Imposex in muricid gastropod *Thais biserialis* (Mollusca: Neogastropoda: Muricidae) from Tuticorin harbour, southeast coast of India

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Imposex has been reported in the muricid gastropod *Thais biserialis* from inside the Tuticorin port. The sex ratio departed from 1:1 and the males were dominant. The frequency of imposex in females was 35%. The Vas deferens sequence (VDS) index indicated the occurrence of initial imposex stages of 1a and 2a i.e. the development of penis and penis with closed duct. The Relative penis size (RPS) index values were less when compared to the reports elsewhere. The observation of imposex indicated the possible contamination of tributyltin (TBT), which could have leached out from antifouling paints of the ships using Tuticorin port.

[ Key words: tributyltin, TBT, imposex, gastropod, muricid, Tuticorin, *Thais biserialis* ]

Antifouling paints containing tributyltin (TBT) compounds were introduced in 1960s and found wider use from mid 1970s. TBT is used as the active biocide in marine antifouling paints and also used as paper, wood and textile preservatives, plastic, especially PVC stabilizers and as slimicides for cooling towers1. The abnormal growth and reproductive failure in cultivated oyster, *Crassostrea gigas* in Arcachon Bay in France was linked to the leaching of TBT from antifoulants on small boats2. It has been proved that TBT causes imposition of male sex characters in females of neogastropods and this is particularly well reported in muricid gastropods3. Imposex is known in 72 species of gastropods belonging to 49 genera4. The development of male sex characters including penis and vas deferens in extreme cases, occludes the genital pore causing the female sterile and some times lead to premature mortality due to build up of egg capsules in the capsule gland.

Imposex is prevalent in places close to ports, shipyards, marinas and around mariculture facilities where organotin compounds are used in antifouling paints3. Among the muricid gastropods, species mainly belonging to the genus *Thais* have been used as indicators of TBT contamination in tropical waters5. TBT has been attributed to the local extinction of some populations of dogwhelks, *Nucella lapillus* in Southwest England6. In India, imposex has been recorded in *Cronia konkanensis* from Marmagao harbour7.

Tuticorin Port was declared as the 10th Indian Major Port in 1974 and the traffic is increasing every year- 899 vessels in 1998-99 to 1236 vessels in 2000-2001. There is no dry dock facility at the Port. The possibility of TBT contamination through leaching from antifouling paints from ships is more in Tuticorin Port area. Hence, the study has been taken up to assess the possible effect on gastropod *Thais biserialis* (Blainville) (Mollusca:Neogastropoda: Muricidae) distributed inside the port area.

Sixty two animals of *Thais biserialis* were collected from inside the port area of Tuticorin (lat. 8° 45’ N and long. 78° 13’ E). The collected specimens were transported in live condition to the laboratory, cleaned and maintained with aeration until further analysis. The animals were narcotized using 7% MgCl₂ and shell length was recorded to the nearest 0.1 mm. The shells were cracked by light taps with a hammer and the soft parts removed. The sex was determined by the presence of prostate gland in males and the capsule gland, albumen gland in females. The length of the penis in both males and females (with imposex) were measured using occulometer under the binocular microscope. The imposex frequency was calculated as the proportion of females with imposex compared with the total number of females sampled6. The condition of the vas deferens in females was assessed using the vas deferens sequence (VDS) index8. Relative penis size (RPS) index is expressed as7:
Relative penis length (RPL) index is expressed as:

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\frac{\text{Mean length of female penis}}{\text{Mean length of male penis}} \times 100
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In *Thais biserialis* distributed in Tuticorin port area, the average length of the male and female shells was 22 mm and 23.3 mm. A marked deviation in the male : female sex ratio was 2.1 : 1. Similar deviation in sex ratio with male dominance has been observed in *T. bitubercularis*, *T. clavigera* and *T. jubilaea* from Singapore. The frequency of imposex was 35% and it is less when compared to the recorded range of 90 – 100% from Marmagoa harbour and in Phuket, Thailand. The mean penis length of the male was 2.8 mm and that of female with imposex 0.4 mm. The correlation between male shell length and penis length [0.0460 (P > 0.05)] and that of female shell length and penis length [−0.0468 (P > 0.05)] were not significant.

The RPS index value was 0.3% and RPL index was 14.3% (Table 1). The RPS index did not exceed 25% and is also less when compared to three *Thais* species studied in Singapore. RPL and RPS values increased with increasing VDS stage. Similar increase in RPL and RPS values corresponding to the VDS stage has been observed for *Cronia konkanensis* from Goa. VDS index is considered as the more valid index for the biomonitoring of TBT pollution and VDS index provides information on the reproductive capability of the population. The recognition of different stages in vas deferens development provides a more sensitive method of categorising the intensity of expression of imposex. The frequency of imposex assessed through VDS indicated the occurrence of stages 1a and 2a, i.e. development of penis and penis with closed duct. The stage 2a is prevalent and occurred in 86% of the females with imposex. It has been indicated that a population with an VDS index of above 4 has sterilized females and thus have a reduced reproductive capacity. However, in the present study VDS index value of 0.7 was observed and is well within 4. No occlusion of genital pore or aborted capsules was noticed during the present observation.

The TBT based antifouling paints used in ships and boats have affected the non-target organisms as well, especially the molluscs. Among the muricid gastropods, species belonging to *Thais* sp. have been used as indicators of TBT contamination in tropical waters. Whereas, *Nucella lapillus* is the commonly used indicator of TBT contamination in temperate zones because of its abundance and sensitivity to TBT. But the observation of imposex in *Nucella lapillus* from the shore adjacent to a gull roost and near breeding colonies of seabirds in UK which has been attributed to the compounds from birds excretion has implications on the use of imposex as an indicator of TBT level in the environment. TBT is considered as the most toxic compound ever deliberately introduced into the natural waters. TBT exhibits no direct effect on the female genital system, but disturbs the biosynthesis of steroid hormones.

The present study showed the initial stages of possible TBT contamination. The unequal sex ratio and the observation of stages 1a and 2a of the VDS index indicated the possible effect of TBT, which could have leached out from the antifouling paints of the ships using the Tuticorin port. Though there is a possibility of inducement of imposex by other contaminants, the widespread observation of imposex in
muricid gastropods due to TBT indicate the possibility of TBT contamination in the present study also.

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References
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