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Seasonal Variation of the Cadmium Content of *Murex trunculus* in a Non-Cadmium Polluted Environment

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Considering the cadmium pollution of the Bay of Calvi (Corsica) and its surrounding waters, Aubert et al. (1983) give values ranging from 200 to 500 ng.l^{-1} . However using anodic stripping voltametry, Gillain and Brihaye (1985)give much lower values ranging from 5 to 20 ng.l^{-1} These values are of the same order of magnitude but lower than those of the Ligurian and Thyrrenian seas(Mart et al. 1982) and very much lower than in the highly polluted North Sea(Gillain et al.,1979), all these data having been recorded using similar analytitical methods We therefore assume that the Bay of Calvi can be considered as unpolluted by cadmium, which fits well with the fact that there is no factory in its vicinity and that the bay is only subjected, in the summertime, to an organic pollution resulting from the well developed touristical activity.

However, in previous works, we have reported that Murex trunculus, collected in 1982 in the Bay of Calvi, contained high levels of cadmium which accumulates, to a large extent, in spherocrystals of the vesicular cells associated with the vascular system and in lysosomes of the pore cells (Bouquegneau et al., 1983 ; Martoja et al., 1984). Since 1982, we have followed the cadmium concentration of the soft tissues during two years (1983 and 1984) and, in some samples, we have determined the quantity of cadmium bound to metallothioneins in the soluble fraction, and present in the insoluble one either under a weakly bound form (probably in spherocrystals) or under a strongly bound one (very likely cadmium sulphide in lysosomes). Total cadmium and cadmium bound to metallothioneins were determined according to Bouquegneau et al.(1983). The insoluble fraction of the soft tissues was divided into two parts. One was mineralized in a mixture of 65%HNO3 and 37%HCl for the determination of the total cadmium and the other part was treated with 0.1 N. HCl for the determination of the weakly bound cadmium.

(1) Correspondence and reprint requests.

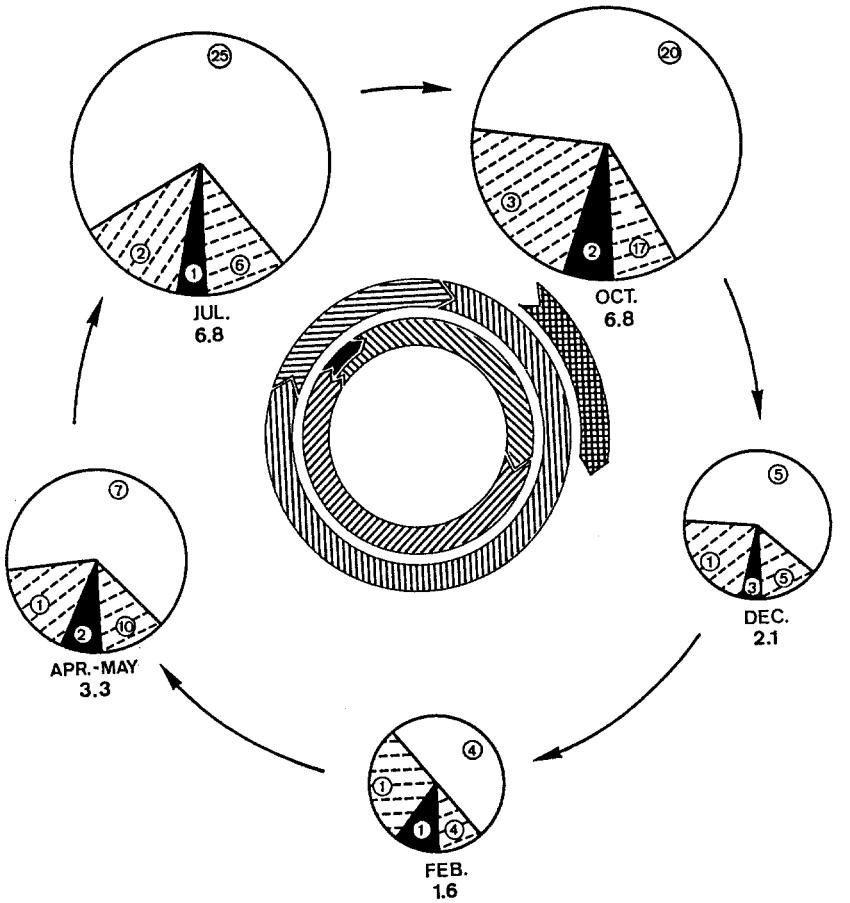

Figure 1. Seasonal variation of the cadmium content (µg .g-1 WW) of soft tissues of Murex trunculus. The surface of the quarters is proportionnal to the cadmium load of the organs. visceral mass, kidney
cephalopodium, palleal complex
Numbers under the dates indicate the cadmium concentration of whole soft tissues (ug.g-1 WW).
shell formation, eggs laying
female gonads: maturation involution
male gonads: maturation involution

Fig 1 shows the seasonal variation of the total cadmium content and some physiological events which have been morphologically or histologically observed. The total cadmium content of the soft tissues increases from February to July and decreases during the other part of

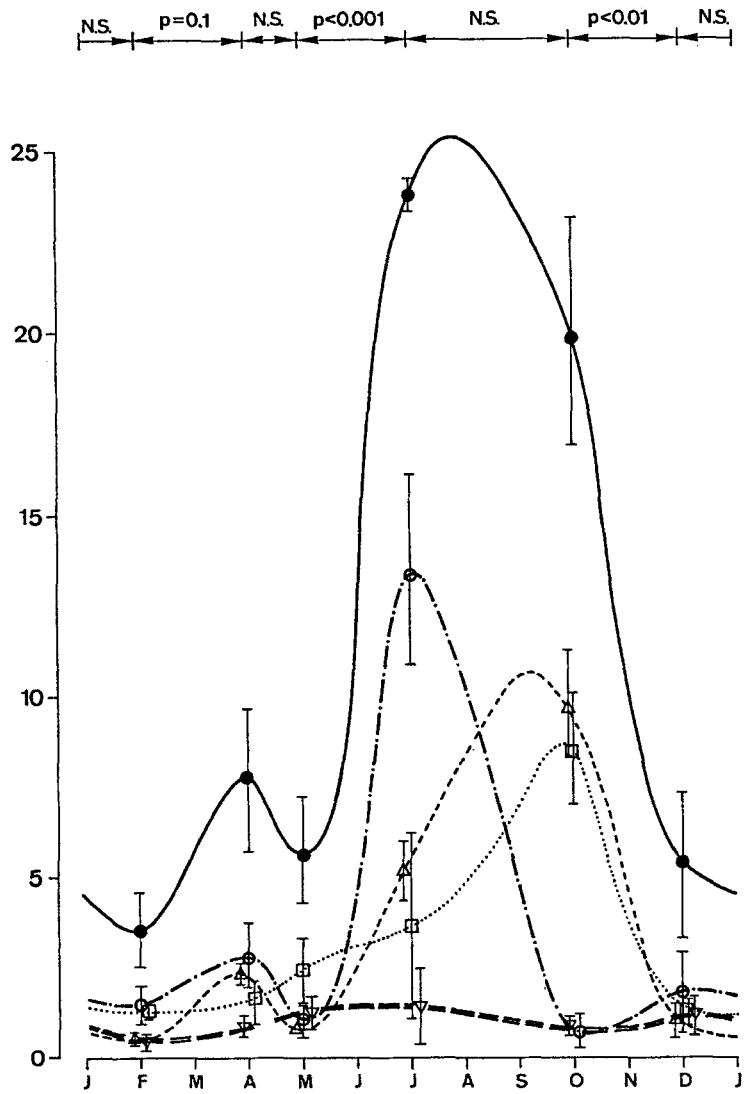

Figure 2. Seasonal variation of the cadmium content (µg .g^{-1} WW) and its speciation in the visceral mass of Murex trunculus. The level of significance between the means (+ or - S.E.) of total cadmium concentrations is given according to t-test. Each mean has been compared to the mean adjacent to it.

□ total cadmium.

Soluble fraction:
- O cadmium bound to metallothioneins
- ● cadmium bound to high molecular weight proteins.

Insoluble fraction:
- △ weakly bound cadmium.
- ▽ strongly bound cadmium.

the year. These variations are not clearly related to the sexual cycle, but it appears that the highest decrease occurs during the shell formation. However, most of the cadmium is really excreted out of the animal since the shell contains cadmium levels too low (about 300 ng.g^{-1}, according to Gervais et al., to be published) to account for the decrease in the soft tissues.

When considering the distribution of cadmium in the organs(Fig.1), most of the metal appears to be located in the visceral mass (i.e. the digestive gland and the gonad, as well as the above - mentioned vesicular cells and pore cells)whilst its weight represents always less than 30 % of the total weight of the soft tissues. Fig. 2 shows the speciation of cadmium in the visceral mass of the animals. The observed variations are significant from a statistical point of view and the different phases of the organs are not equally affected by the metal variations. The summer increase of cadmium is mainly associated with the synthesis of metallothioneins. Then , part of the thionein cadmium is transferred to other soluble proteins of the soluble fraction,and part of it is transferred to the insoluble fraction,where the cadmium is weakly bound. The strongly bound cadmium concentration of the insoluble part of the tissues remains low all year.
Our interpretation of these results is that cadmium could be an essential element for Murex trunculus and be implicated in the process of shell formation, the control of which is imperfectly known (see Wilbur and Saleuddin, 1983). Its accumulation in the visceral mass precedes the formation of the shell and is facilitated by the presence of metallothioneins. One part of this cadmium shifts in the insoluble part of the tissues, probably in spherocrystals, according to the weakness of its binding. During shell growth, these spherocrystals could be partly dissolved. In this case, cadmium would be released in the blood and excreted later from the animal. Further work is performed to test these hypothesis, but, whatever the interpretation, for us, our results illustrate two important ecotoxicological principles:

1. High loads of cadmium in some species are not necessarily correlated with a high level of pollution of their environment.
2. When comparing the contamination level of specimens from a single species caught in different areas, the season during which they have been collected should be taken into account.

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REFERENCES

Aubert M, Revillon P, Breittmayer JP, Gauthier M, Aubert J, Flatau G (1983) Métaux lourds en Méditerranée. Rev Int Oceanogr Med, Tomes LXVIII-LXIX:1-371

Bouquegneau JM, Martoja M, Truchet M (1983) Localisation biochimique du cadmium chez Murex trunculus L. (Prosobranche Néogastropode) en milieu naturel non pollué et après intoxication expérimentale. C R Acad Sc Paris 298, Série III:1121-1124

Gillain G, Brihaye C (1985) A system for taking a representative sample from a large volume of turbid surface sea water for trace elements determinations. Anal Chimica Acta 167:387-391

Gillain G, Duyckaerts G, Distèche A (1979) Direct and simultaneous determination of Zn, Cd, Pb, Cu, Sb and Bi dissolved in sea water by differential pulse anodic stripping voltammetry with a hanging mercury drop electrode. Anal Chimica Acta 106:23-37

Mart L, Rutzel H, Klahre P, Sipos L, Valenta D, Nurmberg HW (1982) Comparative studies on the distribution of heavy metals in the oceans and coastal waters. Sci Total Environ 26:1-17

Martoja M, Truchet M, Bouquegneau JM (1984) Accumulation naturelle du cadmium chez Murex trunculus et Murex brandaris (Prosobranches Néogastropodes): localisation histologique. C R Acad Sc Paris 298, Série III:461-466

Wilbur KM, Saleuddin ASM (1983) Shell formation. In: Wilburg KM (ed) "The Mollusca",vol 4,part 1. Academic Press, 235-287.

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