females is unaffected by these alterations. In stage 1 sperms are spilled off the gaping bursa copulatrix into the mantle cavity. At least the stages 2, 3 and 4 are sterilized because the formation of egg capsules is prevented either by the open structure of the pallial oviduct or by the absence of capsule and covering gland. Such curtailment of breeding activity would result in population decline. These observations can be verified by poor or no recruitment of juveniles before the TBT ban in England (Matthiessen *et al.*, 1991). Additionally, a diminution of the pallial organs of females (receptaculum seminis, albumen, capsule and covering gland) in highly TBT polluted populations is evident.

The intersex index (= ISI, calculated as the average intersex stage of a population) and the average prostate length of females demonstrate a significant and positive correlation to the TBT body burden of *Littorina littorea*. Both indices are most promising parameters for TBT biomonitoring. Obviously intersex development of edible winkles is induced at higher ambient TBT concentrations compared to the imposex phenomenon in other prosobranch species with threshold concentrations of ≤ 0.5 ng TBT as Sn/l (Gibbs *et al.*, 1987 ; Oehlmann *et al.*, 1992 ; Stroben *et al.*, 1992a, b).

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Probable extinction of prosobranch populations as result of TBT pollution in the Bay of Morlaix

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Tributyltin (TBT) induces imposex (superimposition of male sex organs on females) in prosobranch species. As its final point females of muricid gastropods are sterilized by an occlusion of the vagina (*Nucella lapillus* : Oehlmann *et al.*, 1991) or by an incomplete ontogenetic fusion of the pallial oviduct resulting in a splitted capsule gland and bursa copulatrix (*Ocenebra erinacea* : Oehlmann *et al.*, 1992). The blockade of the vagina causes an accumulation of abortive capsules in the pallial glands provoking their rupture and finally the death of the female. The vas deferens sequence (VDS) index allows an exact assessment of the imposex intensity and TBT exposure of a population ; values above 4.0 indicate that a portion of the females and values above 5.0 that all females are sterilized (Oehlmann *et al.*, 1991, 1992).

Between 1988 and 1993 more than 25,000 specimens belonging to 12 prosobranch species were analysed especially in the Bay of Morlaix. We found the highest TBT sensitivity in *Ocinebrina aciculata* (threshold concentration for female sterility ≤ 1.5 ng TBT-Sn/l), followed by *Nucella lapillus* (2.0 ng TBT-Sn/l) and *Ocenebra erinacea* (8.0 ng TBT-Sn/l).

O. aciculata is characterised by a population decline during the last decades. Franc (1940, 1952) had found numerous specimens including juveniles and egg capsules in the entire investigation area. Today this species occurs only at the Ile Verte and near Roscoff harbour. *N. lapillus* also exhibits symptoms of a population decline at Moguériec and between the Marine Biological Institute of Roscoff and Primel Trégastel : (1) VDS values above 4.0, (2) male-biased sex ratios and (3) poor or no recruitment of juveniles. Between April and August 1989 the population at Primel Trégastel was exterminated due to high TBT pollution. Furthermore TBT causes a reduction of the female pallial glands even in species which are not sterilized by imposex. In *Hinia reticulata* the length of the capsule gland is reduced by 20 % and its volume by 49 % between Méan Mélen (control site) and the highly polluted harbour of Roscoff. Consequently, the reproductive performance is reduced at TBT exposed sites. Although the use of TBT based antifouling paints is restricted in France since 1982, harbours and marinas are still sources of TBT pollution. Even today TBT exposure is high enough to endanger sensitive species (e.g. *Ocinebrina aciculata* and *Nucella lapillus).*

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The morphometric differences in the *Littorina obtusata-mariae* (Gastropoda : Prosobranchia) complex in Ireland

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Since Sacchi & Rastelli (1966) separated the flat winkles into two distinct species, *Littorina obtusata* (Linnaeus) and *Littorina mariae* Sacchi & Rastelli, little work has been done on these species in Ireland. Reimchen (1979) concentrated on shell colour variation while Little & Williams (1989) described the distribution of the two species at Lough Hyne Marine Nature Reserve, west Cork.

In the present study, the morphometric and morphological differences in the *Littorina obtusata-mariae* complex were studied in samples collected from a number of sites around Ireland. It was possible to separate the males based on the shape of the penis, including the number of penial glands (Sacchi & Rastelli, 1966) and the females on the colour of the ovipositor (Goodwin & Fish, 1977). The relative lengths of the bursa copulatrix were not examined (Reid, 1990). In *L. mariae* the penial glands ranged in number from 8-15, while in *L. obtusata* 20-62 glands were present, in two-three irregular rows. In both species the sex ratio was close to 1:1.

With respect to shell characters, canonical variate analysis showed that the two species can be separated by shell shape. The parameters measured were those of Colman (1932). The results agree with the separation of *L. obtusata* and *L. mariae* into 'normal' and 'dwarf' respectively, due to size dimorphism (Sacchi & Rastelli, 1966). Both species showed sexual dimorphism, females being larger than males. Furthermore, in agreement with Goodwin & Fish (1977), there was a clear size gradient with wave exposure : the mean