REVIEW OF RESEARCH
ISSN: 2249-894X
IMPACT FACTOR : 5.2331(UIF)
VOLUME - 7 | ISSUE - 5 | FEBRUARY - 2018

SEASONAL VARIATION OF PESTICIDES IN BIVALVE FROM WEST COAST OF MAHARASHTRA.

A. M. Shaikh
Dept.of Zoology, I.C.S.College of Art's, Commerce and Science, Khed. Dist-Ratnagiri.

ABSTRACT

Persistent organic pollutants (POPs) such as organochlorines have been of great concern due to their occurrence in high concentration even in remote ecosystems, despite bans on production and usage (Iwata et al., 1994; Guruge and Tanabe, 2001). Organochlorine pesticides (OCPs) such as hexachlorocyclohexane (HCH) and 1,1,1-trichloro-2,2'-bis (p-chlorophenylethane (DDT) are ubiquitous anthropogenic environmental contaminants (Willett et al., 1998; Nakata et al., 1998). They are persistent, broad-spectrum toxicants that accumulate in the food web with high risks to the ecosystem and human health. Many of these compounds are considered to act as hazardous environmental hormones, which disrupt reproductive cycles of humans and wildlife (Colborn and Smolen, 1996). Some developing countries are still using these compounds because of their low cost and versatility in industry and agriculture for sanitation purpose (Tanabe et al., 1994). Consequently, environmental problems associated with toxic contaminants in these countries are of great concern. It is reported that approximately three million people are poisoned and 200,000 died each year around the world from pesticide poisoning, and a majority of them belongs to the developing countries (WHO, 1990; FAO, 2000). It is also believed that in developing countries, the incidence of pesticide poisoning may even be greater than reported due to under-reporting, lack of data and misdiagnosis (Forget, 1991).

KEY WORDS: *Persistent organic pollutants (POPs) , cycles of humans and wildlife.*

INTRODUCTION

India (Lat. 8°4' N and 37°69' N and Long. 68°7' E and 97°25' E), a tropical south Asian country, has a stretch of ~7500 km coastline, excluding its island territories with 2 million km2 exclusive economic zone (EEZ). There are 14 major, 44 medium and 162 small rivers in India, with a mean annual run-off of 1645 km3, although not all these rivers discharge into the sea. The Arabian Sea and the Bay of Bengal are subject to large semi-diurnal tides with amplitudes of 1–8 m and are also influenced by the biannual reversal of the monsoon winds. These two factors result in the flushing of Indian coastal areas which further help in dispersing pollutants (Glassby and Roonwal, 1995). The catastrophic effects of tsunami and super cyclones also play a major role in changing the coastal morphology and sediment dispersal patterns (Bhattacharya, 2003).In India, organochlorine pesticides (OCPs) especially DDT and HCH were used extensively till recently both for agricultural and sanitary purposes (Pandit et al., 2001; Kumar et al., 2006). It is estimated that about 25,000 MT of chlorinated pesticides was used annually in India and DDT accounted over 40% of this group (Mathur, 1993). Although substantial portions of applied pesticide are dissipated at the site of

application through chemical and biological degradation processes. Still, a reasonable fraction of the OCPs residues reaches the oceans through agricultural run-off, atmospheric transport and sewerage discharge (GESAMP, 1989). Because OCPs are known for their persistence, toxicity and bioaccumulation characteristics, there is a concern about their impact on the marine environment.

The transport, dispersion and finally the ultimate effects of pesticides in marine systems depend upon the persistence of the chemicals under tropical conditions and their bioaccumulation and biodegradation. Although pesticide consumption is low in India compared to the other developed countries, the indiscriminate use of these pesticides has resulted in sporadic occurrence of the residues in biota and other abiotic compartments. In order to understand the role of tropical developing countries as possible emission sources of POPs, it is necessary to elucidate the distribution, behaviour and fate of these compounds in various environmental compartments. The determination of those compounds existing in water and sediment may indicate the extent of aquatic contamination and the accumulation characteristics in the aquatic ecosystems. Hence an attempt has been made to elucidate the distribution, behaviour and fate of these compounds in Indian coastal regions specially west coast which are characteristically different in geomorphological and hydrological set up with varying anthropogenic stresses.

MATERIAL AND METHODS :-

To analyses bivalve samples, samples were combined with acetonitrile & then homogenize with poltroon. The mixture & solvent was too sticky to be homogenized, probably due to high water & salt content of bivalves. Therefore modification of the polarity & salinity of the mixture was required. For this purpose, water & acetone were added to the sample along with acetonitrile prior to homogenization. After homogenization, an additional procedure of salting out was headed in order to enhance the extraction of organic components from water layer. Samples were processed according to food safety and standard & Authority of India, ministry of health & family welfare, Govt. of India by using GC (HP model 6890) & flame photometric detector. The HPLC (Agilent 1100 series) system consisted of post – column derivatizer (Pickering laboratories Pc x 5200) & fluorescence detector CHP1100 Series).

RESULTS AND DISCUSSION :-

RATNAGIRI DISTRICT :

To study seasonal variation of pesticides in bivalve from Ratnagiri district; three study areas were selected as Dapoli, Guhaghar&Ratnagiri. Study was carried out during peak of each season i.e. 20-25. August **2012**. For monsoon, 15-20 December 2012 for winter & 03-08 May 2013 for summer season. The result are expressed in ng/g wet basis.

PERNA VIRIDIS :

P. viridis from Dapoli region, during monsoon season, HCH, DDT, PCB, Endosulfan was recorded 0.80, 2.10, 1.50, 3.35 respectively while during winter season 0.61, 1.80, 1.14, 2.85 respectively whereasduring summer season 0.31, 1.30, 1.01, 1.70 respectively.

In the Guhaghar region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 0.65, 2.15, 1.45, 3.40 respectively while during winter season 0.42, 1.76, 1.20, 2.78 respectively whereasduring summer season 0.34, 1.10, 0.91, 1.79 respectively.

In the Ratnagiri region, during monsoon season HCH, DDT, PCB, Endosulfan found to 0.85, 2.30, 1.58, 3.66 respectively while during winter season 0.72, 2.00, 1.38, 2.96 respectively whereasduring summer season 0.40, 1.43, 1.20, 1.93 respectively

CROSSOSTREA CUTTUKENSIS :

C. cuttukensis from Dapoli region, during monsoon season HCH, DDT, PCB, Endosulfan was recorded 1.56, 2.10, 1.12, 2.57 respectively while during winter season 1.29, 1.53, 1.36, 2.22 respectively whereas during summer season 1.08, 1.12, 0.76, 1.24 respectively.

In the Guhaghar region, during monsoon season HCH, DDT, PCB, Endosulfan found to 1.45, 1.94, 1.36, 2.92 respectively while during winter season 1.22, 1.68, 1.15, 2.11 respectively whereasduring summer season 0.98, 1.17, 0.86, 1.77 respectively.

In the Ratnagiri region, during monsoon season HCH, DDT, PCB, Endosulfan content was 1.96, 2.18, 1.66, 3.36, respectively while during winter season 1.80, 1.98, 1.21, 3.10 respectively whereasduring summer season 1.47, 1.20, 0.95, 2.14 respectively.

SACCOSTREA CUCULATTA :

S. cuculatta from Dapoli region, during monsoon season HCH, DDT, PCB, Endosulfan was recorded 1.28, 3.24, 2.56, 1.80 respectively while during winter season 1.13, 2.89, 2.47, 1.33 respectively whereasduring summer season 0.97, 1.98, 1.92, 1.07 respectively.

In the Guhaghar region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 1.36, 3.10, 2.68, 1.12 respectively while during winter season 2.87, 2.14, 1.84, 0.88 respectively whereasduring summer season 2.37, 1.94, 1.15, 0.68 respectively.

In the Ratnagiri region, during monsoon season HCH, DDT, PCB, Endosulfan content was 1.47, 3.92, 3.20, 4.42, respectively while during winter season 1.13, 3.10, 2.86, 3.90 respectively whereasduring summer season 0.94, 2.82, 2.16, 2.46 respectively.

MERETRIX MERETRIX :

M. meretrix from Dapoli region, during monsoon season HCH, DDT, PCB, Endosulfan was recorded 1.48, 2.69, 2.36, 3.68 respectively while during winter season 1.13, 2.17, 1.96, 3.19 respectively whereasduring summer season 0.96, 1.92, 1.36, 2.58 respectively.

In the Guhaghar region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 1.72, 2.99, 2.23, 3.43 respectively while during winter season 1.60, 2.14, 1.97, 2.94 respectively whereasduring summer season 1.22, 1.85, 1.26, 1.43 respectively.

In the Ratnagiri region, during monsoon season HCH, DDT, PCB Endosulfan content was 1.85, 3.24, 2.73, 4.94 respectively while during winter season 0.57, 1.62, 2.18, 2.86 respectively whereasduring summer season 0.29, 0.93, 1.67, 1.96 respectively.

KATELYSIA OPIMA :

K. opima from Dapoli region, during monsoon season HCH, DDT, PCB Endosulfan was recorded 1.04, 2.10, 0.78, 3.66 respectively while during winter season 0.88, 1.73, 0.61, 3.22 respectively whereasduring summer season 0.73, 1.12, 0.59, 2.84 respectively.

In the Guhaghar region, during monsoon season HCH, DDT,PCB Endosulfan was found to 0.97, 2.18, 0.87, 3.98 respectively while during winter season 0.77, 1.96, 0.65, 2.93 respectively whereasduring summer season 0.65, 1.14, 0.53, 1.84 respectively.

In the Ratnagiri region, during monsoon season HCH, DDT, PCB Endosulfan content was 1.10, 2.54, 0.94, 4.67 respectively while during winter season 0.49, 1.16, 1.10, 2.86 respectively whereasduring summer season 0.32, 0.58, 0.94, 2.53 respectively.

SINDHUDURG DISTRICT :-

To study seasonal variation in bivalve from Sindhudurg district, three study areas were selected as Vengurla, Malvan, Devgad. Study was carried out during peak of each season i.e. 1-5 Sept 2012 for monsoon, 22-26 Dec 2012 for winter & 10-15 May 2013 for summer season. The results are expressed in ng/g wet besis.

PERNA VIRIDIS :

P. viridis from Vengurla region, during monsoon season HCH, DDT, PCB Endosulfan was recorded 1.20, 3.43, 2.34, 5.10 respectively while during winter season 0.81, 1.20, 1.85, 3.20 respectively whereasduring summer season 0.44, 0.93, 1.21, 1.43 respectively.

In the Malvan region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 1.42, 3.24, 2.60, 4.80 respectively while during winter season 0.60, 1.10, 1.20, 2.63 respectively whereasduring summer season 0.51, 0.63, 0.83, 1.20 respectively.

In the Devgad region, during monsoon season HCH, DDT, PCB Endosulfan content was 1.63, 3.94, 3.22, 6.20 respectively while during winter season 1.10, 1.50, 1.28, 3.38 respectively whereasduring summer season 0.72, 1.25, 1.42, 1.80 respectively.

CROSSOSTREA CUTTUKENSIS :

C. cuttukensis from vengurla region, during monsoon season HCH, DDT, PCB Endosulfan was recorded 1.00, 2.83, 1.90, 3.70 respectively while during winter season 0.62, 1.05, 1.38, 2.40 respectively whereasduring summer season 0.42, 0.96, 0.80, 1.24 respectively.

In the Malvan region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 1.18, 2.38, 1.92, 3.65 respectively while during winter season 1.12, 1.86, 1.19, 2.45 respectively whereasduring summer season 0.88, 1.25, 1.15, 1.12 respectively.

In the Devgad region, during monsoon season HCH, DDT, PCB, Endosulfan content was 2.13, 2.96, 2.00, 4.22 respectively while during winter season 1.76, 2.42, 1.45, 3.18 respectively whereasduring summer season 1.20, 1.70, 1.15, 2.34 respectively.

SACCOSTREA CUCULATTA :

S. cuculatta from Vengurla region, during monsoon season HCH, DDT, PCB Endosulfan was recorded 1.38, 4.50, 3.20, 3.80 respectively while during winter season 0.85, 3.35, 1.90, 3.60 respectively whereasduring summer season 0.67, 2.27, 1.86, 1.90 respectively.

In the Malvan region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 1.45, 4.76, 2.38, 5.40 respectively while during winter season 1.25, 3.17, 2.12, 4.38, respectively whereasduring summer season 1.12, 2.60, 2.48, 2.35 respectively.

In the Devgad region, during monsoon season HCH, DDT, PCB, Endosulfan content was 1.58, 4.85, 3.60, 6.38 respectively while during winter season 1.54, 3.72, 2.25, 5.60 respectively whereasduring summer season 1.80, 3.15, 3.55, 3.16 respectively.

MERETRIX MERETRIX :

M. meretrix from Vengurla region, during monsoon season HCH, DDT, PCB, Endosulfan was recorded 1.98, 2.44, 2.60, 3.90 respectively while during winter season 1.40, 2.38, 2.00, 3.47 respectively whereasduring summer season 1.00, 1.78, 1.67, 3.45 respectively.

In the Malvan region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 1.90, 2.35, 2.10, 4.36 respectively while during winter season 0.45, 1.20, 1.87, 2.45 respectively whereasduring summer season 0.25, 0.94, 1.25, 1.80 respectively.

In the Devgad region, during monsoon season HCH, DDT, PCB, Endosulfan content was 2.10, 3.60, 2.80, 5.43 respectively while during winter season 0.68, 1.75, 2.35, 3.44 respectively whereasduring summer season 0.34, 1.10, 1.85, 2.20 respectively.

KATELYSIA OPIMA :

K. opima from Vengurla region, during monsoon season HCH, DDT, PCB, Endosulfan was recorded 1.00, 1.49, 1.17, 3.13 respectively while during winter season 0.48, 0.96, 1.13, 1.97 respectively whereasduring summer season 0.30, 0.39, 1.00, 1.28 respectively.

In the Malvan region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 0.94, 1.80, 0.96, 3.26 respectively while during winter season 0.30, 1.18, 0.95, 2.43 respectively whereasduring summer season 0.22, 0.42, 0.86, 1.79 respectively.

In the Devgad region, during monsoon season HCH, DDT, PCB, Endosulfan content was 1.20, 2.68, 1.27, 5.73 respectively while during winter season 0.56, 1.47, 1.26, 3.22 respectively whereasduring summer season 0.34, 0.67, 1.10, 2.30 respectively.

RAIGAD DISTRICT :-

To study seasonal variation of pesticides in bivalve from Raigad district, three study areas were selected as Shrivardhan, Alibag&Uran. Study was carried out during peak of each season i.e. 10-15 Sept. 2012 for monsoon season, 2-7 Jan. 2013 for winter season & 20-25 May 2013 for summer season. Results are expressed in ng/g wet basis.

PERNA VIRIDIS :

P. viridis from Shrivardhan region, during monsoon season HCH, DDT, PCB, Endosulfan was recorded 0.68, 1.42, 1.12, 1.68 respectively while during summer season 0.58, 1.32, 0.96, 1.35 whereasduring summer season 0.47, 1.10, 0.76, 1.12 respectively.

In the Alibag region, during monsoon season HCH, DDT, PCB, Endosulfan was found 0.42, 0.96, 0.84, 0.96 respectively while during winter season 0.37, 0.86, 0.74, 0.89 respectively whereasduring summer season 0.30, 0.72, 0.63, 0.74 respectively.

In the Uran region, during monsoon season HCH, DDT, PCB, En,dosulfan content was 0.75, 1.16, 1.36, 1.26 respectively while during winter season 0.66, 1.10, 1.06, 1.13 respectively whereasduring summer season 0.54, 0.97, 0.94, 1.10 respectively.

CROSSOSTREA CUTTUKENSIS :

C. cuttukensis from Shrivardhan region, during monsoon season HCH, DDT, PCB, Endosulfan was recorded 0.43, Not detected, 0.23, 0.45 respectively while during winter season 0.20, Not detected, 0.15, 0.38 respectively whereasduring summer season Not detected, Notdetected, Not detected, 0.20 respectively.

In the Alibag region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 0.54, 0.92, Not detected, 0.68 respectively while during winter season 0.47, 0.64, Not detected, 0.53 respectively whereasduring summer season 0.34, 0.32, Not detected, 0.37 respectively.

In the Uran region, during monsoon season HCH, DDT, PCB, Endosulfan content was 0.84, 0.58, Not detected, 0.89 respectively while during winter season 0.72, 0.44, Not detected, 0.66 whereasduring summer season 0.54, 0.22, Not detected, 0.43 respectively.

SACCOSTREA CUCULATTA :

S. cuculatta from Shrivardhan region, during monsoon season HCH, DDT, PCB Endosulfan was recorded Not detected, Not detected, Not detected, 0.85 respectively while during winter season Not detected, Not detected, Not detected, 0.69 respectively whereasduring summer season Not detected, Not detected, Not detected, 0.48 respectively.

In the Alibag region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 0.35, 0.64, Not detected, 0.81, respectively while during winter season Not detected, 0.52, Not detected, 0.65 respectively whereasduringsummer season Not detected, 0.46, Not detected, 0.55 respectively.

In the Uran region, during monsoon season HCH, DDT, PCB, Endosulfan content was 0.53, 0.47, 0.22, 0.65 respectively while during winter season 0.34, 0.24, 0.14, 0.41 respectively whereasduring summer season 0.25, 0.14, Not detected, 0.38 respectively.

MERETRIX MERETRIX :

M. meretrix from Shrivardhan region, during monsoon season HCH, DDT, PCB, Endosulfan was recorded 0.65, 0.44, 0.36, 0.77 respectively while during winter season 0.37, 0.23, 0.15, 0.55 respectively whereasduring summer season 0.20, 0.13, not detected, 0.29 respectively.

In the Alibag region, during monsoon season HCH, DDT, PCB, Endosulfan 0.46, 0.32, 0.50, 0.80 respectively while during winter season 0.34, 0.27, 0.36, 0.62 respectively whereasduring summer season 0.26, 0.21, 0.28, 0.41 respectively.

In the Uran region, during monsoon season HCH, DDT, PCB, Endosulfan content was 0.52, 0.43, 0.36, 0.63 respectively while during winter season 0.39, 0.28, 0.23, 0.51 respectively whereasduring summer season 0.26, 0.18, 0.14, 0.35 respectively.

KATELYSIA OPIMA :

K. opima from Shrivardhan region, during monsoon season HCH, DDT, PCB, Endosulfan was recorded 0.32, Not detected, Not detected, 0.39 respectively while during winter season 0.24, Not detected, Not detected, 0.24 respectively whereasduring summer season 0.11, Not detected, Not detected, 0.10 respectively.

In the Alibag region, during monsoon season HCH, DDT, PCB, Endosulfan was found to 0.28, 0.14, Not detected, 0.25 respectively while during winter season 0.16, 0.12, Not detected, 0.18 respectively whereasduring summer season 0.10, 0.09, Not detected, 0.13 respectively.

In the Uran region,during monsoon season HCH, DDT, PCB, Endosulfan was recorded Not detected, Not detected, 0.14, 0.20 respectively while during winter season Not detected, Not detected, 0.10, 0.16, respectively whereasduring summer season Not detected, Not detected, 0.12, 0.17 respectively.

Amongst all studied pesticides, HCH is recorded lowest value while Enldosulfan was found to maximum concentration. Concern to selected bivalve, crossostreacuttukensis showed high level of pesticides while P. viridis low level. Amongst different study area from Ratnagiri district, Ratnagiri region showed high level of pesticides in all selected bivalve as compare with Dapoli&Guhaghar while from Sindhudurg district showed high levels of pesticides in all studied bivalve belong to Devgad region as compare to Vengurla&Malvanwhereas from Raigad district, P. viridis, C. cuttukensis, S. cucullata showed high levels of pesticides belongs to Uran region while M. meretrix, K. opima showed high levels belongs to Shrivardhan region. In the Raigad region certain pesticides are not detected.

As compare to three district i.e. Ratnagiri, Sindhudurg&Raigad, high level of pesticides are recorded in bivalve from Sindhudurg district while low level was found in Raigad district.

Concern to seasonal variation of pesticides common trend was found in all study areas as well as selected bivalve that concentration raises in monsoon, followed by winter & summer i.e. lowest concentration was detected in summer season.

Using a moored in-situ sampler, Sarkar and Sen Gupta (1989) determined the concentration of residues in seawater off the central west coast of India. Shailaja and Sarkar (1992) reviewed the results where the order of distribution of different chlorinated compounds along the central West Coast of the Arabian Sea was as follows: HCH>aldrin>DDE>dieldrin>DDE>DDT>DDD. The sum of DDT concentrations ranged from 15.8 to 444.0 ng/l. Among DDT isomers, p, p'-DDT was found to be more abundant than others in the southern part of the region whereas o,p'-DDT was present in significant concentrations off the Ratnagiri Coast, western part of India. Gamma-HCH ranged from 0.26 to 9.4 ng/l, whereas aldrin and dieldrin were found at concentrations ranging from 1.4 to 9.8 ng/l and 2.1 to 50.9 ng/l, respectively. In general -HCH and the two cyclodiene compounds aldrin and dieldrin were found more consistently in seawater samples than compounds of the DDT family. Isomers of HCH, aldrin, dieldrin and DDT were detected in water of different regions of the Indian Ocean (Shailaja and Sen Gupta, 1989). Of all organochlorine pesticides, total DDT was found to be present in considerable amounts (15.8–444 ng/l). There was sharp spatial variations of organochlorine compounds in water where enrichment was evident in coastal regions in comparison to open

ocean water, the latter is contaminated mainly due to atmospheric transport of pollutants (Tanabe et al., 1982a,b).

The concentration of HCH was found to be quite low in water as compared to that in sediment which may be due to the hydrophobic characteristics of these compounds as well as dispersion of pollutants in the open ocean. Coastal sediments act as temporary or long-term sinks for many classes of anthropogenic contaminants and consequently act as the source of these substances to the ocean and biota. The applied pesticide can be transported through surface run-off, leaching and vapour phase and ultimately accumulates and settles in the bottom sediments. Hence bottom sedimentsrepresent an integrated measure of particle bound contaminants that have deposited over a longer period of time. Few studies have reported that contamination of OCs in the sediments from Indian coastal regions (Takeoka et al., 1991; Pandit et al., 2002; Sarkar et al., 1997; Sarkar and SenGupta, 1987, 1988c, 1991) indicating the presence of their major emission sources in these regions. Data on the accumulation of pesticides in marine sediments is limited, especially considering the length of India's coastline. Guzzella et al. (2005) documented distribution of various organochlorine pesticides in the surface sediments along the stretch of the Ganges (Hooghly) estuary including Sunderban mangrove wetland, eastern coastal part of India. The results revealed a wide range of spatial variations.

The concentration of various pesticides also exhibited a wide range of fluctuations .The presence of HCH isomers and DDT and its metabolites can be attributed to the use of these insecticides in agriculture as well as anti-malaria sanitary activities carried out throughout the country (Pandit et al., 2002). The concentration of four important isomers of HCHs reveals a heterogenic nature of distribution. Recently Sarkar et al. (2008) reported the first comprehensive account of the organochlorine pesticide residues (HCHs, DDTs and HCB) in core sediments (b63 µparticle size) from Sunderban which revealed an erratic pattern, either top to bottom or vice versa, reflecting non-homogenous input of these compounds. HCB is not only used as fungicide but also generated as a by-product during the production and usage of several agrochemical and industrial chemicals. Furthermore, HCB has also been released into the environment by waste incineration (van-Birgelen, 1998) and in a variety of reactions where it persists because of its thermodynamic stability (Breivik et al., 2004). The residues of HCB in the rest of the stations might be a reflection of its limited sources and the volatile nature of this compound. Breivik et al. (2004) rightly pointed out that HCB emissions can be expected to decrease as developing countries improve their chemical and metal production and handling practices. DDTs were detected in all species, but the contribution of individual metabolites showed differences. The dominance of DDTs in the sediment was also reported by Pandit et al. (2002) from the coastal marine environment of Mumbai, western part of India. This may be attributed to the slow degradation of DDTs or recent input of DDTs in this environment (Tavares et al., 1999; Yuan et al., 2001). The dominance of either pp'-DDT or both pp'-DDT and pp'-DDE in sediments was also recorded by Guruge and Tanabe (2001) from the west coast of India and by Booij et al. (2001) from the northwest coast of Java, Indonesia. Occurrence of DDT in all studied bivalve showed a definite indication of recent use of the DDT. The more contribution of DDT at some study area seems to be associated with use of pesticides for Alphonso Mango & other agricultural growing activities. The use of pesticides in agriculture and aquaculture has generally been increasing due to rising population and demand for more agrochemicals at these sites. The high percentage composition of DDT clearly illustrates that DDT usage has not been eradicated yet in the country, and there might be new input of DDT to the coastal estuary as asserted by Aguilar (1984) and Dimond and Owen (1996). India is ranked the biggest consumer and manufacturer of HCH and DDT in the world (Mehrotra, 1993) as these are cheap as well as effective chemicals (Bashkin, 2003). Sarkar and Sen Gupta (1987) measured pesticide residues in sediments along the west-central coast of India in the Arabian Sea showing the following decreasing order: HCH NaldrinNpp'-DDE Npp'- DDT Nop'-DDE Npp'-DDD Ndieldrin. It is worthwhile to mention that HCH, DDT were found in almost all samples. The concentration of DDT was relatively high in most of the samples. However, PCB &endosulfon could not be detected in a few samples that contained the maximum percentage of silt and sand. Aldrin was much more prevalent than dieldrin and HCH was dominant over. Sarkar et al. (1997) found higher mean concentration of

DDT and dieldrin (by factors of 1.7 and 2.4 respectively) in estuarine sediments of the Arabian Sea areas compared to offshore sediments while mean concentrations of HCH, aldrin, and endrin were similar for both offshore and estuarine samples. There are only a few studies on the fate and behavior of OP pesticides in marine sediments (Sarkar and Sen Gupta 1985; Sarkar and Sen Gupta 1986; Sujatha and Chacko 1991) from Indian waters. They found that the stability and fate of the pesticides monocrotophos, phosphamidon and DDVP in sediment samples were influenced by pH, salinity and exchangeable cations. The low stability of these pesticides in sea sediments indicates that major element cations have reduced the toxic effects of these pesticides in marine organisms (Sarkar and Banerjee 1987). A review of published data of pesticide residues in sediments indicates that isomers of DDT and its metabolites, HCH, aldrin, dieldrin and endrin are present but that, while all may not be found in every sample, the most common and abundant pesticide residues were aldrin, HCHs and DDTs.

Pesticide concentrations in magnitude higher which might be attributed to several factors. All major Indian rivers flow and drain through fertile agricultural lands, which receive a considerable input of pesticides, and carry their sediment loads to marine waters on the coast. Also, the use pattern of pesticides shows a predominance of pesticides to lands bordering the eastern coast. Shailaja and Sen Gupta (1990) had confirmed the presence of DDT and its metabolites, DDD and DDE, in their study on samples obtained from three stations in a transect off Mumbai. In this study, DDD was the major product formed in zooplankton, indicating DDT metabolism in zooplankton. They observed that DDT concentrations showed a declining trend from near-shore to offshore while DDD concentrations increased from the coast to offshore. The concentration of DDT was higher in zooplankton than in both plankton-feeding and carnivorous fish from coastal as well as open ocean regions of the Arabian Sea. Bivalves have been widely accepted and used as sentinel organisms to monitor the concentration of pollutants in coastal marine environments. Different species of oysters, mussels and clams have been used as bio indicators for Mussel Watch Programme in different countries to monitor marine pollution from pesticide residues. Also, Ramesh et al. (1990b) suggest that the bioaccumulation of OCPs by mussels might have implications for human exposure, because mussels are marketed immediately following collection and without depuration. Ramesh et al. (1990b) measured the concentrations of OC residues in green-lipped mussels Pernaviridis L. (Mollusca: Bivalvia) collected from nine locations along the South Indian Coast, which includesthe east and west coasts covering the Bay of Bengal and the Arabian Sea, respectively. They found that HCH isomer (a, ß and y) concentrations ranged from 4.3 to 16 ng/g whereas DDT (the sum of pp'-DDT, pp'- DDE, pp'-DDD and op'-DDT) varied from 2.8 to 39 ng/g. Mussels collected from the west coast had higher levels of DDT, suggesting DDT used for vector control in urban locales, eventually dispersed or areas is in storm water run-off from coastal cities. However, in Ratnagiri and Raigad district, HCH levels were slightly higher than DDT, which is indicative of the use of HCH for agricultural purposes in the nearby areas. Ramesh et al. (1989, 1991) observed considerable pesticide contamination in air and water, especially in agricultural areas.

Number of reports on the effect of pesticides on bivalves are available (Stainken and Rollwagen, 1979). Oysters, in particular, were studied by Emmanuelsen et al. (1978). They have suggested that relatively short term exposures of low levels of dieldrin do not cause histo-pathological damage to Crassostreavirginica. Toxicologicalstudies were carried out in mussels by various authors (Cowan, 1978; Dybern and Jensen, 1978; Frenne, 1978; krieger et al. 1978; Salanki and Varankal, 1978. The reaction of the marine bivalves Katelysiaopima and Donaxcuneatus (both commercially important species in India) to various pesticides and narcotants were studied under laboratory conditions by Mane et al. (1979). Physiological studies were done on mussels i.e. the oxygen uptake by the hepatopancreas, mitochondria of mussels in the normal condition and when affected by DDT (Golovenko and Petrov, 1979). Lethality of aminocarb and the components of aminocarb formulation to a fresh water clam was reported (McLeese et al. 1980). It was exprimentally proved that the mussel sensitivity to DDT depends on the age of molluscs, duration of their contact with the pesticides and concentration of the pesticide (Zaitsev et al. 1981). The changes in the carbohydrate metabolism in selected tissues of freshwater mussel, Lamellidensmarginalis

were studied during induced toxicity of phosphamidon, an organophosphorus pesticide (Moorthy et al. 1983).

With reference to above mentioned work done it was so important to study the level of pesticides in edible bivalve & it is one of important parameter for export hence present work was undertaken.

REFERENCES :

*Agnihotri NP. Contribution of agricultural application of pesticides on quality of ground and river water. Ganga Project Directorate Final Report. New Delhi: IARI; 1993. Aguilar A. Relationship of DDE/DDT in marine mammals to the chronology of DDT input into the ecosystem. Can J Fish AquatSci 1984; 41:840–4.

* Amaraneni Rao S, Pillai RR. Kolleru Lake water pollution pesticides. Indian J Environ Health 2000;42:169–75.

* Bashkin V. Trends in pesticide application in the Asian countries. Pestic Safety News 2003;6(2):4.

* Bhattacharya A, Sarkar SK, Bhattacharya A. An assessment of coastal dification in the low-lying tropical coast of northeast India and role of natural and rtificialforcings. Proceed of the InternatConf on Estuaries and Coasts, 9-11. ; 2003. p. 158–65. Hangzhou, China.

* Booij K, Theo M, Hillerbrand MTJ, Nolting RF, Ooijen JV. Nutrients, trace metals, organic contaminants in Banten Bay, Indonesia. Mar Pollout Bull 2001;42:1187–90.

* Breivik K, Alcock R, Li Y, Bailey RE, Fiedler H, Pacyna JM. Primary sources of selected POPs: regional and global scale emission inventories. Environ Pollut 2004;128:3–16.

* Bruggeman WA. Bioaccumulation and transformation of dichlorobiphenyls in fish. In: Hutzinger O, editor. The Handbook of Environmental Chemistry, vol. 2(B). 1982. pp. 29-47.

* Canadian Council of Ministers of the Environment. Canadian environ mental quality guidelines, Winnipeg, Canada; 2002.

* Colborn T, Smolen MJ. Epidemiological analysis of persistent oranochlorine contaminants in cetaceans. Rev Environ ContamToxicol 1996;146:92–172.

* Das B, Das P. Organochlorine pesticide residues in water, sediment and muscle of River Shad, Hilsallisha (Hamilton, 1822) from the south patches of the Bay of Bengal. Bull Environ ContamToxicol 2004;72:496–503.

* Dimond JB, Owen RB. Long-term residue of DDT compounds in forest soils. Mar Environ Pollut 1996;92:227–30.

* DoongRuey-An, Peng Chin-Kai, Sun Yuh-Chang, Liao Pei-Lin. Composition and distribution of organochlorine pesticide residues in surface sediments from the Wu-Shi River estuary, Taiwan. Mar Pollut Bull 2002;45:246–53.

* Forget G. Pesticides and the third world. J Toxicol Environ Health 1991;32:11–31.FAO/WHO. Maximum residue limits in codex Alimentarious, Vol-2B; 2000. GESAMP. The atmospheric input of trace species to the world ocean. GESAMP, Rep Stud 1989;38.

* Georgakopoulos-Gregoriades E, Vassilopoulou V, Stergiou KI. Multivariate analysis of organochlorine in red mullet from Greek Waters. Mar Pollut Bull 1991;22:237–41.

* Glasby GP, Roonwal GS. Marine pollution in India: an emerging problem. CurrSci 1995;68:495–7.

* Gong KS, Qi S, Wang Y, Julia EB, Chunling Lv. Historical Contamination and sources of organochlorine pesticides in sediment cores from Quanzhou Bay, southeast China. Mar Pollut Bull 2007;54(9):1434–40.

* Guruge KS, Tanabe S. Contamination by persistent organochlorines and butylin compounds in the west coast of Sri Lanka. Mar Pollut Bull 2001;2(3):179–86.

* Guzzella L, Roscioli C, Vigano L, Saha M, Sarkar SK, Bhattacharya A. Evaluation of the concentration of HCH, DDT, HCB, PCB and PAH in the sediments along the lower stretch of Hugli estuary, West Bengal, northeast India. Environ Int 2005;31:523–34.

* Hong H, Xu L, Zhang L, Chen JC, Wong YS, Wen TS. Environmental fate and chemistry of organic pollutant in sediment of Xiamen and Victoria harbors. Mar Pollut Bull 1995;31:229–64.

* Hong SH, Yim UH, Shim WJ, Oh JR, Lee IS. Horizontal and vertical distribution of PCBs and chlorinated pesticides in sediments from Masan Bay, Korea. Mar Pollut Bull 2003;46:244–53.

* James RA, Ramesh R. Distribution of pesticides in the river sediments. In: Subramanium V, editor. Environmental hazards in south Asia. Capital Publishing Company; 2002. p.161–5.
* Kannan ST, Sen Gupta R. Organochlorine residues in zooplankton of the Saurashtra Coast, India. Mar Pollut Bull 1987;18:92–4.
* Kannan K, Tanabe S, Tatsukawa R. Biodegradation capacity and residue pattern of organochlorines in Ganges river dolphins from India. Toxicol Environ Chem 1994;42:249–61.
* Kannan K, Sinha RK, Tanabe S, Ichihashi H, Tatsukawa R. Heavy metals and organochlorine residues in Ganges river dolphins from India. Mar Pollut Bull 1993;26:159–62.
* Kannan K, Ramu K, Kajiwara N, Sinha RK, Tanabe S. Organochlorine pesticides, polychlorinated biphenyls, and polybrominateddiphenylethers in Irrawaddy dolphins from India. Arches Environ Contam Toxicol 2005;49(3):415–20.
* Karuppiah S, Subramanian A, Obbard JP. Organochlorine residues in odontocete species from the southeast coast of India. Chemosphere 2005;60(7):891–7.
* Kumar A, Dayal P, Shukla G, Singh G, Joseph PE. DDT and HCH residue load in mother's breast milk: a survey of lactating mother's from remote villages in Agra region.EnvironInt 2006;32:248–51.
* Kureishy TW, George MD, Sen Gupta R. Concentration in zooplankton from the Arabian Sea. Indian J Mar Sci 1978;7:54–5.
* Leach AW, Mumford JD. Pesticide environmental accounting: a method for assessing the external costs of invididual pesticide applications. Environ Pollut 2008;151:139–47.
* Liu M, Yang Y, Hou L, Xu S, Ou D, Zhang B, Liu Q. Chlorinated organic contaminants in surface sediments from the Yangtze estuary and nearby coastal areas. China. Mar Pollut Bull 2003;46:672–6.
* Long ER, MacDonald DD, Smith SC, Calder FD. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environ Manag 1995;1:81–97 19.
* Maroni M, Colosio C, Ferioli A, Fait A. Biological monitoring of pesticide exposure: a review. Toxicol 2000;143:1–123.
* Mathur SC. Pesticides industry in India. Pesticide information 1993;19:7–15.
* Mehrotra KN. Status of insecticide resistance in insect pests. In: Dhaliwal Balwinder, Singh Balwinder, editors. Pesticides — their ecological impact in developing countries. New Delhi: Commonwealth Publishers; 1993. p. 30.
* Monirith I, Ueno D, Takahashi S, Nakata H, Sudaryanto A, Subramanian A, et al. AsiaPacific mussel watch: monitoring contamination of persistent organochlorine compounds in coastal waters of Asian countries. Mar Pollut Bull 2003;46:281–300.
* Muir DGC, Norstom RJ, Simon M. Organochlorine in Arctic marine food chains: accumulation of specific polychlorinated biphenyl's and chlordane related compounds. Environ SciTechnol 1990;22:1071–9.
* Mukherjee I, Gopal M. Insecticide residues in baby food, animal feed, and vegetables by gas liquid chromatography. Bull Environ ContamToxicol 1996;56:381–8.
* Nair A, Mandapati R, Dureja P, Pillai MKK. DDT and HCN load in mothers and their infants in Delhi, India. Bull EnvireonContamToxicol 1996;56:58–64.
* Nakata H, Kannan K, Jing L, Thomas N, Tanabe S, Giesy JP. Accumulation pattern of organochlorine pesticides and polychlorinated biphenyls in southern sea otters (Enhydralutrisnereis) found stranded along coastal California, USA. Environ Pollut 1998;103:45–83.
* Nayak AK, Raha R, Das AK. Organochlorine pesticide residues in middle stream of the Ganga river, India. Bull Environ ContamToxicol 1995;54:68–75.
* Pandit GG, Mohan Rao AM, Jha SK, Krishnamoorthy TM, Kale SP, Raghu K, et al. Monitoring of organochlorine pesticide residues in the Indian marine environment. Chemosphere 2001;44(2):301–5.
* Pandit GG, Sahu SK, Sadasivan S. Distribution of HCH and DDT in the coastal marine environment of Mumbai, India. J Environ Monit 2002;4:431–4.
* Porte C, Albaiges J. Buioaccumulation pattern of hydrocarbons and polychlorobiphynyls in bivalves, crustaceans and fish. Arch Environ ContamToxicol 1993;26:273–81.

* Rajendran RB, Subramanian AN. Chlorinated pesticide residues in surface sediments from the river Kaveri, South India. J Environ Sci Health B 1999;34(2):269–88.
* Rajendran RB, Subramanian AN. Pesticide residues in water from the river Kaveri, south India. ChemEcol 1997;13:223–36.
* Ramesh A, Tanabe S, Iwata H, Tatsukawa R, Subramanian AN, Mohan D, Venugopalan VK. Seasonal variation of persistent organochlorine in secticide residues in Vellar River waters Tamil Nadu, South India. Environ Pollut 1990a;67(4):289–301.
* Ramesh A, Tanabe S, Subramanian AN, Mohan D, Venugopalan VK, Tatsukawa R. persistent organochlorine residues in green mussels from coastal waters of South India. Mar Pollut Bull 1990b;12:587–90.
* Ramesh A, Tanabe S, Kannan K, Subramanian AN, Kumaran PL, Tatsukawa R. Characteristic trend of persistent organochlorine contamination in wildlife from a tropical agricultural watershed, South India. Arch Environ ContamToxicol 1992;23 (1):26–36.
* Ramesh A, Tanabe S, Morase H, Subramanian A, Tatsukawa R. Distribution and behavior of persistent organochlorine insecticides in paddy soils and sediments in tropical environment: a case study in South India. Environ Pollut 1991;74:293–307.
* Sarkar A, Banerjee G. Component analysis of some chemical parameters influencing the stability of DDVP in sediment along the East Coast of India. Int J Environ Studies 1987;29:171–4.
* Sarkar A, Nagarajan R, Chaphadkar S, Pal S, Singbal SYS. Contamination of organochlorine pesticides in sediments from the Arabian Sea along the West Coast of India. Water Res 1997;31(2):195–200.
* Sarkar A, Sen Gupta R. Persistance and fate of some organophosphorous pesticides in sea sediments. In: Proc. 2nd Annual Conf. Nat. Environ. Sci. Acad, Faizabad, India: NESA; 1985. pp. 5–8.
* Sarkar A, Sen Gupta R. Persistence and fate of some organophosphorous pesticides in the sea sediments along the East Coast of India. Indian J Mar Sci 1986;15:72–4.
* Sarkar A, Sen Gupta R. Chlorinate pesticide residues in sediments from Arabian Sea along the central West Coast of India. Bull Environ ContamToxicol 1987;39:1049–54.
* Sarkar A, Sen Gupta R. DDT residues in sediments from the Bay of Bengal. Bull Environ ContamToxicol 1988a;41:664–9.
* Sarkar A, Sen Gupta R. Chlorinated pesticide residues in marine sediments. Mar Pollut Bull 1988b;19:35–7.
* Sarkar A, Sen Gupta R. DDT residues in sediments from the Bay of Bengal. Bull Environ ContamToxicol 1988c;41:664–9.
* Sarkar A, Sen Gupta R. Determination of organochlorine pesticides in Indian coastal waters using a moored in situ sample. Water Res 1989;23:975–8.
* Sarkar A, Sen Gupta R. Pesticide residues in sediments from the West Coast of India. Mar Pollut Bull 1991;22(1):42–5.
* Sarkar, S.K., Binelli, A., Riva, C., Parolini, M., Chatterjee, M., Bhattacharya, A.K., et al.,, Organochlorine pesticide residues in sediment cores of Sunderban wetland, north eastern part of Bay of Bengal, India and their ecotoxicological significance. Arch Environ ContamToxicol in press. Senthilkumar K, Kannan K, Sinha RK, Tanabe S, Giesy JP. Bioaccumulation profiles of polychlorinated biphenyl congeners and organochlorine pesticides in Ganges River dolphins. Environ ToxicolChem 1999;18(7):1511–20.
* Senthilkumar K, Kannan K, Subramanian A, Tanabe S. Accumulation of organochlorine pesticides and polychlorinated biphenyls in sediments, aquatic organisms, birds, bird eggs and bats collected from South India. Environ SciPollut Res 2001;8(1):35–47.
* Shailaja MS, Nair M. Seasonal differences in organochlorine pesticide concentrations of zooplankton and fish in the Arabian Sea. Mar Environ Res 1997;44:264–74.
* Shailaja MS, Sarkar A. Chlorinated hydrocarbon pesticides in the Northern Indian Ocean. In: Desai BN, editor. Oceanography of the Indian Ocean. New Delhi: Oxford, IBH Publishers; 1992. p. 379–83.
* Shailaja MS, Sarkar A. Organochlorine pesticide residues in sea around India. Internal Report for Chemical Research and Environmental Needs (CREN) joint program of Council of Scientific and Industrial Research

(CSIR). New Delhi and Commonwealth Science Council (CSC), London, Goa, India. National Institute of Oceanography (NIO) 1993.
* Shailaja MS, Sen Gupta R. DDT residues in fishes the eastern Arabian Sea. Mar Pollut Bull 1989;20:620–30.
* Shailaja MS, Sen Gupta R. Residues of dichlorodiphenyltrichloroethane and metabolites in zooplankton from the Arabian Sea. CurrSci 1990;59:929–31.
* Shailaja MS, Singbal SYS. Organochlorine pesticide compounds in organisms from Bay of Bengal. Estuar Coastal Shelf Sci 1994;39(3):219–21.
* Stout V. Organochlorine residues in fish from Northeast Atlantic Ocean and the Gulf of Mexico. Fish Bull US 1980;78:51–8.
* Subramaniam K, Solomon RDJ. Organochlorine pesticides BHC and DDE in human blood in and around Madurai, India. Indian J Clinical Biochem 2006;21(2):169–72.
* Sujatha CH, Chacko J. Malathion sorption by sediments from tropical estuary. Chemosphere 1991;23:167–80.
* Sujatha CH, Nair SM, Kumar NC, Chacko J. Distribution of organochlorine pesticides in a tropical waterway: HCH isomers. Toxicol Environ Chem 1993;39(1-2):103–11.
* Sujatha CH, Nair SM, Kumar NC, Chacko J. Distribution of dichlorodiphephenyltrichloroethane (DDT) and its metabolites in an Indian waterway. Environ Toxicol Water Qual 1994a;9:155–60.
* Sujatha CH, Nair SM, Chacko J. Sorption of malathion and methylparathion by tropical aquatic sediments: influence of pH.Toxicol Environ Chem 1994b; 41:47–55.
* Sujatha CH, Nair SM, Chacko J. Determination and distribution of endosulfan and malathion in an Indian Estuary. Water Res 1999;33(1):109–14.
* Takeoka H, Ramesh A, Iwata H, Tanabe S, Subramanian AN, Mohans D, et al. Fate of the insecticide HCH in the tropical coastal area of South India. Mar Pollut Bull 1991;22(6):290–7.
* Tanabe S, Kawano M, Tatsukawa R. Chlorinated hydrocarbons in the Antarctic, western Pacific and eastern Indian Ocean. Trans Tokyo Univ Fish 1982a;5:97–109.
* Tanabe S, Tatsukawa R, Kawano M, Hidaka H. Global distribution and atmospheric transport of chlorinated hydrocarbons, HCH (BHC) isomers and DDT compounds in the western Pacific, eastern Indian and Antarctic Oceans. J OceanogrSoc Japan 1982b;38:137–48.
* Tanabe S, Subramanian AN, Ramesh A, Kumaran PL, Miyazaki N, Tatsukawa R. Persistent organochlorine residues in dolphins from the Bay of Bengal, south India. Mar Pollut Bull 1993;26:311–6.
* Tanabe S, Iwata H, Tatsukawa R. Global contamination by persistent organochlorines and their ecotoxicological impact on marine mammals. Sci Tot Environ 1994;154:163–77.
* Tavares TM, Beretta M, Costa MC. Ratio of DDT/DDE in the All Saints Bay, Brazil and its use in environmental management. Chemosphere 1999; 38:1445–52.
* USEPA US Environmental Protection Agency. National Sediment Quality Survey, App D, Washington DC, USA; 1997.
* van-Birgelen APJM. Hexachlorobenzene as a possible major contributor to the dioxin activity of human milk. Environ Health Pers 1998; 106:683–8.
* WHO/UNEP Working Group. Public health impact of pesticides used in agriculture. Geneva: World Health Organization; 1990.
* Willett KL, Ulrich EM, Hites A. Differential toxicity and environmental fates of hemachlorocyclohexane isomers. EnvironmenSciTechnol 1998;32:2197–207.
* Wurl O, Obbard JP. Organochlorine pesticides, polychlorinated biphenyls and polybrominateddiphenyl ethers in Singapore's coastal marine sediments. Chemosphere 2005; 58(7):925–33.
* Yuan D, Yang D, Wade TL, Qian Y. States of persistent organic pollutants in the sediments from several estuaries in China. Environ Pollut 2001; 114:101–11.
* Zhang ZL, Hong HS, Zhou JL, Huang J, Yu G. Fate and assessment of persistent organic pollutants in water and sediment from Minjiang River estuary, Southeast China. Chemosphere 2003; 52:1423–30.

TABLE : 1

Seasnal variation of Pesticides in bivalve.

From Ratnagiri District

Sr. No	Name of the species	Study Area	*MANSOON*				*WINTER*				*SUMMER*			
			HCH	DDT	PCB	Endosul fan	HCH	DDT	PCB	Endosul fan	HCH	DDT	PCB	Endosul fan
1	Perna viridis	1	0.80	2.10	1.50	3.35	0.61	1.80	1.14	2.85	0.31	1.30	1.01	1.70
		2	0.65	2.15	1.45	3.40	0.42	1.76	1.20	2.78	0.34	1.10	0.91	1.79
		3	0.85	2.30	1.58	3.66	0.72	2.00	1.38	2.96	0.40	1.43	1.20	1.93
2	Crossostrea cuttukensis	1	1.56	2.10	1.12	2.57	1.29	1.53	1.36	2.22	1.08	1.12	0.76	1.24
		2	1.45	1.94	1.36	2.92	1.22	1.68	1.15	2.11	0.98	1.17	0.86	1.17
		3	1.96	2.18	1.66	3.36	1.80	1.98	1.21	3.10	1.47	1.20	0.95	2.14
3	Saccostrea cuculatta	1	1.28	3.24	2.56	1.80	1.13	2.89	2.47	1.33	0.97	1.98	1.92	1.07
		2	1.36	3.10	2.68	1.12	2.87	2.14	1.84	0.88	2.37	1.94	1.15	0.68
		3	1.47	3.92	3.20	4.42	1.13	3.10	2.86	3.90	0.94	2.82	2.16	2.46
4	Meretrix meretrix	1	1.48	2.69	2.36	3.68	1.13	2.17	1.96	3.19	0.96	1.92	1.36	2.58
		2	1.72	2.99	2.23	3.43	1.60	2.14	1.97	2.94	1.22	1.85	1.26	1.43
		3	1.85	3.24	2.73	4.94	0.57	1.62	2.18	2.86	0.29	0.93	1.67	1.96
5	Katelysia opima	1	1.04	2.10	0.78	3.66	0.88	1.73	0.61	3.22	0.73	1.12	0.59	2.84
		2	0.97	2.18	0.87	3.98	0.77	1.96	0.65	2.93	0.65	1.14	0.53	1.84
		3	1.10	2.54	0.94	4.67	0.49	1.16	1.10	2.86	0.32	0.58	0.94	2.53

N.D. :- Note detected.

Result are expresed in ng/g wet. Besis

Study 1 :- Dapoli, Study area 2 :- Guhaghar, Study area 3 :- Ratnagiri

TABLE : 2

Seasnal variation of Pesticides in bivalve.

From Sindhudurg District

Sr. No	Name of the species	Study Area	*MANSOON*				*WINTER*				*SUMMER*			
			HCH	DDT	PCB	Endosul fan	HCH	DDT	PCB	Endosul fan	HCH	DDT	PCB	Endosul fan
1	Perna viridis	1	1.20	3.43	2.34	5.10	0.81	1.20	1.85	3.20	0.44	0.93	1.21	1.43
		2	1.42	3.24	2.60	4.80	0.60	1.10	1.20	2.63	0.51	0.63	0.83	1.20
		3	1.63	3.94	3.22	6.20	1.10	1.50	1.28	3.38	0.72	1.25	1.42	1.80
2	Crossostrea cuttukensis	1	1.00	2.83	1.90	3.70	0.62	1.05	1.38	2.40	0.42	0.96	0.80	1.24
		2	1.18	2.38	1.92	3.65	1.12	1.86	1.19	2.45	0.88	1.23	1.15	1.12
		3	2.13	2.96	2.00	4.22	1.76	2.42	1.45	3.18	1.20	1.70	1.15	2.34
3	Saccostrea cuculatta	1	1.38	4.50	3.20	3.80	0.85	3.35	1.90	3.60	0.67	2.27	1.88	1.90
		2	1.45	4.76	2.38	5.40	1.25	3.17	2.12	4.38	1.12	2.60	2.48	2.35
		3	1.58	1.85	3.60	6.38	1.54	3.72	2.25	5.60	1.80	3.15	3.55	3.16
4	Meretrix meretrix	1	1.98	2.44	2.60	3.90	1.40	2.38	2.00	3.47	1.00	1.78	1.67	3.45
		2	1.90	2.35	2.10	4.36	0.45	1.20	1.87	2.45	0.25	0.94	1.25	1.80
		3	2.10	3.60	2.80	5.43	0.68	1.75	2.35	3.44	0.34	1.10	1.85	2.20
5	Katelysia opima	1	1.00	1.49	1.17	3.13	0.48	0.96	1.13	1.97	0.30	0.39	1.00	1.28
		2	0.94	1.80	0.96	3.26	0.30	1.18	0.95	2.43	0.22	0.42	0.86	1.79
		3	1.20	2.68	1.27	5.73	0.56	1.47	1.26	3.22	0.34	0.67	1.10	2.30

Result are expresed in ng/g wet. Besis

Study 1 :- Vengurla, Study area 2 :- Malvan, Study area 3 :- Devgad

N.D. :- Note detected.

TABLE : 3

Seasnal variation of Pesticides in bivalve.

From Raigad District

Sr. No	Name of the species	Study Area	*MANSOON*				*WINTER*				*SUMMER*			
			HCH	DDT	PCB	Endosul fan	HCH	DDT	PCB	Endosul fan	HCH	DDT	PCB	Endosul fan
1	Perna viridis	1	0.68	1.42	1.12	1.68	0.58	1.32	0.96	1.35	0.47	1.10	0.76	1.12
		2	0.42	0.96	0.84	0.96	0.37	0.86	0.74	0.89	0.30	0.72	0.63	0.74
		3	0.75	1.16	1.36	1.26	0.66	1.10	1.06	1.13	0.54	0.97	0.94	1.10
2	Crossostrea cuttukensis	1	0.43	N.D.	0.23	0.45	0.20	N.D.	0.15	0.38	N.D.	N.D.	N.D.	0.20
		2	0.54	0.92	N.D.	0.68	0.47	0.64	N.D.	0.53	0.34	0.32	N.D.	0.37
		3	0.84	0.58	N.D.	0.89	0.72	0.44	N.D.	0.66	0.54	0.22	N.D.	43.00
3	Saccostrea cuculatta	1	N.D.	N.D.	N.D.	0.85	N.D.	N.D.	N.D.	0.69	N.D.	N.D.	N.D.	0.48
		2	0.35	0.64	N.D.	0.81	N.D.	0.52	N.D.	0.65	N.D.	0.46	N.D.	0.55
		3	0.53	0.47	0.22	0.65	0.34	0.24	0.14	0.41	0.25	0.14	N.D.	0.38
4	Meretrix meretrix	1	0.65	0.44	0.36	0.77	0.37	0.23	0.15	0.55	0.20	0.13	N.D.	0.29
		2	0.46	0.32	0.50	0.80	0.34	0.27	0.36	0.62	0.26	0.21	0.28	0.41
		3	0.52	0.43	0.36	0.63	0.39	0.28	0.23	0.51	0.26	0.18	0.14	0.35
5	Katelysia opima	1	0.32	N.D.	N.D.	0.39	0.24	N.D.	N.D.	0.24	0.11	N.D.	N.D.	0.10
		2	0.28	0.14	N.D.	0.25	0.16	0.12	N.D.	0.18	0.10	0.09	N.D.	0.13
		3	N.D.	N.D.	0.14	0.20	N.D.	N.D.	0.10	0.16	N.D.	N.D.	0.12	0.17

N.D. :- Note detected.

Result are expresed in ng/g wet. Besis

Study 1 :- Shrivardhan, Study area 2 :- Alibag area, Study area 3 :- Uran.