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English title: Estimation of the Cd intake in the human dietary from the shellfish caught in the seashore of Charente-Maritime (France)

French title: Estimation du taux de Cd dans l'alimentation humaine à partir de coquillages et crustacés ramassés dans les eaux littorales de la Charente-Maritime (France)

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SUMMARY: Gironde inputs leads to a Cd enrichment of the waters of Charente-Maritime. This presentation describes the potential risk of Cd ingestion due to the seashells by some inhabitants of the coasts of Charente-Maritime. Wild oysters analysed along the coasts showed a good correlation between Cd concentrations in their tissues and the distance from the Gironde estuary, with minimum values in the north of the department and the maximum values in the estuary where shellfish collection is by the way forbidden. These results have allowed us to choose five different sites situated along the Cd gradient in which the major species consumed seashells collectors have been sampled for Cd analysis. The Cd intake due to the seashells consumption has been assessed by the Cd concentrations found in these species which have been compared with the Cd Provisional Tolerable Weekly Intake (PTWI) of 7 µg/kg. This consumption is added to the normal Cd intake due to the food and drinks estimated to 38 % of the PTWI (investigation of the «Direction Générale de la Santé», 1995). As an example, the weekly consumption of 300-400 g of scallops *Chlamys varia* from Château d'Oléron by a man of 65 kg is sufficient to reach the PTWI. On the contrary, the weekly consumption of 10-13 kg of edible cockles *Cerastoderma edule* from the same site are necessary to reach the PTWI. The scientific investigation carried out in the aim to determine the levels of seashells consumption in Charente-Maritime allowed to determine three different categories of consumers:

- category 1, middle consumers : 6.5 kg of seashells per year (including 2.6 kg of oysters)
- category 2, high consumers : 13.2 kg of seashells per year (including 8.5 kg of oysters)
- category 3, very high consumers : 38.5 kg of seashells per year (including 24.8 kg of oysters)

According to the seashell ratio determined in this investigation, our results show that for all consumers of seashells collected in Charente- Maritime out of the Gironde estuary, the Provisional Cd Tolerable Weekly Intake is never reached even for the very high consumers.

Keywords: Cd; seashells; Charente-Maritime coasts; human dietary; PTWI.

RÉSUMÉ : Les apports de la Gironde conduisent à un enrichissement en Cd des eaux littorales de la Charente-Maritime. Cette présentation étudie le risque potentiel de l'ingestion de Cd, du aux coquillages, pour certains habitants du littoral de la Charente-Maritime. Les analyses des huîtres sauvages, le long des côtes, ont montré une bonne corrélation entre la concentration en Cd dans leurs tissus et la distance de l'estuaire de la Gironde, avec des valeurs minimales au nord du département et des valeurs maximales dans l'estuaire où la collecte est, de ce fait, interdite. Ces résultats nous ont permis de sélectionner huit sites différents, répartis le long du gradient de Cd, où les espèces principalement consommés par les pêcheurs à pied ont été échantillonnées pour l'analyse du Cd. L'apport en Cd du à la consommation de coquillages a été évalué à partir des concentrations en Cd trouvées dans ces espèces, lequel a été comparé avec la dose hebdomadaire tolérable (DHT) de 7 µg/kg par semaine. Cette consommation a été ajoutée à l'apport normal en Cd, du à l'alimentation et à la boisson, estimé à 38 % de la DHT (enquête de la «Direction Générale de la Santé», 1995). A titre d'exemple, la consommation hebdomadaire de 300-400 g de pétoncles *Chlamys varia* du Château d'Oléron, par un homme de 65 kg, est suffisante pour atteindre la DHT. Au contraire, la consommation hebdomadaire de 10-13 kg de coques comestibles *Cerastoderma edule* provenant du même site est nécessaire pour atteindre la DHT. L'étude visant à préciser les niveaux de consommation de coquillages en Charente-Maritime a permis de déterminer trois catégories différentes de consommateurs :

- catégorie 1, consommateurs moyens : 6,5 kg de coquillages par an (incluant 2,6 kg d'huîtres),
- catégorie 2, forts consommateurs : 13,2 kg de coquillages par an (incluant 8,5 kg d'huîtres),
- catégorie 3, très forts consommateurs : 38,5 kg de coquillages par an (incluant 24,8 kg d'huîtres).

Selon la proportion de coquillages prise en compte dans ces recherches, nos résultats montrent que pour tous les consommateurs de coquillages collectés en Charente-Maritime, excepté l'estuaire de la Gironde, la dose hebdomadaire tolérable en Cd n'est jamais atteinte, même pour les très forts consommateurs.

Mots clés : Cd ; fruits de mer ; côtes de Charente-Maritime ; alimentation humaine ; DHT.

Introduction

Gironde inputs have been well documented for years 1981 (BOUTIER et al., 1989) and leads to a Cd enrichment to the waters of Charente-Maritime (Anonymous, 1995a). These inputs are due to an old extracting Zn ore plant «Vieille Montagne» situated upstream far from more than 250 km of the Gironde estuary. This factory, closed in 1986, has discharged into the river, very high quantity of Cd (60 Kg/day). The pollution of the Gironde estuary is mainly due to an input of contaminated particles. In the area where sea water - fresh water mixed together, the Cd is desorbed from particles and is mainly under dissolved form in the plume of the Gironde river. Just now, fluxes are estimated to be about 4 to 5 tons/year, among which 500 Kg may reach the Marennes-Oléron bay (BOUTIER, personal communication). Indeed, recent studies have shown a Cd bioaccumulation by all species collected in some areas along the Charente-Maritime coasts (MIRAMAND et al., 1999, PIGEOT et al., 2000, PIGEOT, 2001). This presentation describes the potential risk of Cd ingestion due to the seashells by some inhabitants of the coasts of Charente-Maritime.

Materials and methods

12 common shellfish (*Mytilus edulis*, *Crassostrea gigas*, *Patella vulgata*, *Littorina littorea*, *Chlamys varia*, *Cerastoderma edule*, *Scrobicularia plana*, *Tapes decussatus*, *Ruditapes phillipinarum*, *Carcinus maenas*, *Necora puber*, *Palaemon serratus*) were collected at five different sites situated along the coasts of Charente-Maritime, while wild oysters *C. gigas* were sampled on 26 different stations (Fig. 1 and 2). All the shellfish were analysed for Cd contents by atomic absorption spectrophotometry, method commonly carried out in our laboratory (CAURANT et al., 1999, FICHET et al., 1999) and regularly controlled by participation of the laboratory to international intercalibration exercise.

Results and discussion

Wild oysters analysed along the coasts of Charente-Maritime showed a good correlation between Cd concentrations in their tissues and the distance from the Gironde estuary (Fig. 1) with minimum values in the north of the areas (between 1.5 and 2.4 $\mu\text{g}\cdot\text{g}^{-1}$ dry weight) and maximum values (between 15 and 28 $\mu\text{g}\cdot\text{g}^{-1}$ dry weight) in the estuary where shellfish collection is, by the way, forbidden since 1996.

These results allowed us to select eight different sites located along the Cd gradient where the major species consumed by seashells collector have been sampled for Cd analysis (Fig. 2).

The Cd concentrations ($\mu\text{g}\cdot\text{g}^{-1}$ dry weight) measured in the common species collected in these areas are given in Figure 3.

Generally, for all species, the highest concentrations were found in shellfish collected in the estuary. Among them, oysters and limpets exhibited concentrations above 10 $\mu\text{g}\cdot\text{g}^{-1}$ dry weight, the limit defined by the European council for the authorisation of shellfish consumption. We may also notice high concentrations in scallops *Chlamys varia* sampled in the bay of Marennes Oléron (above 10 $\mu\text{g}\cdot\text{g}^{-1}$ dry weight). Among the 12 species collected, limpets, winkles, oysters, mussels and scallops showed in all sites the highest Cd concentrations; on the contrary, burrowing bivalves (cockles, clams, *Scrobicularia*) and decapods crustaceans (shrimps and crabs) displayed low concentrations ranged between 1 and 2 $\mu\text{g}\cdot\text{g}^{-1}$ dry weight.

The Cd intake due to the shellfish consumption has been assessed by the Cd concentrations found in these species which have been compared with the Cd Provisional Tolerable Weekly Intake (PTWI) of $7 \mu\text{g}\cdot\text{Kg}^{-1}$. This Cd intake due to shellfish consumption is added to the normal Cd intake due to the food and drink estimated to represent 38 % of the PTWI (investigation of the Direction Générale de la Santé, Anonymous, 1995b).

As an example, for a 65 kg man, the weekly consumption of 800 g of scallops *Chlamys varia* from Ré island, or 600 to 900 g of oysters or mussels from the Gironde estuary is sufficient to reach the PTWI.

On the contrary, the weekly consumption of 5 kg (Gironde estuary) or 17 kg (Ré island) of cockles is necessary to reach the PTWI (see Fig. 4).

The scientific investigation carried out in the aim to determine the levels of shellfish consumption in Charente-Maritime allowed to determine three different categories of consumers (Anonymous, 1994):

- category 1, middle consumers : 6.5 Kg of shellfish per year (including 2.6 Kg of oysters)
- category 2, high consumers : 13.2 Kg of shellfish per year (including 8.5 Kg of oysters)
- category 3, very high consumers : 38.5 Kg of shellfish per year (including 24.8 Kg of oysters).

According to the shellfish consumption determined in this investigation, our results show that for all consumers collected in Charente-Maritime excepted the Gironde estuary, the Provisional Cd Tolerable Weekly Intake is never reached even for the very high consumers (Fig. 5).

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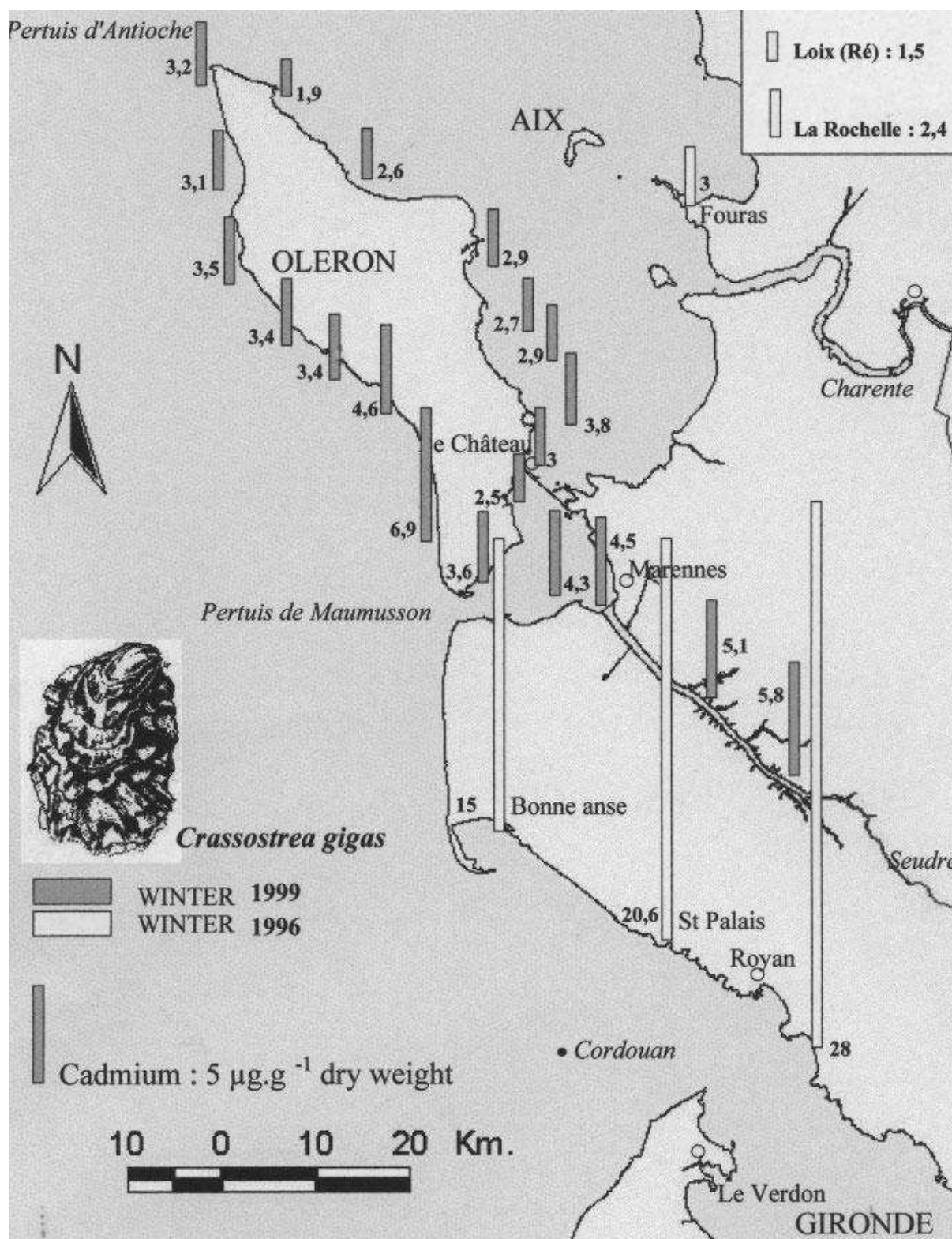


FIGURE 1. — Cd concentrations ($\mu\text{g}\cdot\text{g}^{-1}$ dry weight) measured in wild oyster *Crassostrea gigas* collected along the coasts of Charente-Maritime.

FIGURE 1. — Concentrations en Cd ($\mu\text{g}\cdot\text{g}^{-1}$ poids sec) mesurées dans les huîtres sauvages *Crassostrea gigas* collectées sur le littoral de la Charente-Maritime.

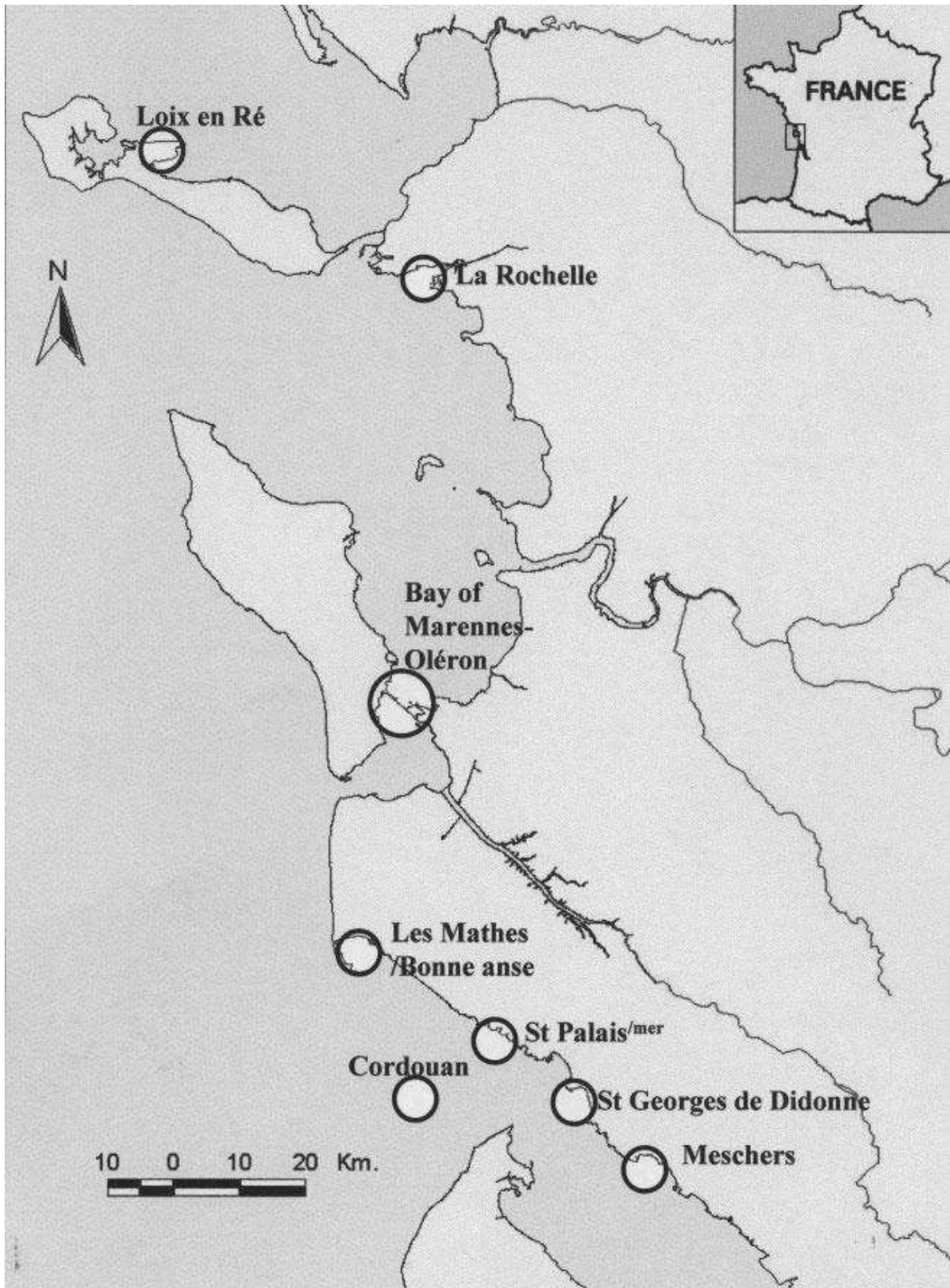


FIGURE 2. — Sampling areas.
FIGURE 2. — Zones d'échantillonnage.

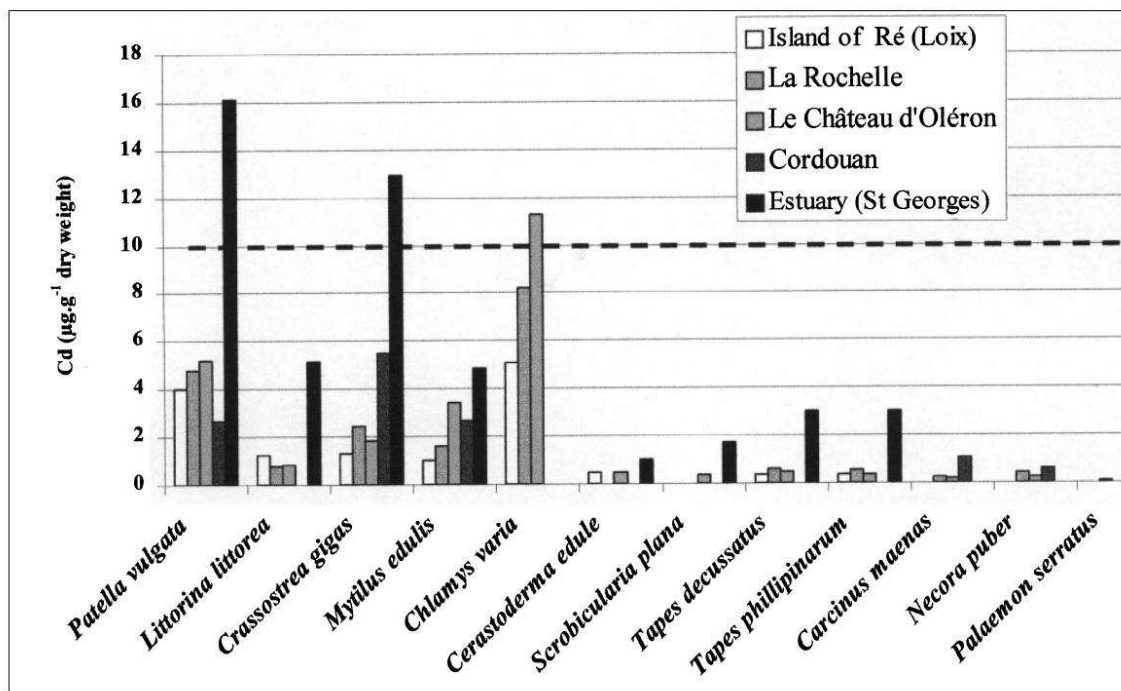


FIGURE 3. — Cd concentrations ($\mu\text{g}\cdot\text{g}^{-1}$ dry weight) measured in common shellfish species collected along the coasts of Charente-Maritime.

FIGURE 3. — Concentrations en Cd ($\mu\text{g}\cdot\text{g}^{-1}$ poids sec) mesurées dans les espèces communes de coquillages et crustacés collectées sur le littoral de la Charente-Maritime.

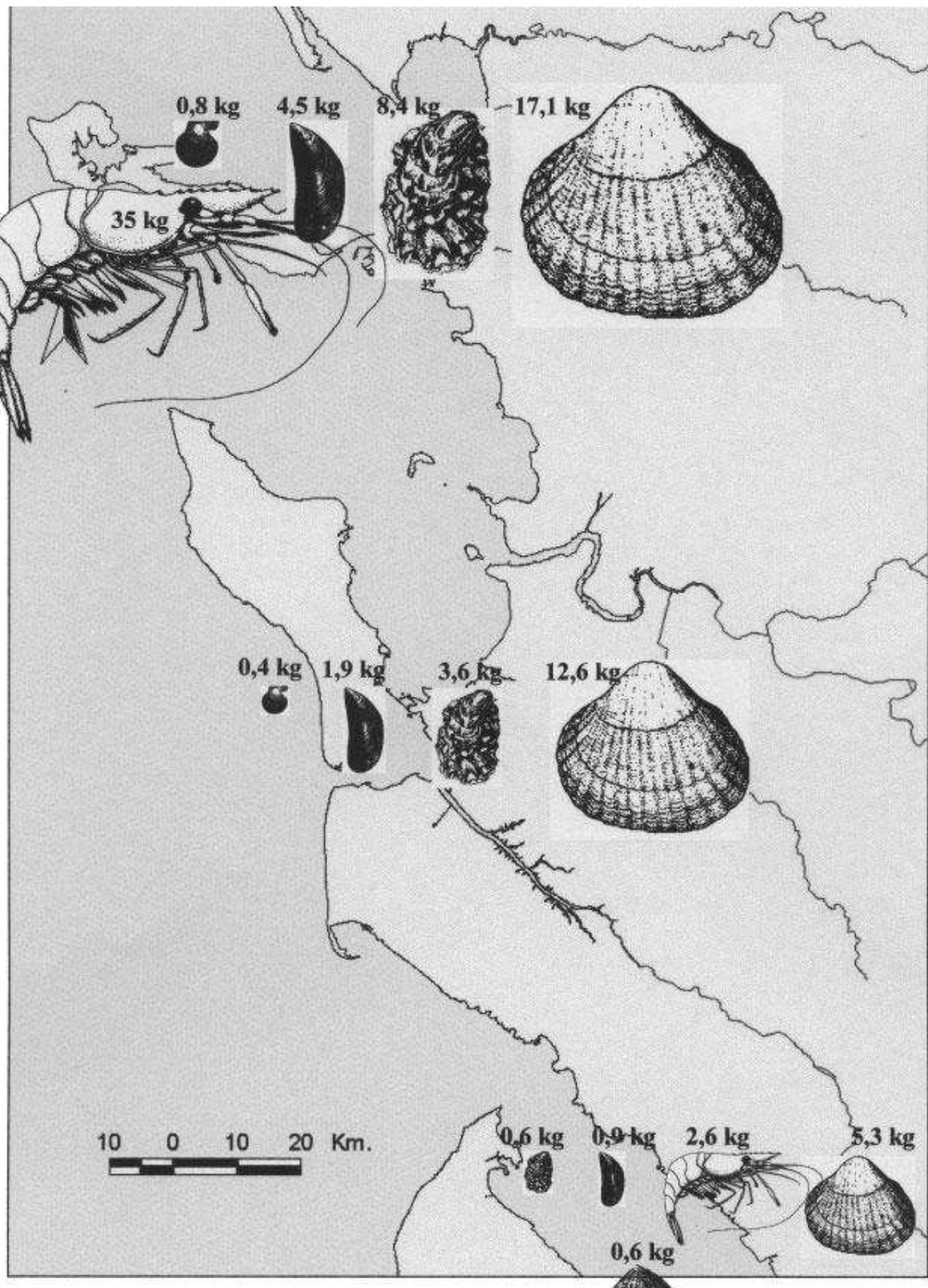


FIGURE 4. — Weekly shellfish consumption in a 65 Kg man sufficient to reach the Cd Provisional Tolerable Weekly Intake (PTWI): $7 \mu\text{g} \cdot \text{Kg}^{-1}$. Calcul includes a Cd input due to normal food and drink which represents 38 % of the PTWI.

FIGURE 4. — Consommation hebdomadaire de coquillages et crustacés pour un homme de 65 kg nécessaire pour atteindre la dose hebdomadaire tolérable (DHT) en Cd : $7 \mu\text{g} \cdot \text{kg}^{-1}$. Le calcul inclut l'apport en Cd du à l'alimentation habituelle et les boissons, soit 38 % de la DHT.