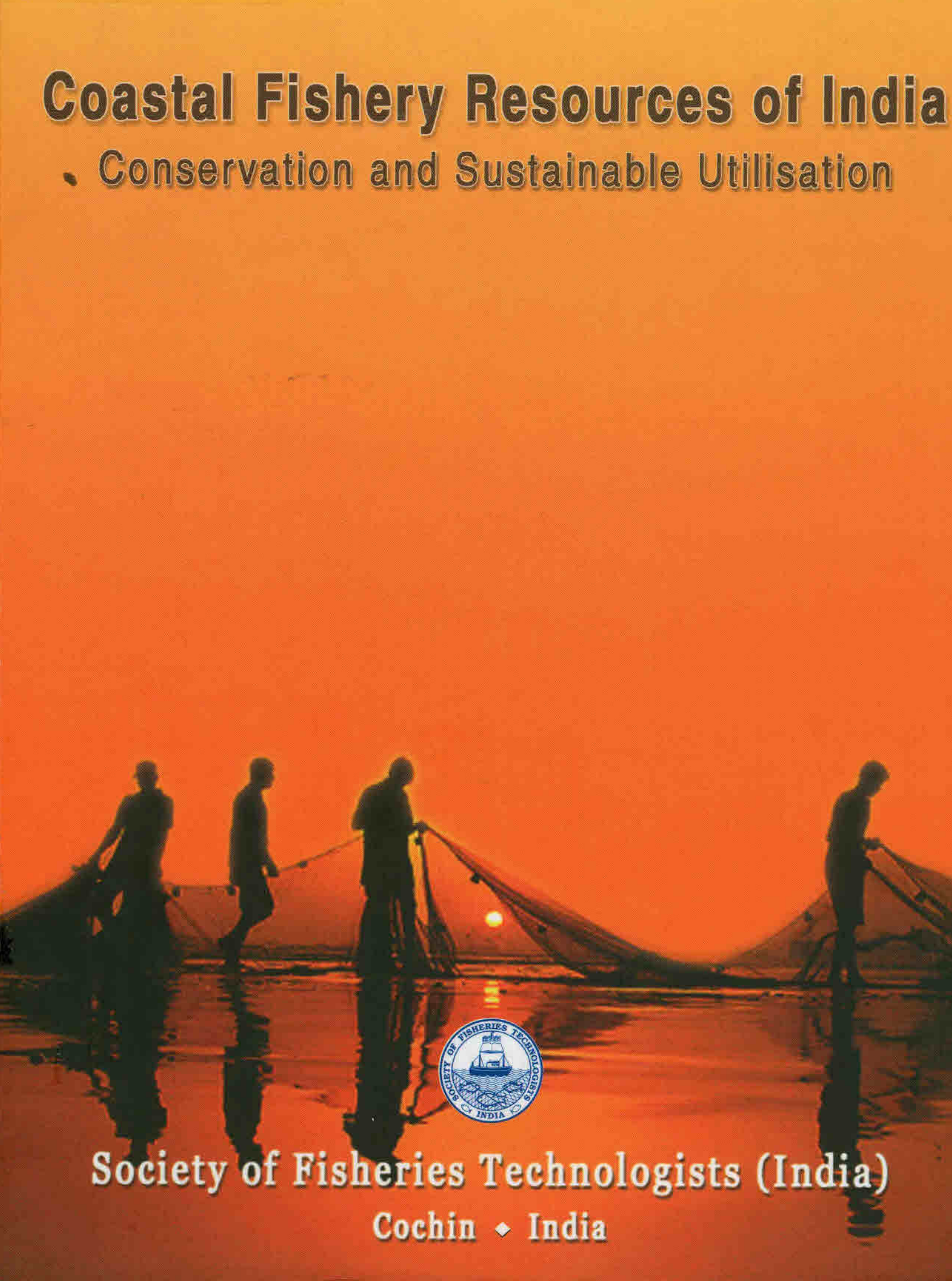
Coastal Fishery Resources of India

Conservation and Sustainable Utilisation



Society of Fisheries Technologists (India)
Cochin ◆ India

Coastal Fishery Resources of India: Conservation and Sustainable Utilisation

Proceedings of the National Seminar on Conservation and Sustainability of Coastal Living Resources of India, 1-3 December 2009, Cochin

Organised by
Society of Fisheries Technologists (India), Cochin
and
Centre for Ocean and Environmental Studies, New Delhi

In association with
Ministry of Earth Sciences (New Delhi)
Central Marine Fisheries Research Institute (Cochin)
National Institute of Oceanography (Goa) and
Central Institute of Fisheries Technology (Cochin)

MoES

ISBN: 978-81-901038-7-9

Published by
Society of Fisheries Technologists (India)
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, India

URL : www.fishtech.org
Phone : 91 (0)484-2666845
Fax : 91 (0)484-2668212
Telegram : FISHTECH / MATSYAOUDYOGIKI
E-mail : cift@ciftmail.org
enk_ciftaris@sancharnet.in

Citation:

Rao, G.S. (2010) Current status and prospects of fishery resources of the Indian continental shelf, In: Coastal Fishery Resources of India: Conservation and Sustainable Utilisation (Meenakumari, B., Boopendranath, M.R., Edwin, L., Sankar, T.V., Gopal, N. and Ninan, G., Eds.), p. 1-13, Society of Fisheries Technologists (India), Cochin

Cover design: Vineethkumar, P., CIFT, Cochin

Printed at PAICO, Cochin - 682 035, India

Coastal Fishery Resources of India

Conservation and Sustainable Utilisation

Editors

B. Meenakumari
M.R. Boopendranath
Leela Edwin
T.V. Sankar
Nikita Gopal
George Ninan

Society of Fisheries Technologists (India)
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, India

2010

Impact of Bottom Trawling on the Meiobenthos off Veraval Coast, Gujarat

Usha Bhagirathan*, B. Meenakumari, Satyen Kumar Panda
V. R. Madhu, D. T. Vaghela
Central Institute of Fisheries Technology
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, Kerala, India
**Email: ushasreenath@yahoo.co.in*

Introduction

The commercial trawler fleet of India consists of 29,241 small and medium fishing boats (CMFRI, 2006). The northwest coast of India has the highest number of mechanized vessels operating in the Arabian Sea (Vivekanandan *et al.*, 2005). The recommended optimum fleet size of mechanised trawlers for Gujarat is 1,473 (Kurup and Devaraj, 2000). However, presently 7402 commercial trawlers are operating in Gujarat waters (Anon, 2005). Veraval is an important fishing port of Gujarat from where 2793 trawlers are being operated (Anon, 2005).

Infauna are animals that live entirely within the sediment. Meiofauna are infaunal organisms that pass through a 500 µm sieve, but are retained in a 63 µm sieve (Mare, 1942). They contribute significantly to the processing of carbon by benthic communities because they are abundant and have higher rates of reproduction and growth. The meiofauna have high diversity and lack pelagic larvae. For these reasons, meiofauna are widely regarded as ideal organisms to study the potential ecological effects of anthropogenic impacts (Coull and Chandler, 1992). The impact of chronic trawling disturbance on meiofauna has been investigated in North Sea (Duplisea *et al.,* 2002; Schratzberger and Jennings, 2002; Schratzberger *et al.,* 2002) and in Thermaikos Gulf (Lampadariou *et al.*, 2005). In India, studies on meiobenthos have been conducted off Kerala coast by Kurup (2004a), Sreedevi (2008) and off Mangalore coast by Zacharia (2004) and Gowda (2004). The aim of the present study is to assess the impact of bottom trawling on meiofaunal communities in the commercial fishing grounds, off Veraval (Gujarat, India).

Materials and Methods

Experimental bottom trawling was carried out every month, for 15 months (September 2005 - November 2006) excluding the trawl ban period

(June to August) in the fishing ground off Veraval (20°542 N lat and longitude 70°222 E long) (Gujarat, India) (Fig. 1). Trawling was carried out from CIFT Research vessel MFV Sagarkripa (15.5 m L_{OA}; 125 hp stern trawler) along five transects representing five depth zones ranging from 15 to 40m. The experimental design involves the collection of sediment samples before and after experimental trawling along the pre-identified track. Transect, corresponding to a particular depth zone was fixed using a GPS (Garmin, USA) installed onboard the vessel and coordinates were stored for navigation to the respective stations for sample collection. A dual frequency (50/200 kHz) Fish Finder (Simrad, Norway) was also used to fix transects by avoiding areas with rocky bottom and other physical disturbances. The five transects included five depth zones of 15-20 m, 21-25 m, 26-30 m, 31-35 m and 36-40 m, off Veraval coast. From the point fixed in the pre-identified depth zone, sediment samples were collected using a van Veen Grab ($0.1 m^2$ mouth area) before and after experimental trawling. A 34 m head rope four seam high opening bottom trawl net rigged with 23 kg of sinkers in the foot rope, seven numbers of 150 mm Ø plastic floats in the head rope and a pair of V- form steel otter boards (80 kg each) was used for fishing operations. The mesh sizes ranged from 400 mm in the wing sections, 300 to 90 mm in the belly sections and 40 mm in the codend. This type of trawl net is commonly used by fishermen of Veraval. The tow duration was one hour in each depth zone and operations were repeated, every month during the study period.

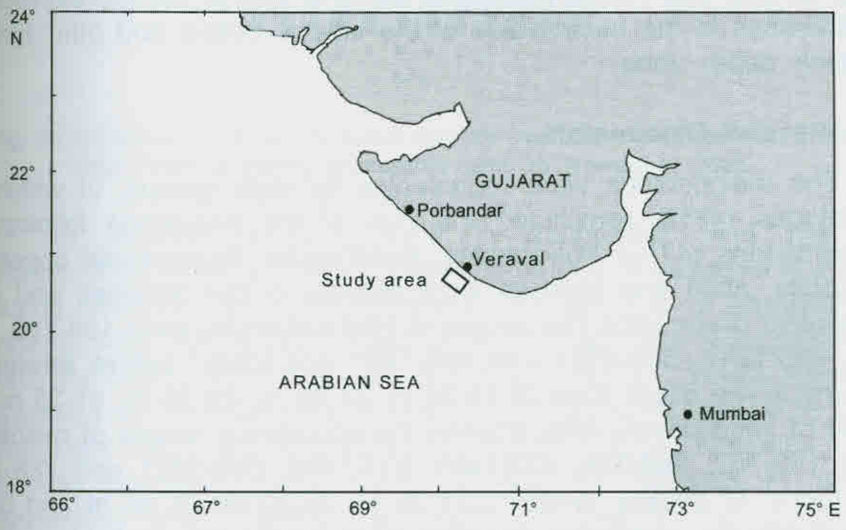


Fig. 1: Map showing study area

Immediately after hauling the van Veen grab, the undisturbed nature of the sediment was ascertained and sub samples were taken for meiobenthos by using a glass corer with an internal diameter of 3.81 cm and a length of 20 cm. The core samples were sliced onboard into 3 equal parts of upper, lower and middle portion. Each portion was then transferred to 150 ml plastic bottles and fixed in 7% buffered formalin. In the laboratory, the core samples were washed through a set of 500 µm and 63 µm sieves. The sediment retained in the 63 µm was used for meiofauna extraction by the classic method of decantation. All meiofaunal organisms were sorted from sediment and enumerated under stereomicroscope. The organisms were preserved in 5% buffered formalin and identified to the group level. The organisms that were intact were counted and numerical density was recorded in numbers per 10 cm^2. The diversity indices of meiofaunal organisms before and after trawling were calculated using PRIMER v5 software package (Version 5.2.9; Plymouth Marine Laboratory, Plymouth, UK) (Clarke and Warwick, 2001). The biodiversity indices such as species (S), number (N), Margalef index (d), Pielou's evenness index (J'), Brillouin index (H), Fisher's Alpha (α), Shannon index (H'), Simpson index (1-λ'), Hill's number (N1 and N2), taxonomic diversity index Δ), taxonomic distinctness index (Δ*), average taxonomic diversity index (Δ+), total taxonomic diversity index (s Δ+), variation in taxonomic distinctness (Var TD or Lambda+), average phylogenetic diversity (φ+) and phylogenetic diversity (s φ+) were analysed. The $\log_{10}$ (X+1) transformed indices were used for one way ANOVA using SPSS 12.0 to find out the significance of difference in the mean value of the indices before and after trawling in each depth zone.

Results and Discussion

The meiobenthos were represented by eight groups, of which the nematodes (48%) constituted the bulk of the population followed by foraminiferans (47%). Polychaetes, kinorhynchs, harpacticoid copepods, ostracods, acari and bivalves were present in low densities and were of irregular occurrence. The ranges of total meiofauna were 134-710, 180-737, 385-1247, 509-1581 and 668-1851 nos.10cm^{-2} before trawling at stations in the depth zone of 15-20 m, 21-25 m, 26-30 m, 31-35 m and 36-40 m, respectively. After trawling the abundance ranges of meiofauna were 153-762, 258-835, 472-1405, 557-1656, 668-1851 and 788-2273 nos.10cm^{-2} at depths 15-20 m, 21-25 m, 26-30 m, 31-35 m and 36-40 m, respectively. Meiofauna densities were appreciably high along 36-40 m depth (mean: 1177 nos.10cm^{-2}) and lowest at depth 15-20 m (mean:

391 nos.10cm^{-2}). More than 90% of the fauna resided in the upper core. The total numerical abundance increased after trawling at all depths (Fig. 2).

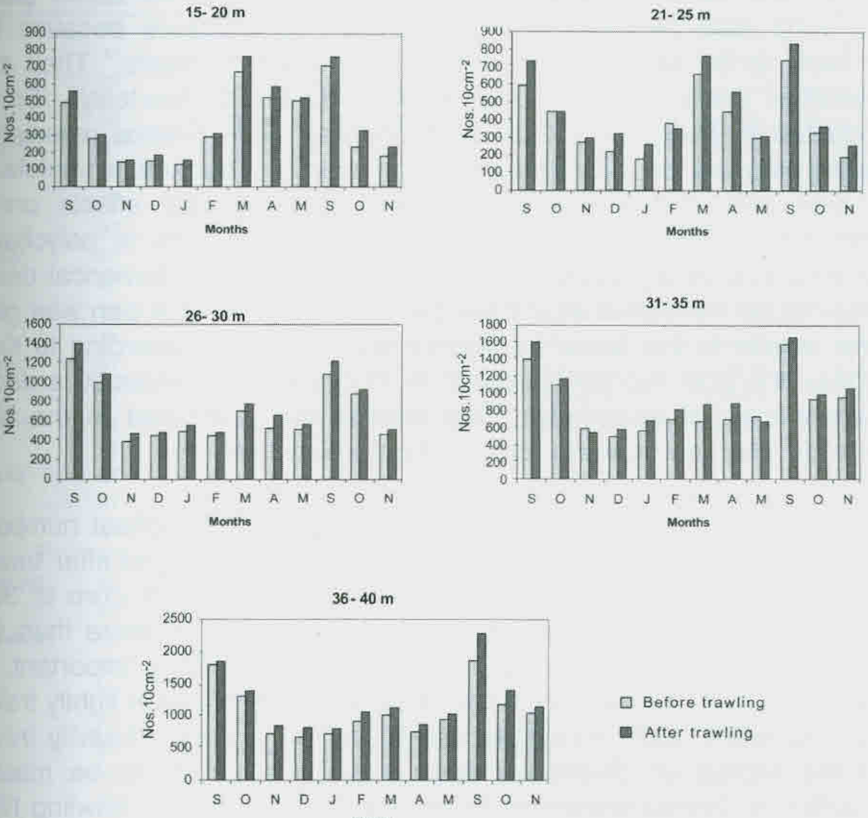


Fig. 2: Variations in total numerical density (nos.10cm^{-2}) of meiofauna before and after trawling during September 2005 to November 2006

An average 13% increase in abundance was noted after experimental trawling. This increase can be due to exposure of organisms during churning up of the sediment. The increase in abundance after trawling was mainly contributed by nematodes and foraminiferans that form the major proportion of fauna at all depths. Similar results were observed in the studies conducted at Kerala and Mangalore showing significant increase in the density of nematodes and foraminiferans after trawling (Zacharia, 2004; Kurup, 2004b). The increase in number of nematodes after trawling has been attributed to the dominance of opportunistic species in response to bottom trawling (Gowda, 2004).

According to Zacharia (2004) the impact on meiobenthos varied with the depth. The numerical density and biomass of meiofauna increased at 10 and 20 m depths after trawling while a decrease was noted at 30, 40 and 50 m depths. According to Lampadariou *et al.* (2005), meiofauna may be more resistant to trawling pressure because they are likely to be re-suspended rather than killed by trawls. Their short generation times allow populations to endure high mortality. Studies conducted in Thermaikos Gulf, north Aegean Sea, Greece revealed no trawling impacts on abundance and community structure of meiofauna, 30 days after trawling. But there were recognizable effects on the community structure of nematodes and the abundance of polychaetes (Lampadariou *et al.*, 2005). In the present study, the numerical density of meiofauna increased after trawl ban showing that trawl ban was giving some respite to the fauna for rejuvenation (Fig. 2). According to Kurup (2004a), the post monsoon season in Kerala coast manifested a decline in abundance of nematodes. This decline was attributed to the lift of monsoon ban on trawling during this season.

Out of seventeen diversity indices analysed, the highest number of indices (ten) that significantly differed ($P < 0.05$) before and after trawling is in the upper core at 15-20 m (Table 1). In the upper core at 36-40 m, none of the indices were significantly different. As more than 90% of the fauna, resides in the upper core this result is very important. The impact of bottom trawling is evident at 15-20 m depth as it is lightly trawled area. As water depth increases (36-40 m) the station is heavily trawled and the impact on diversity indices may be assumed to be masked. According to Schratzberger and Jennings (2002), chronic trawling has a significant impact on the composition of meiofaunal assemblages of North Sea. They analysed nematode communities in beam-trawled fishing areas in the central North Sea. The number of species, diversity and species richness of the community were significantly lower in the area subjected to high levels of trawling disturbance than in the areas of low or medium levels of disturbance. The level of disturbance at the 'low' and 'medium' areas is insufficient to cause marked long term changes in community structure. The smaller meiofauna that are very productive and have fast generation times are relatively unaffected by experimental trawling disturbance (Schratzberger *et al.*, 2002; Duplisea *et al.*, 2002). The diversity indices reduced after trawling in the studies conducted by Zacharia (2004) along Mangalore coast and Kurup (2004b) along Kerala coast.

Table 1: Diversity indices (mean ± SE) of total meiobenthos in the upper core, in different depth zones

Diversity Index	Trawling Mode [a]	15-20 m	21-25 m	26-30 m	31-35 m	36-40 m
S	BT	5.00±0.54	2.67±0.51	4.00±0.40	4.00±0.58	4.00±0.43
	AT	3.00±0.19*	3.33±0.41	3.00±0.23*	3.00±0.39	4.00±0.54
N	BT	417.00±71.62	320.42±74.62	773.00±99.87	981.00±117.84	1165.00±123.49
	AT	473.00±76.49	509.83±70.29	895.00±112.26	1132.00±123.85	1392.00±151.78
Margalef	BT	0.59±0.08	0.37±0.08	0.37±0.05	0.48±0.08	0.44±0.06
	AT	0.26±0.03*	0.38±0.06	0.22±0.03*	0.29±0.06	0.35±0.08
Pieolu	BT	0.52±0.05	0.72±0.08	0.53±0.08	0.45±0.05	0.47±0.05
	AT	0.68±0.06*	0.61±0.07	0.70±0.07	0.56±0.07	0.59±0.07
Brillouin	BT	0.68±0.05	0.55±0.03	0.53±0.05	0.57±0.05	0.59±0.05
	AT	0.58±0.03	0.58±0.03	0.58±0.05	0.51±0.05	0.58±0.04
Fisher	BT	0.74±0.09	0.53±0.09	0.48±0.05	0.59±0.09	0.54±0.06
	AT	0.37±0.03*	0.49±0.07	0.32±0.03*	0.39±0.06	0.45±0.09
Shannon	BT	0.70±0.05	0.54±0.05	0.54±0.05	0.57±0.05	0.60±0.05
	AT	0.59±0.03	0.59±0.03	0.58±0.05	0.52±0.05	0.59±0.04
Simpson	BT	0.42±0.03	0.38±0.03	0.35±0.04	0.34±0.03	0.35±0.04
	AT	0.39±0.02	0.38±0.03	0.39±0.04	0.32±0.03	0.37±0.03
Hill's N_1	BT	2.03±0.09	1.73±0.08	1.74±0.07	1.80±0.09	1.85±0.09
	AT	1.81±0.05*	1.82±0.06	1.82±0.08	1.69±0.07	1.81±0.06
Hill's N_2	BT	1.74±0.07	1.62±0.07	1.59±0.08	1.56±0.07	1.58±0.08
	AT	1.67±0.06	1.64±0.07	1.70±0.09	1.51±0.07	1.62±0.06
Δ (Tax div)	BT	40.86±2.56	34.46±4.12	34.94±3.92	33.09±3.50	34.26±3.53
	AT	39.03±2.44	37.56±2.87	38.75±3.85	31.70±3.45	36.82±2.79
Δ* (Tax dist)	BT	98.15±0.53	90.17±8.27	99.38±0.25	98.20±1.12	97.44±0.95
	AT	99.65±0.22*	98.95±0.53	99.66±0.21	99.20±0.46	99.16±0.40
AvTD	BT	87.92±2.08	88.17±8.23	92.72±1.54	90.87±1.72	90.78±1.58
	AT	95.83±1.49*	93.72±1.77	96.94±1.39	95.61±1.62	93.68±1.83
TTD	BT	392.11±40.56	247.33±41.15	318.00±30.78	361.56±38.66	363.33±33.44
	AT	244.44±14.05*	304.50±32.08	238.89±17.79*	280.00±31.14	317.43±41.78
VarTD	BT	186.98±42.22	45.67±25.42	84.26±18.24	102.75±19.97	103.19±19.85
	AT	75.00±36.88	71.81±21.36	41.67±20.29	39.74±14.19*	65.87±18.23
AvPD	BT	85.62±2.65	87.50±8.27	92.22±1.80	89.91±2.17	89.94±1.92
	AT	95.56±1.71*	93.22±2.02	96.81±1.49	95.61±1.62*	93.13±2.14
PD	BT	378.33±36.97	100.00±27.52	315.00±29.14	355.00±35.60	358.33±31.57
	AT	243.33±13.45*	116.67±27.06	238.33±17.49*	280.00±31.14	313.33±39.11

[a] BT: Before trawling; AT: After trawling; * Significant at 0.05 level

Conclusion

The disturbance to the meiobenthic fauna due to bottom trawling is evident at all water depths investigated in the present study. The total numerical density increased after trawling due to exposure of organism during churning up of sediment. Regarding diversity indices, the impact was obvious in lightly trawled station at 15-20 m water depth. In heavily trawled areas, these impacts may have been masked. The trawling impact was evident in the upper core where bulk of the fauna is present. The highest numerical densities in the month of September shows that trawl ban period is giving some respite to the fauna for recoupment. Studies on impact of trawling should be taken up focused on each group of meiofauna and the effect of trawling on community structure has to be studied. Impact studies on minor groups such as polychaetes, kinorhyncs, ostracods, acari, harpacticoid and copepods also may give more insight to the problem of impact of trawling. Appropriate un-trawled control sites are needed for comparative assessment. These studies will be useful in identifying indicators of bottom trawling impact. The study indicates the need for the promotion of eco-friendly trawls, which minimizes impacts on sea bottom.

The authors gratefully acknowledge the Ministry of Earth Sciences, Government of India, for the financial assistance rendered to carry out this work.

References

Anon (2005) Gujarat Fisheries Statistics-2003-04, Commissionerate of Fisheries, Government of Gujarat, Gandhinagar, Gujarat: 75 p.

Clarke, K.R. and Warwick, R.M. (2001) Change in Marine Communities: An Approach to Statistical Analysis and Interpretation, 2nd edn, PRIMER-E, Plymouth, UK, 172 p.

CMFRI (2006) Marine Fisheries Census 2005 Part I, Central Marine Fisheries Research Institute, Cochin: 97 p.

Coull, B.C. and Chandler, G.T. (1992) Pollution and meiofauna: field, laboratory and mesocosm studies, Oceanogr. Mar. Biol. Annu. Rev. 30: 191-271

Duplisea, D.E., Jennings, S., Warr, K.J. and Dinmore, T.A. (2002) A size-based model of the impacts of bottom trawling on benthic community structure, Can. J. Fish. Aquat. Sci. 59(11): 1785-1795

Gowda, G. (2004) Impact of bottom trawling on benthic communities, Final Report submitted to Ocean Science and Technology Cell on Marine Benthos, Ministry of Ocean Development, Government of India: 62 p.

Kurup, B.M. (2004a) Immediate effect of trawling on sea bottom and its living communities along Kerala coast, In: CMFRI Winter School on Ecosystem based Management of Marine Fisheries, p. 174-179, Central Marine Fisheries Research Institute, Cochin:

Kurup, B.M. (2004b) Impact of bottom trawling on the sea bottom and its living communities along the coastal waters of Kerala, Final Report submitted to Ocean Science and Technology Cell on Marine Benthos, Ministry of Ocean Development, Government of India: 177 p.

Kurup, K.N. and Devaraj, M. (2000) Estimates of optimum fleet size for the exploited Indian shelf fisheries, Mar. Fish. Inf. Serv. Tech. Ext. Ser. 165: 2-12

Lampadariou, N., Hatziyanni, E. and Tselepides, A. (2005) Meiofaunal community structure in Thermaikos Gulf: Response to intense trawling pressure, Cont. Shelf Res. 25: 2554-2569

Mare, M.F. (1942) A study of the marine benthic community with special reference to the micro-organisms, J. Mar. Biol. Assoc. UK. 25: 517-554

Schratzberger, M. and Jennings, S. (2002) Impacts of chronic trawling disturbance on meiofaunal communities, Mar. Biol. 141(5): 991-1000

Schratzberger, M., Dinmore, T.A. and Jennings, S. (2002) Impacts of trawling on the diversity, biomass and structure of meiofauna assemblages, Mar. Biol. 140: 83-93

Sreedevi, C. (2008) Impact of bottom trawling on benthic ecology along the coastal waters of Kerala coast with special reference to meiofauna, Ph.D. Thesis, Cochin University of Science and Technology, Kerala, India: 196 p.

Vivekanandan, E., Srinath, M. and Kuriakose, S. (2005) Fishing the marine food web along the Indian coast, Fish. Res. 72: 241-252

Zacharia, P.U. (2004) Investigations on the effect of bottom trawling on the benthic fauna off Mangalore coast, Final Report submitted to Ocean Science and Technology Cell on Marine Benthos, Ministry of Ocean Development, Government of India: 71 p.