

OBSERVATIONS ON THE EFFECT OF BOTTOM TRAWLING ON DISLOCATION OF NON-EDIBLE BIOTA IN THE PALK BAY AND GULF OF MANNAR, SOUTH EAST COAST OF INDIA

I.Jagadis, N.G.Menon* and A.Shanmugavel
Mandapam Regional Centre of CMFRI, Tamilnadu
* Senior Scientist, CMFRI, Kochi

A B S T R A C T

Observations on the dislocated non-edible biota by bottom trawlers in the Palk Bay and Gulf of Mannar were made during 1995-1998. Data was collected at trawl landing centers, Rameswaram (Palk Bay) and Pamban (Gulf of Mannar). The average composition of non-edible biota to the total trawl discard was 38.1% and 33.9% at Rameswaram and Pamban respectively. The dislocated non-edible biota was classified into three groups i.e., (i) major invertebrates, (ii) minor invertebrates (including seaweeds) and (iii) non living forms and their rates of dislocation are presented for both the centres. The annual average rate of dislocations increased gradually from 44.7 to 71.5 kg/unit at Rameswaram whereas at Pamban it varied between 49.5 and 61.5 kg/unit during the observation period. Though the number of boats operated varied greatly between these two centres, the average rate of dislocations for both the centres during the whole period was more or less equal.

Among the different groups of organisms dislocated, non-edible crab was dominant at both the centres followed by echinoderms, stomatopods and molluscs at Rameswaram and stomatopods, molluscs and echinoderms at Pamban. Among the minor invertebrates sea weeds and sea pens were represented in higher magnitude compared with other components at Rameswaram. Whereas at Pamban, sponges and sea weeds were dominating.

Introduction

The Palk Bay and Gulf of Mannar along the South-east coast of India is well known for its rich biodiversity. Rameswaram in Palk Bay and Pamban in Gulf of Mannar are the two major fish landing centres of this region. This region

is extensively fished by both mechanized and non-mechanised fishing crafts almost throughout the year. Although mechanized bottom trawling is targeted at shrimp or cephalopods, the fishing has invariably trampled the bottom habitat often affecting other components in the ecosystem through bycatch, physical damage or through food chain effects. The non-edible biological components that are being destroyed or dislocated by trawling are very basic and important for the ecobalance and recruitment. These bottom trawl literally sweep the sea bottom while fishing and causes habitat alteration, degradation and loss of feeding grounds of many benthic fishes. Studies on these aspects are not reported from Indian waters. Very limited works had been carried out abroad (Gibbs *et al.*, 1980 and Walter, 1997).

This paper is an attempt to focus the extent of damage caused on the benthic biota, composition and its proportion to the trawl landings of these centres, which will serve as 'Bench mark survey' for future specific observations and recommendations, if any, for decision making.

Methodology

Data on the trawling grounds, direction, depth, craft and gears engaged and fishermen population were collected by enquiries. Random samples of discards of 2-3 kg each were taken and the edible and non-edible biota were separately weighed and their proportions recorded. All the components of the living and non-living forms represented in the non-edible biota were item-wise recorded along with their weights using a field balance of 5 gms accuracy. The data were further used to estimate the total weight of dislocated biota based on that days total number of boats operated in that centre. Percentage composition of the non-edible biota in terms of total trawl landings were estimated by using the landing data collected from the respective centres. Data were also collected on the non-edible biota being thrown overboard at the fishing ground itself to arrive at a factor to estimate the actual volume of the non-edible biota that is dislocated.

Results

The fishing grounds

The trawling ground of Rameswaram landing centre in Palk Bay (Fig.1) is 20-25 km away from the shore in North, North-west direction and at a depth of 12-18m, while the trawling grounds of Pamban landing centre in Gulf of Mannar is 25-30 km away in the South-west direction at 12-16 m depth.

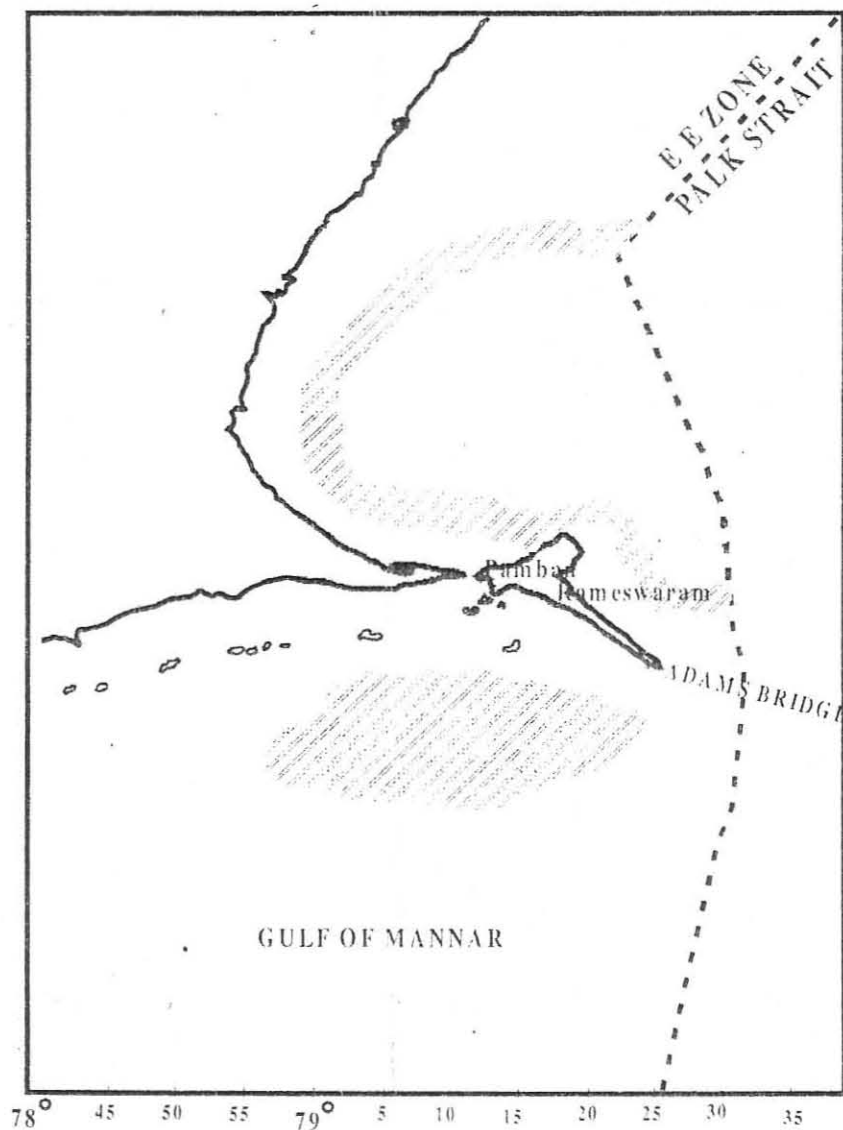


Fig.1 Fishing grounds in the Palk Bay and Gulf of Mannar

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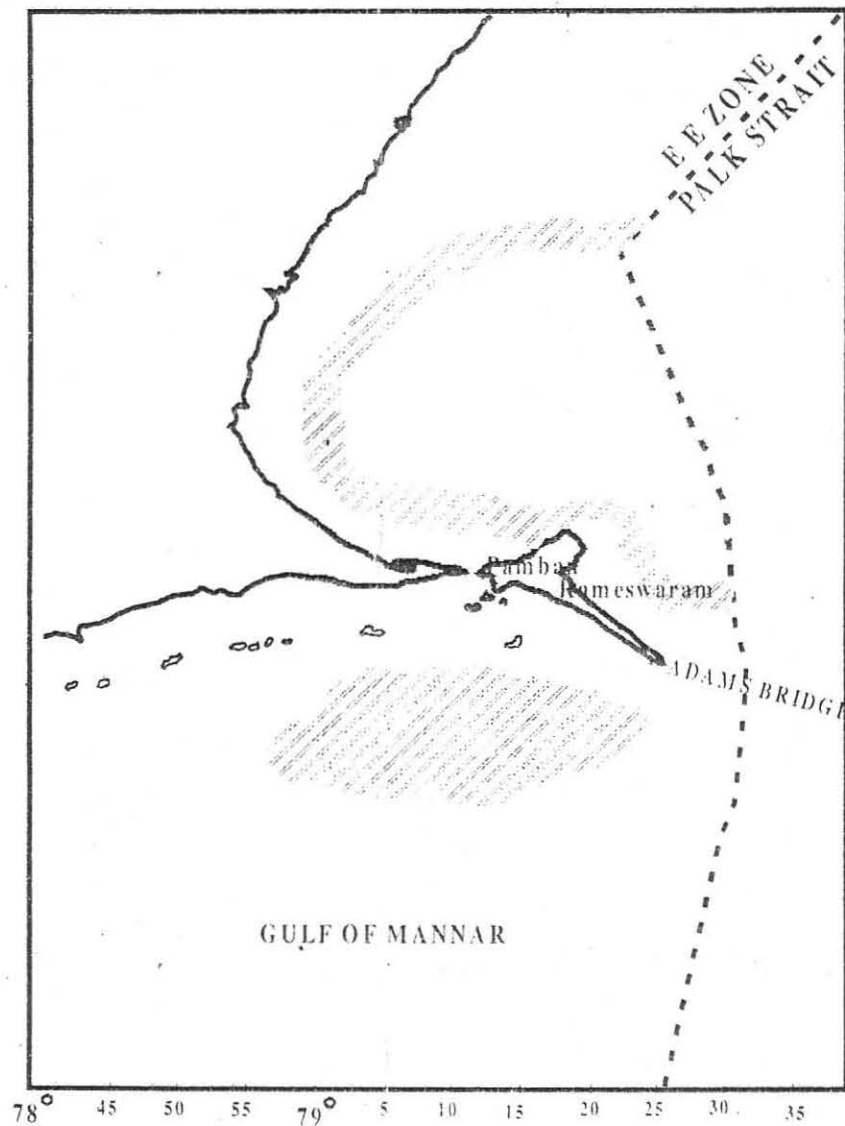


Fig.1 Fishing grounds in the Palk Bay and Gulf of Mannar

Fishermen, Craft and Gears

Rameswaram is relatively a bigger landing centre with fishermen population of 40,000. Of which 15,000 are actively engaged in fishing. Two types of trawlers namely 'Stern Trawling boats' (80%) and I B boats (20%) with a capacity of 98 to 108 HP and 92 HP respectively are operated. Shrimp trawl and fish trawl with cod end mesh sizes of 20 mm and 25-30 mm respectively are used.

Pamban landing centre supports the living of 5,000 fishermen, of which 500 are involved in active fishing. Both mechanized and non-mechanised craft are operated. The mechanized vessels are Stern trawlers of 108-110 HP and the gear used are Shrimp trawl and fish trawl with cod end mesh sizes of 20-30 mm and 40-50 mm respectively.

Composition of non-edible and edible components of the trawl discards

The constituents of the trawl discards of both the landing centres were separated into edible (comprising food fishes, shrimps and squids) and non-edible forms. Their monthly proportion was estimated (Table 1). The proportion of edible groups at Rameswaram ranged from 58.4 to 64.0% (average 61.9%) and at Pamban from 63.0 to 70.5% (average 66.1%). The non-edible forms ranged from 36.0 to 41.6% (average 38.1%) and 29.5 to 37.0% (average 33.9%) at Rameswaram and Pamban respectively for the observation period (1995-98).

Table 1 : Percentage composition of non-edible components of trawl discard at Rameswaram and Pamban landing centres (1995-1998)

Components	Rameswaram			Pamban		
	95-96	96-97	97-98	95-96	96-97	97-98
Non-edible	21.7-64.1 (41.6)	19.7-50.9 (36.0)	15.7-71.8 (36.8)	18.4-58.9 (37.0)	12.6-49.0 (29.5)	14.0-54.7 (35.1)
Edible	35.9-78.3 (58.4)	49.1-80.3 (64.0)	28.2-84.2 (63.2)	41.1-81.6 (63.0)	51.0-87.4 (70.5)	45.3-86.0 (64.9)

Composition of non-edible biota discarded at fishing ground

Enquiries among the fishermen (150 nos.) engaged in bottom trawling operations from the two landing centres revealed that few components (i.e. gorgonids, jelly fish, sponges etc.) are thrown into the sea at the fishing ground

itself, since they do not fetch any price compared to other items which are brought to the shore and sold for the purpose of making poultry feed. The percentage discard of such components as estimated by the fishermen usually ranged from 15-25% of the total trawl discards. Hence the mid value of these figures i.e. 20% can be considered as fairly reasonable value which is being discarded at the ground itself. Hence, the actual biomass being dislocated by the bottom trawlers can be arrived at by multiplying the estimated landings (given in this paper) with the factor 1.2 for each landing centre.

Observations on the dislocated non-edible biota

Monthly composition of the dislocated non-edible biota for Rameswaram and Pamban landing centres for the period 1995-1998 were presented in Tables 2-7. For the sake of analysis, the components were grouped into (i) major invertebrates (comprising crustaceans, molluscs, echinoderms and coelenterates), (ii) minor invertebrates (comprising sea pens, gorgonids, antipatharians, sponges, ascidians and sea plants such as seaweeds and sea grass) and (iii) non-living items of biological origin (comprising of coral stones and shells).

Rameswaram Landing Centre (Palk Bay)

A total of 1,11,398 trawl units were operated during 1995-96 and landed 4976.4 t of non-edible biota. Among the major invertebrate forms, non-edible crabs dominated and its monthly landings ranged from 12.9 (July) to 443.0 t (December). The monthly catch of stomatopods varied from 3.5 (April) to 420.8 t (January). Echinoderms represented by sea stars, sand dollars, sea urchins and lilies formed a substantial percentage of major invertebrate discard and their catch fluctuated from 4.9 (July) to 374.6 t (November). Molluscs were dislocated in high quantity in May, June, December and January in the range of 78.5 (December) to 183.7 t (June). Jelly fishes were found more in April, October and February in the range of 1.7 to 4.8 t and low in July (0.6 t), the average dislocation was 0.98 t.

Sea pens dominated among the minor invertebrate with quantities ranging from 1.5 (July) to 62.7 t (October). Sea plants occurrence ranged from 1.9 (July) to 32.1 t (May). The landing of gorgonids were within the range of 0.6 (September) and 53.9 t in December. Sponges were recorded in the catch to the

Table 2 : Month-wise composition (kg) of non-edible biota dislocated at Rameswaram landing centre (1995-1996)

Group	Apr.'95	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan.'96	Feb	Mar*	Annual total	Annual average
A. Major invertebrate forms														
Crustaceans														
Stomatopods	3471 (1.67)	46320 (2.27)	6724 (0.30)	40372 (2.07)	80163 (3.20)	59114 (3.07)	115675 (4.8)	25019 (0.8)	420778 (12.4)	110445 (3.85)	33363 (1.02)	-	941444 (35.45)	85585.8 (3.22)
Crabs (Non edible)	79074 (3.80)	116583 (5.72)	171054 (7.62)	12919 (0.66)	82545 (3.29)	101824 (5.28)	178332 (7.4)	249512 (8.0)	443220 (13.1)	198909 (6.93)	64587 (1.97)	-	1698559 (63.77)	154414.5 (5.79)
Molluscs														
Gastropods & Bivalves	47445 (2.28)	92992 (4.57)	183662 (8.18)	52410 (2.69)	13096 (0.52)	22903 (1.19)	60515 (2.5)	10143 (0.3)	78546 (2.3)	132427 (4.61)	61379 (1.88)	-	755518 (31.02)	68683.5 (2.82)
Echinoderms														
Sea stars & Sea lily	37591 (1.81)	29576 (1.45)	7145 (0.32)	4991 (0.26)	160724 (6.42)	62518 (3.24)	62657 (2.6)	374606 (12.0)	33662 (1.0)	83102 (2.90)	32935 (1.01)	-	889507 (33.01)	80864.3 (3.00)
Jelly fish	3630 (0.17)	-	-	587 (0.03)	-	-	4821 (0.2)	-	-	-	1711 (0.05)	-	10749 (0.45)	977.18 (0.04)
B. Minor invertebrate forms														
Sea pen	3370 (0.16)	4695 (0.23)	1681 (0.07)	1468 (0.08)	-	26307 (1.36)	62657 (2.6)	12171 (0.4)	-	-	8982 (0.27)	-	121331 (5.17)	11030.1 (0.47)
Gorgonids	1815 (0.09)	8998 (0.44)	841 (0.04)	1321 (0.07)	1191 (0.05)	619 (0.03)	7497 (0.3)	-	53860 (1.3)	-	1283 (0.04)	-	77425 (2.66)	7038.6 (0.21)
Antipatharians	2333 (0.11)	2739 (0.13)	-	440 (0.02)	-	309 (0.02)	-	-	-	5361 (0.19)	2139 (0.07)	-	13321 (0.54)	1211.0 (0.05)
Sponges	2852 (0.14)	13849 (0.68)	1261 (0.06)	1908 (0.10)	1587 (0.06)	2785 (0.14)	7497 (0.3)	-	29174 (0.9)	-	1069 (0.03)	-	61982 (2.41)	5634.7 (0.22)
Ascidians	777 (0.04)	-	-	294 (0.02)	10318 (0.41)	-	-	-	-	-	-	-	11389 (0.47)	1035.4 (0.04)
Seaweeds and Sea grasses	15815 (0.76)	32158 (1.58)	3362 (0.15)	1908 (0.10)	3968 (0.16)	3404 (0.12)	21422 (0.90)	2705 (0.1)	29174 (0.9)	-	2566 (0.08)	-	116482 (4.85)	10589.3 (0.43)
C. Non-living forms														
Coral stones etc.	29815 (1.43)	43308 (2.13)	44550 (1.98)	28187 (1.45)	43257 (1.73)	29713 (1.54)	14459 (0.6)	2029 (0.1)	33662 (1.0)	5898 (0.21)	3850 (0.12)	-	278728 (12.29)	25338.9 (1.12)
TOTAL	227988 (12.46)	391218 (19.2)	420280 (18.7)	146805 (7.55)	396849 (15.8)	309496 (15.99)	535532 (22.2)	676185 (21.7)	1122076 (32.9)	536142 (18.69)	213864 (6.54)	-	4976435 (191.79)	452403.18 (17.4)

() : % in total trawl landings

* : Data not available due to change of fishing gears

Observations on the effect of bottom trawling on dislocation of non-edible biota in South East coast of India

Table 3 : Month-wise composition (kg) of non-edible biota dislocated at Rameswaram landing centre (1996-1997)

Group	Apr.'96	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan.'97	Feb	Mar*	Annual total	Annual average
A. Major invertebrate forms														
Crustaceans														
Stomatopods	46906 (0.60)	108239 (2.15)	62348 (1.13)	49389 (2.20)	40213 (1.79)	8627 (0.28)	4209 (0.24)	40297 (1.52)	95874 (4.41)	8623 (0.69)	20198 (0.65)	17861 (0.29)	502784 (15.95)	41898.7 (1.33)
Crabs (Non edible)	400137 (5.15)	450276 (8.94)	300344 (5.43)	41136 (1.83)	31483 (1.40)	26103 (0.86)	124860 (7.01)	46238 (1.74)	117475 (5.40)	5463 (0.43)	69526 (2.23)	194481 (3.19)	1807522 (43.61)	150626.8 (3.63)
Molluscs														
Gastropods & Bivalves	58393 (0.75)	89478 (1.77)	79778 (1.42)	13153 (0.58)	9657 (0.43)	12167 (0.40)	13561 (0.76)	14465 (0.55)	21600 (0.99)	8838 (0.70)	20198 (0.64)	72765 (1.19)	414053 (10.18)	34504.4 (0.85)
Echinoderms														
Sea stars & Sea lily	141675 (1.82)	70716 (1.40)	75086 (1.36)	16506 (0.74)	24604 (1.10)	60833 (2.0)	50037 (2.81)	28931 (1.09)	68211 (3.13)	23513 (1.87)	44862 (1.44)	181913 (2.98)	786887 (21.74)	65573.9 (1.81)
Jelly fish	22974 (0.30)	541197 (10.74)	-	-	6614 (0.30)	8627 (0.28)	7248 (0.41)	66128 (2.49)	40169 (1.85)	2892 (0.23)	7186 (0.23)	30429 (0.50)	733464 (17.33)	61122.0 (1.44)
B. Minor invertebrate forms														
Sea pen	5744 (0.07)	1443 (0.03)	24805 (0.45)	-	-	-	4209 (0.41)	-	-	1446 (0.11)	-	36382 (0.60)	74029 (1.67)	6169.1 (0.14)
Gorgonids	22974 (0.30)	11546 (0.23)	12738 (0.23)	-	529 (0.02)	34730 (1.14)	935 (0.05)	1808 (0.07)	-	107 (0.01)	194 (0.01)	1323 (0.02)	86884 (2.08)	7240.3 (0.17)
Antipatharians	13402 (0.17)	5773 (0.12)	2682 (0.05)	1805 (0.08)	1587 (0.07)	8627 (0.28)	468 (0.03)	1033 (0.04)	-	54 (0.004)	777 (0.02)	3308 (0.05)	39516 (0.91)	3293 (0.07)
Sponges	22974 (0.30)	18762 (0.37)	14749 (0.27)	774 (0.04)	661 (0.03)	664 (0.02)	468 (0.03)	22990 (0.86)	3032 (0.17)	54 (0.004)	1359 (0.04)	18522 (0.20)	105009 (2.33)	8750.7 (0.20)
Ascidians	10530 (0.14)	12989 (0.26)	12738 (0.23)	4900 (0.22)	3704 (0.17)	-	7015 (0.39)	1809 (0.07)	1516 (0.06)	160 (0.01)	14566 (0.47)	1984 (0.03)	71911 (2.05)	5992.6 (0.17)
Seaweeds and Seagrasses	22974 (0.30)	7216 (0.14)	10056 (0.18)	516 (0.02)	3978 (0.02)	8627 (0.28)	5612 (0.32)	17307 (0.65)	15537 (0.71)	1714 (0.14)	777 (0.02)	29768 (0.49)	120501 (3.27)	10041.7 (0.27)
C. Non-living forms														
Coral stones etc.	188581 (2.43)	125558 (2.49)	75086 (1.36)	774 (0.04)	12831 (0.57)	52206 (1.72)	15198 (0.85)	17307 (0.65)	5536 (0.70)	696 (0.06)	14565 (0.47)	72765 (1.19)	591103 (12.53)	49258.6 (1.04)
TOTAL	957266 (12.33)	1443193 (28.64)	670410 (12.1)	128953 (5.75)	132280 (5.9)	221211 (7.27)	233820 (13.13)	258213 (9.73)	378950 (17.42)	53560 (4.26)	194208 (6.22)	661590 (10.84)	5333564 (133.6)	444471.8 (11.13)

() : % in total trawl landings

Table 4 : Month-wise composition (kg) of non-edible biota dislocated at Rameswaram landing centre (1997-1998)

Group*	Apr.'97	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan.'98	Feb	Mar*	Annual total	Annual average
A. Major invertebrate forms														
Crustaceans														
Stomatopods	14344 (0.34)	78416 (1.73)	162820 (4.68)	28975 (0.73)	3739 (0.12)	-	95052 (2.68)	116207 (3.88)	3707 (0.15)	37406 (1.77)	43380 (1.61)	35381 (0.77)	619427 (18.46)	56311.5 (1.68)
Crabs (Non edible)	156190 (3.64)	746762 (16.46)	96947 (2.78)	28604 (0.72)	7435 (0.23)	-	85606 (2.4)	315808 (10.5)	14276 (0.56)	140448 (6.66)	124681 (4.63)	71089 (1.55)	1787846 (50.1)	162531.5 (4.56)
Molluscs														
Gastropods & Bivalves	58438 (1.37)	85654 (1.88)	193136 (5.6)	20431 (0.51)	5244 (0.16)	-	18302 (0.51)	45799 (1.5)	9959 (0.39)	65637 (3.12)	24572 (0.91)	70761 (1.55)	597933 (17.53)	54357.5 (1.59)
Echinoderms														
Sea stars & Sea lily	146096 (3.42)	109782 (2.42)	431288 (12.4)	28975 (0.73)	5200 (0.16)	-	77931 (2.2)	83395 (2.79)	13667 (24.7)	6352 (0.30)	8191 (0.30)	11794 (0.26)	922671 (49.66)	83879.2 (4.51)
Jelly fish	24438 (0.57)	-	57174 (1.64)	11516 (0.29)	8939 (0.28)	-	886 (0.03)	7519 (0.25)	1717 (0.05)	-	21539 (0.80)	23587 (0.52)	157315 (4.43)	14301.4 (0.40)
B. Minor invertebrate forms														
Sea pen	29219 (0.68)	-	41016 (1.18)	23031 (0.58)	-	-	590 (0.02)	-	609 (0.02)	18703 (0.89)	62189 (2.31)	59296 (1.29)	234653 (6.97)	21332.1 (0.63)
Gorgonids	1063 (0.02)	2413 (0.05)	2486 (0.07)	1857 (0.05)	129 (0.004)	-	886 (0.03)	684 (0.02)	-	3176 (0.15)	-	-	12694 (0.39)	1154.0 (0.03)
Antipatharians	2656 (0.06)	1206 (0.03)	3729 (0.11)	2600 (0.07)	387 (0.01)	-	295 (0.01)	1367 (0.05)	-	-	-	2293 (0.05)	14533 (0.39)	1321.2 (0.03)
Sponges	14875 (0.35)	8445 (0.19)	8700 (0.25)	5944 (0.15)	2235 (0.07)	-	590 (0.02)	25292 (0.84)	1881 (0.07)	-	2730 (0.10)	5897 (0.13)	76589 (2.17)	6962.6 (0.19)
Ascidians	1594 (0.04)	86861 (1.91)	-	11516 (0.29)	-	-	1771 (0.05)	684 (0.02)	-	46934 (2.23)	2427 (0.09)	23915 (0.52)	175702 (5.15)	15972.9 (0.47)
Seaweeds and Seagrasses	23907 (0.56)	47050 (1.03)	55931 (1.61)	196510 (4.92)	4469 (0.14)	-	1771 (0.05)	43748 (1.46)	1881 (0.07)	3176 (0.15)	5460 (0.20)	11794 (0.26)	395697 (10.45)	35972.5 (0.95)
C. Non-living forms														
Coral stones etc.	58438 (1.37)	39811 (0.88)	187679 (5.39)	11516 (0.29)	5200 (0.16)	-	11512 (0.32)	43065 (1.44)	9904 (0.39)	3176 (0.15)	8191 (0.30)	11794 (0.26)	390286 (10.95)	35480.5 (0.99)
TOTAL	531258 (12.42)	1206400 (26.58)	1240906 (35.71)	371475 (9.33)	42978 (1.33)	-	295192 (8.32)	683568 (22.8)	57601 (26.4)	325008 (15.4)	303360 (11.3)	327601 (7.15)	5385347 (176.65)	489577 (16.06)

() : % in total trawl landings

* : Data not available due to change of fishing gears

Observations on the effect of bottom trawling on dislocation of non-edible biota in South East coast of India

Table 5 : Month-wise composition (kg) of non-edible biota dislocated at Pampan landing centre (1995-1996)

Group	Apr.'95	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan.'96	Feb	Mar*	Annual total	Annual average
A. Major invertebrate forms														
Crustaceans														
Stomatopods	1538 (0.80)	2448 (0.57)	10915 (3.61)	3485 (0.71)	8455 (1.58)	18365 (3.57)	29869 (4.93)	45060 (6.7)	47722 (6.49)	9741 (2.57)	11321 (1.68)	-	188919 (33.21)	17174 (3.02)
Crabs (Non edible)	899 (0.47)	1944 (0.45)	15191 (5.02)	19012 (3.89)	12303 (2.31)	7865 (1.66)	39756 (0.77)	39796 (5.9)	51955 (7.10)	38881 (10.3)	44024 (6.52)	-	271626 (44.33)	24693 (4.03)
Molluscs														
Gastropods & Bivalves	1270 (0.66)	23580 (5.50)	5321 (1.76)	10140 (2.10)	7030 (1.32)	3933 (0.82)	17692 (2.92)	8212 (1.22)	8852 (1.21)	22362 (6.17)	28301 (4.19)	-	137693 (27.85)	12517 (2.53)
Echinoderms														
Sea stars & Sea lily	1045 (0.54)	2484 (0.58)	4093 (1.35)	7605 (1.56)	9928 (1.86)	649 (0.14)	2081 (0.34)	2000 (0.30)	4105 (0.56)	6439 (1.70)	8595 (1.27)	-	49024 (10.20)	4457 (0.90)
Jelly fish	-	-	7368 (2.44)	3802 (0.78)	-	-	1145 (0.19)	1158 (0.16)	6158 (0.84)	330 (0.09)	629 (0.09)	-	20590 (4.59)	1872 (0.42)
B. Minor invertebrate forms														
Sea pen	276 (0.14)	504 (0.12)	364 (0.12)	507 (0.10)	998 (0.19)	108 (0.02)	2081 (0.34)	-	-	165 (0.04)	210 (0.03)	-	5213 (1.10)	474 (0.10)
Gorgonids	251 (0.13)	684 (0.16)	591 (0.19)	190 (0.04)	380 (0.07)	144 (0.03)	208 (0.03)	-	-	330 (0.09)	419 (0.06)	-	3197 (0.80)	291 (0.07)
Antipatharians	164 (0.09)	180 (0.04)	-	10140 (2.08)	-	72 (0.02)	1249 (0.21)	-	-	495 (0.13)	524 (0.08)	-	12824 (2.65)	1166 (0.24)
Sponges	2583 (1.35)	576 (0.13)	46 (0.02)	507 (0.10)	998 (0.19)	1624 (0.34)	2081 (0.34)	2000 (0.30)	3335 (0.45)	495 (0.13)	315 (0.05)	-	14560 (3.40)	1324 (0.31)
Ascidians	-	72 (0.02)	227 (0.08)	63 (0.01)	143 (0.03)	-	-	106 (0.02)	-	1156 (0.31)	1258 (0.19)	-	3025 (0.66)	275 (0.06)
Seaweeds and Seagrasses	121 (0.06)	576 (0.13)	273 (0.09)	1153 (0.24)	3800 (0.71)	1985 (0.42)	833 (0.14)	4948 (0.74)	3463 (0.46)	330 (0.09)	524 (0.08)	-	18006 (3.16)	1637 (0.29)
C. Non-living forms														
Coral stones etc.	493 (0.26)	2951 (0.67)	1092 (0.36)	1458 (0.30)	3468 (0.65)	1355 (0.28)	7077 (1.77)	2000 (0.30)	2694 (0.36)	826 (0.22)	8700 (1.29)	-	32094 (6.46)	2917 (0.59)
TOTAL	8640 (4.50)	35999 (8.37)	45481 (15.04)	58062 (11.9)	47503 (8.91)	36080 (7.3)	104072 (11.98)	105280 (15.6)	128284 (17.47)	82550 (21.8)	104820 (15.53)	-	756771 (138.4)	68797 (12.56)

() : % in total trawl landings

* : Data not available due to change of fishing gears

Table 6 : Month-wise composition (kg) of non-edible biota dislocated at Pamban landing centre (1996-1997)

Group	Apr.'96	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan.'97	Feb	Mar*	Annual total	Annual average
A. Major invertebrate forms														
Crustaceans														
Stomatopods	2410 (1.29)	5336 (1.36)	8707 (2.95)	10558 (5.1)	52930 (3.68)	20577 (3.48)	8954 (0.56)	1833 (0.69)	2755 (0.08)	99 (0.003)	6308 (0.21)	284 (0.02)	120751 (19.42)	10062.6 (1.62)
Crabs (Non edible)	18099 (9.67)	20079 (5.11)	8138 (2.76)	6610 (3.2)	18848 (1.32)	20506 (3.45)	25071 (1.56)	10925 (4.13)	4133 (0.12)	149 (0.01)	16573 (0.56)	11234 (0.60)	160365 (32.49)	13363.7 (2.71)
Molluscs														
Gastropods & Bivalves	10870 (5.80)	5336 (1.36)	7284 (2.47)	1173 (0.57)	13477 (0.94)	12488 (2.10)	4298 (0.26)	6379 (2.41)	3099 (0.09)	3301 (0.10)	11547 (0.39)	3933 (0.21)	83185 (16.70)	6932.1 (1.39)
Echinoderms														
Sea stars & Sea lily	8460 (4.52)	6693 (1.70)	3499 (1.19)	406 (0.20)	684 (0.05)	10289 (1.73)	4298 (0.27)	9092 (3.40)	6199 (0.18)	5509 (0.17)	6308 (0.21)	3934 (0.21)	65371 (13.86)	5447.6 (1.15)
Jelly fish	-	-	5819 (1.97)	2662 (1.29)	-	4115 (0.69)	3530 (0.22)	4546 (1.72)	5510 (0.16)	50 (0.002)	3849 (0.13)	284 (0.02)	30365 (6.20)	2530.4 (0.52)
B. Minor invertebrate forms														
Sea pen	257 (0.14)	328 (0.80)	855 (0.29)	-	-	-	-	-	-	-	-	-	1440 (1.23)	120 (0.10)
Gorgonids	615 (0.33)	1030 (0.26)	569 (0.19)	45 (0.02)	195 (0.01)	852 (0.14)	1074 (0.07)	367 (0.14)	3444 (0.09)	25 (0.001)	428 (0.01)	70 (0.004)	8714 (1.26)	726.2 (0.10)
Antipatharians	359 (0.19)	655 (0.17)	1465 (0.50)	135 (0.07)	195 (0.01)	1064 (0.18)	716 (0.04)	1832 (0.69)	138 (0.004)	50 (0.002)	7698 (0.26)	70 (0.004)	14377 (2.12)	1198.1 (0.18)
Sponges	8460 (4.52)	3323 (0.85)	569 (0.19)	135 (0.07)	7617 (0.53)	426 (0.07)	2507 (0.16)	9092 (3.43)	4822 (0.14)	74 (0.002)	1925 (0.06)	142 (0.002)	39092 (9.89)	3257.7 (0.82)
Ascidians	615 (0.33)	1685 (0.43)	569 (0.19)	135 (0.07)	-	-	-	-	207 (0.01)	49 (0.002)	-	5918 (0.32)	9178 (1.35)	764.8 (0.11)
Seaweeds and Seagrasses	615 (0.33)	655 (0.17)	285 (0.10)	45 (0.02)	195 (0.01)	639 (0.11)	716 (0.04)	9092 (3.43)	2066 (0.06)	15187 (0.47)	43410 (1.46)	7584 (0.41)	80489 (6.61)	6707 (0.55)
C. Non-living forms														
Coral stones etc.	513 (0.27)	1685 (0.43)	2930 (0.99)	654 (0.32)	3516 (0.25)	-	-	20163 (7.62)	2060 (0.06)	323 (0.01)	8874 (0.30)	1985 (0.11)	42703 (10.36)	3558.6 (0.86)
TOTAL	51273 (27.4)	46805 (12.6)	40689 (13.8)	22558 (10.9)	97657 (6.80)	70956 (11.9)	51164 (3.18)	73321 (27.7)	34433 (0.99)	24816 (0.68)	106920 (3.59)	35438 (1.91)	656030 (121.49)	54670 (10.07)

() : % in total trawl landings

* : Data not available due to change of fishing gears

Observations on the effect of bottom trawling on dislocation of non-edible biota in South East coast of India

Table 7 : Month-wise composition (kg) of non-edible biota dislocated at Pamban landing centre (1997-1998)

Group	Apr.'97	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan.'98	Feb	Mar*	Annual total	Annual average
A. Major invertebrate forms														
Crustaceans														
Stomatopods	770 (0.07)	990 (1.11)	15319 (3.93)	8417 (1.38)	24304 (1.83)	-	8756 (1.26)	-	402 (0.16)	235 (1.92)	218 (1.01)	2383 (8.25)	61794 (20.92)	6179.4 (2.09)
Crabs (Non edible)	4671 (0.45)	1379 (1.55)	68994 (17.72)	14013 (2.30)	3484 (0.26)	-	8756 (1.26)	-	1551 (0.63)	1386 (11.3)	4351 (20.14)	1879 (6.5)	110464 (62.11)	11046.4 (6.21)
Molluscs														
Gastropods & Bivalves	3025 (0.30)	400 (0.45)	12350 (3.17)	10665 (1.74)	6246 (0.47)	-	11369 (1.63)	-	1022 (0.51)	108 (1.88)	648 (2.99)	361 (1.25)	46194 (13.39)	4619.4 (1.34)
Echinoderms														
Sea stars & Sea lily	2241 (0.22)	384 (0.43)	4631 (1.19)	3922 (0.64)	681 (0.05)	-	2612 (0.38)	-	185 (0.07)	299 (2.43)	109 (0.56)	362 (1.25)	15426 (7.16)	1542.6 (0.72)
Jelly fish	-	1653 (1.86)	7719 (1.98)	3396 (0.56)	1401 (0.11)	-	-	-	-	41 (0.33)	-	-	14210 (4.84)	1421.0 (0.48)
B. Minor invertebrate forms														
Sea pen	67 (0.01)	16 (0.02)	1069 (0.27)	-	-	-	-	-	-	-	-	-	1152 (0.30)	115.2 (0.03)
Gorgonids	121 (0.01)	-	1188 (0.31)	191 (0.03)	2082 (0.16)	-	147 (0.02)	-	16 (0.01)	5 (0.04)	-	-	3750 (0.57)	375.0 (0.06)
Antipatharians	1877 (0.18)	11 (0.01)	1900 (0.49)	287 (0.05)	360 (0.03)	-	221 (0.03)	-	8 (0.003)	7 (0.06)	-	-	4671 (0.85)	467.1 (0.08)
Sponges	94 (0.02)	305 (0.34)	713 (0.18)	3348 (0.55)	561 (0.04)	-	2171 (0.3)	-	16 (0.01)	10 (0.08)	55 (0.25)	-	7273 (1.78)	727.3 (0.18)
Ascidians	162 (0.01)	-	713 (0.18)	96 (0.02)	-	-	-	-	4 (0.002)	5 (0.04)	24 (0.11)	368 (1.27)	1372 (1.63)	137.2 (0.16)
Seaweeds and Seagrasses	162 (0.01)	11 (0.01)	356 (0.09)	96 (0.02)	280 (0.02)	-	184 (0.03)	-	122 (0.05)	277 (2.26)	218 (1.01)	433 (1.5)	2139 (5.00)	213.9 (0.50)
C. Non-living forms														
Coral stones etc.	310 (0.03)	116 (0.13)	3800 (0.98)	3396 (0.56)	641 (0.05)	-	2575 (0.37)	-	619 (0.25)	22 (0.18)	436 (2.02)	142 (0.49)	12057 (5.06)	1205.7 (0.51)
TOTAL	13500 (1.30)	5265 (5.91)	118752 (30.5)	47827 (7.85)	40040 (3.02)	-	36791 (5.29)	-	3945 (1.59)	2395 (19.5)	6059 (28.03)	5928 (20.5)	280502 (123.5)	28050.1 (12.35)

() : % in total trawl landings

* : Data not available due to change of fishing gears

tune of 1.1 t (February) to 29.2 t (December). Antipatharians were found in low quantity, 0.4 t in July and 5.4 t in January. Ascidians were recorded in April (0.78 t), July (0.29 t) and August (10.3 t). Non living forms of biological origin were estimated to be 278.7 t in the bottom trawl landing of 1995-96.

During 1996-97 a total of 5335 t of non-edible biota were landed by 92,698 trawl units. Non-edible crabs dominated the dislocated biota with a total of 1807 t and the monthly catch ranged from 5.5 t in January to 450.3 t in May. Large quantity of echinoderms to the tune of 786.9 t were caught by this gear with an average monthly landing of 65.6 t. Their dislocation was low in the range of 16.5 (July) to 28.9 t (November) and moderate in May, June, September, October, December and February in the range of 44.9 (February) to 75.1 t (June) and high in April (141.7 t) and March (181.9 t). The annual total stomatopod dislocation was low during September, October and January to March ranging from 4.2 (October) to 20.2 t (February), moderate during July, August and November ranging from 40.2 (August) to 49.3 t (July) and was high in May, June and December (62.3 to 108.2 t). The annual landing of gastropods and bivalves together was 414.1 t with a monthly mean of 34.5 t. Their dislocation was low during July to February (8.8 t in January to 21.6 t in December) and high during April to June and March (58.4 t in April to 89.5 t in May). Jelly fishes were landed to an extent of 733.4 t with a monthly average of 61.1 t. It was low during January, August to October and February (2.9 to 8.6 t) and was moderate during April, November, December and March (22.9 t in April to 66.1 t in November) and very high during May (541.2 t).

Among the minor biota landed by trawlers, sea plants formed 120.5 t and their monthly catch fluctuated from 0.4 t (August) to 29.8 t (March). Sponges were landed to the tune of 105 t with the highest catch of 23.0 t recorded in November. During this year 86.9 t of gorgonids were caught by the trawlers. The discards were low in August, October, November and January to March (0.1 t in January to 1.8 t in November) and was more in April to June and September (11.5 t in May to 34.7 t in September). A total of 71.9 t of Ascidians were dislocated in this year. These landings were low during November to January and March (0.16 t in January to 1.98 t in March), moderate in July (4.9 t) and August (3.7 t) and was high in April to June, October and February in the range of 7.0 (October) to 14.6 t (February). About 39.5 t of Antipatharians were dislocated during this year. Their landings were low in October, November, January and February (0.05 in January to 1.0 t in November), moderate in June to August, November and March (1.6 to 3.3 t) and was more in April, May and September (5.7 in May to 13.4 t in April). Besides the above, during this year about 591 t of dead shells and corals were also discarded by the trawlers.

An estimated 5385 t of non-edible biota was dislocated from the bottom habitat and discarded during 1997-98. Several species of non-edible crabs dominated the catch (1787.9 t). Their landing was low during July (28.6 t), August (7.4 t) and December (14.3 t), moderate during April, June, October and January to March (71.1 t in March to 156.2 t in April) and was high in May (746.7 t) and November (315 t). Echinoderms were next dominant group forming 922.7 t. Their landing was low during July, August and December to March (5.2 t in August and 28.9 t in July), moderate during October (77.9 t) and November (83.4 t) and was high during April (146.1 t), May (109.8 t) and June (431.3 t). Stomatopods formed 619 t in the annual total catch and the monthly landings ranged from 3.7 (August) to 162.8 t (June). Molluscs landing was to the tune of 597.9 t during the year 1997-98. It was low during July to December and February (5.2 t in August to 45.8 t in November) and was more in April, May, June, January and March (58.4 t in April to 193.1 t in June). Jelly fishes landed to the tune of 157.3 t and the monthly catch ranged from 0.9 (October) to 57.2 t (June).

Sea plants were invariably dislocated by the bottom trawl and their annual landing was 395.7 t (ranging from 1.8 t in October to 196.5 t in July). The sea-pen dislocation ranged from 0.6 t (October) to 62.2 t (February) and the annual landing was 234.7 t. About 175.4 t of Ascidians were caught in the monthly range of 0.68 t (November) to 86.9 t (May). Sponges were dislocated to the extent of 76.6 t and their monthly landings ranged from 0.6 t (October) to 62.2 t (February) and the annual landing was 234.7 t. About 175.4 t of Ascidians were caught in the monthly range of 0.68 t (November) to 86.9 t (May). Sponges were dislocated to the extent of 76.6 and their monthly landings ranged from 0.6 t (August) to 25.3 t (November). Antipatharians were dislocated to the tune of 0.4 t (August) to 3.7 t (June) and their total catch was 14.5 t. Gorgonids occurred frequently in the trawl landings and in 1997-98 the catch was 12.7 t with peak landings in January (3.2 t).

The total non-edible biota dislocated at Rameswaram landing centre during the observation period 1995-1998 along with the relative proportion of major, minor invertebrate forms (including sea plants) and non-living components are shown in Table 8.

Table 8 : Relative proportion of major, minor invertebrate and non-living components of the total non-edible biota dislocated at Rameswaram and Pamban landing centres (1995-1998)

Components	Rameswaram			Pamban		
	95-96	96-97	97-98	95-96	96-97	97-98
Total non-edible biota (t)	4976.4	5333.6	5385.3	756.8	656.0	280.5
Major invertebrate forms (t / %)	4295.8 (86.3)	4244.7 (79.6)	4085.2 (75.8)	667.9 (88.2)	460.0 (70.12)	248.1 (88.45)
Minor invertebrate forms (t / %)	401.9 (8.08)	497.8 (9.3)	909.9 (16.9)	56.8 (7.51)	153.3 (23.37)	20.4 (7.27)
Non-living forms (t / %)	278.7 (5.6)	591.1 (11.1)	390.3 (7.2)	32.1 (4.24)	42.7 (6.51)	12.0 (4.28)

Pamban landing centre (Gulf of Mannar)

During 1995-96, a total of 13,051 trawlers were operated in the Gulf of Mannar and landed an estimated 756.8 t of non-edible biota at Pamban. Among the major invertebrates caught, non-edible crab was dominant, 0.9 t (April) and 51.9 t (December) and their annual total dislocation was 272 t. Stomatopod catch was to the tune of 188.9 t ranging from 1.5 (April) to 11.3 t (February). Gastropods and bivalve dislocation was 137.7 t with the peak occurrence during May, October, January and February in the range of 17.7 (October) to 28.3 t (February). About 49.0 t of Echinoderms were dislocated with peak occurrence in July, August, January and February with a range of 6.4 (January) to 8.6 t (February). Jelly fishes were caught in trawl to an extent of 20.6 t with the maximum landing in June (7.4 t).

Sea-pen dislocation was 5.2 t during the year with peak landing in October (2.0 t). Gorgonids were dislocated to the tune of 3.2 t and were frequent in the catches of April (0.3 t), January (0.3 t) to May (0.68 t). Out of 12.8 t of Antipatharians caught during this year, 78% of them landed in July. Sponges accounted for 14.6 t in the trawl catch with the maximum occurrence in December (3.3 t). Ascidiars appeared in the catch infrequently with 0.06 (July) to 1.26 t (February). Sea grass and sea weeds were commonly dislocated in August, September, November and December in the range of 2.0 to 5.0 t. An estimated quantity of 32.0 t of dead shells and corals were also landed in the year 1995-96.

In 1996-97, 10,685 trawlers were operated at this centre landing 656 t of non-edible biota at a catch rate of 61.5 kg/unit effort. Non-edible crabs

dominated the discard (160.4 t) ranging from 0.15 (January) to 25.1 t (October). Their dislocation was low during June, July, November to January and March (0.15 to 11.2 t) and was more during April, May, August to October and February (16.6 t in February to 25.1 t in October). Total Stomatopod dislocation was 120.7 t ranging from 0.1 (January) to 52.9 t (August). Its landing was low during April to June, October and November (0.1 t in January to 8.9 t in October) and high during July (10.5 t) to September (20.6 t). The molluscs formed 83 t in the trawl catch with a range of 1.2 (July) to 13.5 t (August). Echinoderms landed in sizeable quantity (65.4 t) ranging from 3.5 (June) to 10.3 t (September). Jelly fish was caught frequently during June (5.8 t) and July (2.7 t) with a mean monthly landing of 2.5 t.

The dislocation of Sponges ranged from 0.07 (January) to 9.1 t (November) with a monthly average of 3.2 t. Antipatharians landed at a rate of 1.2 t/month with the peak in February (7.7 t). Gorgonids occurrence ranged from 0.02 (January) to 3.4 t (December). Its occurrence was more (0.85 to 1.1 t) during May, September and October with a maximum of 3.4 t in December. Seapen were discarded only during April (0.26 t) to June (0.86 t), whereas ascidians landing ranged from 0.05 (January) to 5.9 t (March). Sea plants were dislocated to the tune of 6.7 t/month. About 42.7 t of dead shells and corals were also landed by the trawlers during 1996-97.

During 1997-98, the trawlers landed an estimated 280.5 t of non-edible biota by an effort input of 5662 units. Non-edible crab was the dominant group (110.5 t) with an average catch of 11.0 t/month. Its dislocation ranged from 1.4 (May and January) to 69.0 t (June). Stomatopods appeared in low quantities in April, May and December to March (0.22 to 2.4 t) and was more during June to August and October (8.4 to 24.3 t) with an average of 6.2 t/month. Dislocations of molluscs were more during June to August and October in the range of 6.2 to 12.4 t with a monthly mean of 4.6 t. During April, June, July and October, echinoderms were dislocated in the range of 2.2 to 4.6 t and in May, August and December to March, 0.12 to 0.68 t. The bycatch of Jelly fish ranged from 0.04 (January) to 7.7 t in June.

Sponges monthly landings fluctuated from 0.01 to 3.3 t, whereas the antipatharians catch ranged from 0.01 (January) to 1.9 t (June). Gorgonids were found more in June, August (1.2 & 2.1 t), low in April, July and October (0.12 to 0.19 t), ascidian landings were negligible during December and January and varied from 0.004 to 0.7 t in the remaining months. Seapen was recorded in April and May in the range of 0.02 to 0.06 t and in June, 1.1 t. Sea plants were present moderately throughout the period in quantity ranging from 0.01 to 0.4 t. Non-living bycatch during the year was 12.0 t.

The total non-edible biota dislocated at Pamban landing centre during the observation period 1995-1998 along with the relative proportion of major, minor invertebrate forms (including sea plants) and non-living components are shown in Table 8.

Discussion

The data presented in this paper on the bottom trawl dislocated non-edible biota of the two major landing centre of this region is an extensive, broad based one to serve as a 'Data base' for future specific work. The average proportion of non-edible component as against edible proportion was more at Rameswaram (38.1%) than at Pamban (33.9%).

The yearly dislocation/unit (Table 9) was varying in different years (58.0, 61.5 & 49.5 kg) at Pamban whereas at Rameswaram it was in an ascending order (44.7, 57.5 & 71.5 kg). The overall average dislocation for the observation period (1995-1998) was 56.3 kg/unit effort respectively.

Table 9 : Estimated average non-edible biota dislocated / unit at Rameswaram and Pamban landing centre (1995-1998)

Landing centre	1995-96	1996-97	1997-98
Rameswaram Landing Centre			
Average units / month (Nos.)	10,127	7,725	6,844
Average non-edible biota dislocated / month (tonnes)	452.4	444.5	489.6
Average non-edible biota dislocated / unit (Kgs.)	44.7	57.5	71.5
Pamban Landing Centre			
Average units / month (Nos.)	1,186	890	565
Average non-edible biota dislocated / month (tonnes)	68.8	54.7	28.0
Average non-edible biota dislocated / unit (Kgs.)	58.0	61.5	49.5

The percentage composition of the different groups of non-edible biota of both the landing centres (Table 10) revealed that non-edible crab was the dominant group dislocated at both the centres (4.3 & 4.6%) followed by echinoderms (3.1%), stomatopods (2.1%) and molluscs (1.8%) at Rameswaram,

whereas at Pamban, it was stomatopods (2.2%), molluscs (1.75%) and echinoderms (0.9%).

Table 10 : Group-wise composition (%) of major and minor invertebrate forms in relation to total trawl landing at Rameswaram and Pamban (1995-1998)

Group / Year	Rameswaram Landing Centre				Pamban Landing Centre			
	95-96	96-97	97-98	Av.	95-96	96-97	97-98	Av.
Major invertebrate forms								
Crab (non-edible)	5.79	3.63	4.58	4.66	4.03	2.71	6.21	4.34
Stomatopods	3.32	1.33	1.68	2.11	3.02	1.62	2.09	2.24
Molluscs	2.82	0.85	1.59	1.75	2.53	1.39	1.34	1.75
Echinoderms	3.00	1.81	4.51	3.11	0.90	1.15	0.72	0.92
Jelly fish	0.04	1.44	0.40	0.62	0.42	0.52	0.48	0.47
Minor invertebrate forms								
Sea pen	0.47	0.14	0.63	0.41	0.10	0.10	0.03	0.08
Gorgonids	0.21	0.17	0.03	0.14	0.07	0.10	0.06	0.08
Antipatharians	0.05	0.07	0.03	0.05	0.24	0.18	0.08	0.17
Sponges	0.22	0.20	0.19	0.20	0.31	0.82	0.18	0.47
Ascidians	0.04	0.17	0.47	0.23	0.06	0.11	0.16	0.11
Sea plants	0.44	0.27	0.95	0.55	0.29	0.55	0.50	0.45

The reasons for the non availability of different groups of organisms in various months during the observation period could not be attributed as the non-representation does not show any pattern.

Among the minor invertebrate forms, jelly fish and sea plants were dominating (0.6 & 0.55%) followed by sea-pen (0.4%), ascidians (0.23%), sponges (0.2%), gorgonids (0.14%) and antipatharians (0.05%) at Rameswaram whereas at Pamban jelly fish, sponges and sea plants were equally dislocated (0.44 - 0.47%) followed by antipatharians (0.07%), ascidians (0.11%), sea-pen and gorgonids (0.08%). Many of these sedentary organisms are of great value for extraction of different bioactive components of biomedical importance. The dislocation of such biota might affect the biodiversity of coastal habitats of Palk Bay and Gulf of Mannar.

Comparison of total discard in respect of trawlers operated in a particular centre would yield information on the average discard by weight and

composition of different animal groups. A sequential analysis of such information over a fairly longer period is expected to yield information about :

- (i) any significant quantum reduction in the dislocation
- (ii) any significant elimination of representing groups
- (iii) the above information is of greatest importance to understand the nature and extent of damage being caused to the benthic ecosystem due to the operation of coastal bottom trawlers.

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