1) By enhancing the fishing of all the species mentioned under Column (c) from the Gulf of Mannar and other new areas.

2) By extending the fishing activity to new areas indicated in Fig. 8 for species not included under Column (a).

Chemicals from gorgonids

a) *Prostaglandins*

Gorgonids were relatively unknown to chemical and medical world till 1969 when Weinheimer and Spraggins discovered the presence of prostaglandins in the gorgonid *Plexaura homomalla* (Esper) so common in the reefs off Florida. The compounds which they extracted from *P. homomalla, i.e.* 15-epi-PGA_2 (I) and its diester (II) present in the air-dried cortex to the extent of 0.2 and 1.3% respectively are epimeric with the potent mammalian hormone at the allylic hydroxyl centre. They are also devoid of the dramatic blood pressure lowering effect (demonstrated in dogs) of PGA_2. Though possessing the same gross structure as in mammalian PGA_2, compound (I) was found to be inactive in physiological tests suggesting diasteromerism at one or more of its five possible sites in the molecules. Further, the workers opined that in the current state of limited supply of mammalian prostaglandins the availability of large quantities of (I) and (II) from the widely distributed gorgonids invites their thorough evaluation as possible synthetic precursors to current members of this important hormone system.

Bundy *et al.* (*Ann. N.Y. Acad. Sci.*, 1971) described some novel methods for converting the normal PGA to more useful forms such as PGE_2 and PGF_2-alpha. The overall yield of PGF_2-alpha from coral prostaglandins, as per the above workers, was about 15%. Schneider and his associates (*J. Amer. Chem. Soc.*, **99**, 1977) described the isolation and characterisation of (15 R) and (15 S) prostaglandin A_2 from *P. homomalla*. However, (15 R) – prostaglandin A_2 and its acetate methyl ester do not exhibit the biological activities so common in prostaglandins from mammalian sources and their biological role in the gorgonid is also not fully understood at present. Further, the same workers, when they analysed the specimens of the same species from Florida, could get only (15 S) PGA_2 rather than (15 R) PGA_2, previously found to occur in specimens from the Caribbean Sea. In addition to this the Caribbean species contained crystalline PGE_2 (about 0.06%) which is identical in both biological and physical properties to those of mammalian prostaglandin. The above authors have also described several routes for the conversion of these animal products to the primary, biologically more efficient prostaglandin PGE_2 and PGF_2-alpha. The presence of 5, 6-Trans PGA_2 in *P. homomalla*, its separation from PGA_2 and its conversion to 5, 6-Trans PGE_2-alpha are also briefly discussed in the above cited paper. The physiological effects of various prostaglandins, as now understood, are summarised in Table II.

Table 2. *Properties of prostaglandins*

Sl. No.	Potential use	Isomeres	Effects
1.	Birth control	PGF_2-alpha	Reduce progestrone formation
2.	Induced child birth	PGE_2 & PGF_2-alpha	Uterine contraction at low strength
3.	Abortion and induction of menstruation	PGE_2 & PGF_2-alpha	Mechanism not fully understood
4.	Prevention of peptic ulcer	PGE_1 & PGE_2	Inhibits gastric secretion (acid) and pepsin (in Rat)
5.	Treatment of asthma	PGE_1	Relaxes the muscle of bronchial tube
6.	Nasal decongestant	PGE_1	Clears nasal passage
7.	Regulation of blood pressure	PGA_1 & PGE_2	Lowers blood pressure
8.	–do–	PGF_2-alpha	Raises blood pressure
9.	Metabolic regulation	PGE_1	Counteracts the effect of hormones which stimulate metabolism
10.	–do–	PGE_2	Inhibits release of excess epinephrines in response to nerve stimulation.

b) *Terpenoids*

Gorgonids are also known to be a rich source of terpenoids. So far about 74 such compounds have been isolated from different species and these may be classified under diterpene, sesquiterpene and artifact. Many of the species known from Indian waters are rich in Asperdiol, Crassin acetate, Eunicin, Briarein A, Bisabolene, Cadinene, Corgonene, Copaene, Alloaromadendrene *etc.*

Our knowledge regarding the origin of these peculiar chemical compounds in gorgonids is still meagre. Some are of the opinion that these are produced by zooxanthellae which grow symbiotically inside the tissue of the gorgonid, while others opine that these chemicals are produced by the animal itself. Many workers have shown that the hosts (gorgonid) feed directly on these zooxanthellae which they harbour. This sort of a trophic relationship often obscures the precise origin of these chemicals. Hence there is every possibility that these chemicals may be produced by the animal, by symbiotic algae, by the association of both or even by extraneous source (a dietary origin).

The various chemicals extracted from coelenterates exhibit very interesting bio-dynamic properties. Chemicals such as Lobolide, Sarcophine, Lobophytollide, Crassolide and Africanol are toxic to fish. Antineoplastic properties are exhibited by Sinulariolide, Sinularin, Crassin acetate, Jeunicin, Eunicin and Africanol.

The ecological significance of many of these specific compounds are not yet fully understood. There is ample evidence to show that these terpenoids have a protective function for the colonies. Sessile colonies have to protect themselves from both predation and invasion of other micro-organisms, algae, larvae of other animals *etc.*, and these chemicals become so handy in their struggle for existence.

RECOMMENDATIONS AND CONCLUSIONS

1. The discovery of prostaglandins in the Caribbean sponge *Plexaura homomalla* (Esper) triggered off a world-wide 'hunt' for the species or its congeners. The present demand for gorgonids from India, started in 1975, may be said to be part of this world wide 'hunt' for raw materials.

2. The total quantity of gorgonids exported from India during 1975-'84 was estimated at 36.4 tonnes valued at Rs. 9.9 lakhs. The increasing demand for gorgonids from India by foreign agencies resulted in indiscriminate fishing of this commodity along our coasts and this culminated in the depletion of many of our rich gorgonid beds.

3. At present 22 species of gorgonids referable to seven families and 15 genera are exported from India under four trade names or 'types' such as 'Black', 'Red', 'Monkey tail' and 'Flower'. The above commercial classification is based on colour and growth form, and no genetic affinity is taken into consideration. 'Black' and 'Red' types have heavy demand in the foreign market.

4. Though gorgonids are distributed all along the coasts of India, their presence in fishable magnitude is noted only in the Gulf of Mannar.

5. The absence of any stock assessment prior to the commencement of the commercial exploitation makes the assessment of damage caused to the gorgonid beds by indiscriminate fishing rather complicated. The present work was initiated in 1980 and by that time it is estimated that as much as 25 tonnes have been removed from our beds and this includes a record harvest of 14.7 tonnes during 1978–'79 period.

6. When commercial exploitation of gorgonids started in 1975, the specimens fished out were large so characteristic of any virgin bed and 10–15 of them made one kg, but by 1982 the condition changed drastically and the average size of specimens started showing a decreasing trend resulting in the dominance of smaller specimens numbering 40–45/kg.

7. The above situation, no doubt, affected the price structure of Indian gorgonids in the foreign market. But when some of the importing countries started imposing size regulation at least in a few 'types', it led to a reorientation of our gorgonid fishery in many centres on the following lines: a) fishermen started exploiting new grounds in search of larger specimens and b) fishing exclusively for gorgonids gave place to collections made by fishermen who were primarily engaged in chank or mussel picking, trap fishing and so on.

8. Fishing in new and distant grounds brought in larger specimens initially, but indiscriminate fishing appears to have continued here too, for, during the present investigation it was found that our beds, both conventional and new, were dominated by smaller specimens particularly in some species which were much esteemed in the foreign market. A total ban on the

collection of such species (vide list of species and areas given earlier) would help considerably in restoring their stock position to the original level.

9. To avoid a drastic cut in the quantity of gorgonids exported consequent on the ban on four of the common and widely distributed species in the Gulf of Mannar *(Echinomuricea indica, Gorgonella umbraculum, Heterogorgia flabellum* and *Echinogorgia complexa)* diversification into fishing of other species by (a) enhancing the rate of exploitation of certain other species from Tuticorin (2 species), Keelakarai (3 species) and Rameswaram (2 species) and (b) optimising exploitation at the present level with regard to certain other species at Tuticorin (8 species), Keelakarai (4 species) and Rameswaram (5 species) could also be attempted. Extending the fishing activity to new areas as outlined in the section entitled 'Areas where fishing could be intensified' may also be tried simultaneously.

10. In the case of those species where exploitation has to be optimised at the present level of export, this may be done by fixing a quota for each species. This can be monitored at the present export outlet level by any organisation which is entrusted with such responsibilities.

11. The present survey revealed that gorgonid resources in certain areas would support a healthy fishery in future. Details are given in the section dealing with 'Areas where fishing could be intensified'.

12. At present while harvesting the specimens, they are removed from the substratum and this means total destruction of the colony. This method is unscientific since the colony takes an unusually long period to reach a size of 60 cm in height (approximate rate of growth is 2 cm/year). Also several million larvae are spawned every season by each colony. A complete removal of specimens inhibits the recolonising capacity of our beds. During 1975 to 1984 period a total of 36.4 tonnes of gorgonids have been removed from our beds and the loss of larvae resulting from this could be well imagined. In this context a system to harvest them by cutting and removing parts of the specimen while retaining the basal portion *in situ* to regenerate and reproduce (conservative pruning) should replace the present system of harvest which is rather unscientific.

Since species comprising each type form a polypyletic assemblage of various growth patterns the method of 'pruning' should suit the growth form prevalent in each species. Though this method of harvesting is scientifically sound, the fishermen may find the whole exercise cumbersome underwater. If necessary a type-wise or species-wise method of pruning may be worked out in detail at a later period.

13. It has been found that in a gorgonid colony, 2 cm (average) growth/year amounts to 22% increase in total weight. The weight removed from the stock by fishing every year should not go above this limit to maintain a balanced fishery. Examination of the past years' export figures and observations on the present condition of the beds seem to indicate that fishing had been going on in excess althrough the period and the depletory trend now reflected is the cumulative effect of overfishing going on for the entire period.

In the light of the above findings, the export of this item from India should be restricted to an arbitrary working figure of one tonne annually in future. This quota, if necessary, may be revised every year/season after making an on-the-spot study of the material fished at every centre.

14. It is advisable to fix a minimum size for each species at which their exploitation could be commenced. This will help not only in conserving our resources but also in retaining a sizable fraction of the population for a longer period to reproduce and replenish the beds. This size has to be fixed both species and centre-wise just prior to the commencement of each season after evaluating the fishing pressure of the preceding season/year.

15. *Follow up action:* Barring those species which are here recommended for a total ban on the exploitation, the exploitation of all the other species may go on as per the guidelines provided under the section 'Recent status of our gorgonid beds'.

It is also important to keep a vigil on the harvested material to know whether the suggestions made from time to time are strictly adhered to or not.

16. In the event of extending the fishing activity to any of the virgin areas indicated in the section entitled 'Areas where fishing could be intensified', care should be taken to earmark some selected areas as 'gorgonid reserves.' The natural growth exhibited by gorgonids in these 'reserves' could be compared and contrasted with those in areas where fishing is in vogue for a sufficiently known period. Information of this sort may

give some direct evidence on the problem of human intervention. Further, the gorgonid population in such 'reserves' may help in replenishing the adjacent beds through larvae liberated during every breeding season.

17. India should step up synthesising the various chemicals (prostaglandins, terpenoids and the like) that act as 'wonder drugs' and release them in market without much delay. And for this we have to utilise properly the technical knowhow now available in India. A joint venture may be initiated by pooling the personnel and knowhow available in the various National Institutions, and the Central Marine Fisheries Research Institute, Cochin may be identified as a nodal Institution for the purpose. Further, advanced training, if necessary, may be arranged with foreign laboratories that are competent in these lines.

Speaking revenue-wise this could be a better deal, for the processed extracts *from one tonne of gorgonid can fetch a higher revenue* than what was realised from the export of raw materials for the last 10 years!

18. As a preliminary step in this line measures may be taken to evaluate the chemical composition of the various species available in our waters. The bio-active properties of the various chemicals, thus isolated, may be tested thoroughly and standardised.

19. Species which show encouraging results may be collected and the resource potential may be assessed both in time and space. In case any of these species become scarce, steps may be taken to cultivate them in their natural habitat. It is true that the various chemicals elaborated by them show both seasonal and regional variations and this is why transplantation gives poor results.

20. But, can the overfishing and damage done to the gorgonid stock be staved off? Luckily the stage of no return has not yet been reached and hence remedial measures can still be taken.

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