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翡翠贻贝（*Perna Viridis*）的个体大小对^{125}I在其体内积累与分布的影响

EFFECT OF BODY SIZE ON ACCUMULATION AND DISTRIBUTION OF ^{125}I IN THE GREEN MUSSEL (*PERNA VIRIDIS*)

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摘　要

翡翠贻贝（*Perna viridis*）的个体大小对放射性核素^{125}I在其体内的积累与分布影响显著。实验结果表明，小个体对^{125}I的浓集能力比大个体强。在贝体各部分中，足丝对^{125}I的浓缩因子（约0.5×10^3～1.5×10^3）比其他部分高得多，为软体组织的30～200倍，为足的200～600倍，为贝壳的600～1000倍。足丝的湿重虽不及整体湿重的1%，但积累的^{125}I占贝体总量的一半以上，甚至可高达75%。足丝对^{125}I的浓缩因子与贻贝整体湿重（或壳长）呈负的幂指数关系。

Effect of Body Size on Accumulation and Distribution of ^{125}I in the Green Mussel (*Perna Viridis*)*

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ABSTRACT

Effect of body size on accumulation and distribution of ^{125}I in the green mussel (*Perna viridis*), has been studied. The results showed that concentration capacity of every part in smaller mussels was higher than that in larger ones. Concentration factors of ^{125}I in byssus (about $0.5\times10^3\sim1.5\times10^3$), the highest in all parts of the mussels, were 30～200 times as that in soft tissues, 200～600 times as that in feet, 600～1000 times as that in shells. Although wet weight of byssus was no more than 1% of whole body's wet weight, the content of ^{125}I accumulated in it accounted for as high as 75% of total ^{125}I content. The relationship between concentration factor of ^{125}I in byssus and whole body's wet weight (or shell length) can be discribed as a negative power function.

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INTRODUCTION

Certain environmental and biological factors influenced the uptake and loss of pollutants by molluscs (Li Yongqi and Ding Meili, 1991). Some reports showed that body size, one of the biological factors, was directly associated with the accumulation of pollutants in molluscs: Boyden (1974, 1977), Cossa (1980), Boalch (1984) and Talbot (1985, 1987) reported that the relationship between the metal content of *Mytilus edulis* and body weight of the mussels can be described as power functions. Cossa (1980) further pointed out that the size of the mussels, season and collection site markedly affected the exponential parameter. A slight decrease in concentration of heavy metals (Cd, Cu, Zn, Pb) in *Mgtilus edulis* was observed for growing individuals (Amiard, 1986). But Morgan (1964) and Lane (1985) found a linear relation between the pollutant uptake rate and shell length of the mussels. The results of Chen Shunhua et al. (1996) and Cai Lizhe et al. (1988) indicated that the relationship between the shell length and body's wet weight of *perna viridis* can be represented as a power curve. Therefore, we think that the two factors can be expressed as only one parameter.

Some researchers concluded that smaller mussels concentrate certain metals and radionuclides to a greater degree than larger individuals [Shimizu (1971), Simpson (1979), Unlu and Fowler (1979), Cossa (1980), Boalch (1981), Olafsson (1986)]. Studing on the effect of body size (or body weight) of the mussels on accumulation and distribution in *Perna viridis*, this paper reached the smae conclusion. Since the concentration capacity of the byssus was so much higher than that of any other parts in the mussels (Chen Shunhua et al, 1994), byssus was singled out to study the relation between concentration factor of ^{125}I in byssus and body weight or shell length of the mussels.

1 MATERIALS AND METHODS

Mussels (*Perna viridis*) were collected from Daya Bay, Aotou, South China Seas. In the laboretory, the mussels were cleaned and divided by shell length into four size classes of 3～4 cm (group A), 4～5 cm (group B), 5～6 cm (group C) and 6～7 cm (group D). Each group included 30 similar-sized mussels. Encrusting organisms and the external byssus were removed from the mussels. Each individual was placed in a perforated plastic bottle, and then the mussels were acclimated in artificial seawater (31‰ S. aerated) at 22±2°C for 4 days (Chen Shunhua et al, 1996).

1.1 Bioaccumulation

Following acclimation, the mussels were transferred to four aquaria (corresponding number was A, B, C and D respectively, each group in a aquarium) the specific activity was 18.5 kBq/L sea water, total volume being 20 L maintained at the same temperature. Throughout the 10 days in order to maintain the ^{125}I concentration relatively constant (the radioactive sea water was changed everythird day) and avoid possible ^{125}I complexation with excreted metabolites. The mussels were not fed at any time.

Frequently, throughout the bioaccumulation phase, three mussels from each group were removed from their bottles, rinsed for 1 to 2 minutes with clean sea water. Then each mussel was dissected into 5 parts: shell, pallial fiuid, byssus, foot and reminder of soft tissues. Two seawater samples (each 1 ml) were taken along with the mussels (Chen Shunhua et al, 1996).

1.2 Radioanalysis

The radioactivity in the sea water and tissues samples was detected with an γ-ray counter (FJ-2003/50).

Calculation of concentration factors is defined as CPM ^{125}I/g wet tissue divided by CPM/ml sea water.

2 RESULTS AND DISCUSSION

After 10 days exposure to ^{125}I, the highest concentration factors were found in the byssus with much lower values computed for shell and soft tissues. The concentration factors for ^{125}I in the tissues fell in the following order: byssus>soft tissues >foot>shell>pallial fluid (see Table 1).

Concentration factors of ^{125}I in byssus (about $0.5\times10^3\sim1.5\times10^3$) were 30~200 times as high as that in soft tissues, 200~600 times as that in feet, 600~1000 times as that in shells. Byssus may prove to be the most useful tissue in acting as an efficient bioindicator of radioiodine pollution because of its rapid uptake and relatively high ^{125}I concentration factors.

The fact that smaller mussels concentrate ^{125}I to a greater degree than larger individuals may be caused by smaller mussels' higher metabolic rate (Unlu, 1976; Cossa, 1980; Olafsson, 1986).

Table 1 Concentration Factors of Every Part in the Mussels during the Bioaccumulation Experiment

Exposure time d	Group number of the mussels	Byssus	Foot	Pallial fluid	Soft tissues	Shell
1	A	802.60	2.50	1.51	27.31	1.60
	B	580.48	1.83	1.28	22.50	0.57
	C	364.85	1.42	1.12	10.26	0.37
	D	272.75	1.35	0.95	7.26	0.19
2	A	782.17	2.95	1.82	26.73	2.44
	B	539.24	1.94	1.24	12.46	1.23
	C	503.98	1.35	1.02	10.72	0.55
	D	376.84	1.47	1.32	8.02	0.59
4	A	1048.91	4.36	0.94	15.78	4.11
	B	1045.67	1.87	0.85	9.32	1.47
	C	1009.48	1.91	0.80	5.15	0.82
	D	510.84	1.33	0.97	3.02	0.81
6	A	1431.26	3.19	1.14	8.77	3.45
	B	1136.52	2.73	0.95	7.30	2.18
	C	1064.66	1.74	0.74	5.44	1.18
	D	521.07	2.00	0.59	3.99	1.56
8	A	1194.62	3.86	0.64	7.59	2.48
	B	1062.88	5.93	0.82	7.21	1.65
	C	954.53	4.87	0.97	6.80	0.87
	D	503.64	3.72	0.56	5.43	0.69
10	A	1107.72	4.38	0.58	7.93	2.73
	B	1064.35	3.73	0.65	6.81	2.09
	C	1047.55	2.42	0.57	4.80	0.86
	D	498.21	2.97	0.54	3.96	1.02

Fig. 1 shows the percentage of total body's wet weight and percentage of total body ^{125}I content. In general, the order for percentage of wet weight of each part in total body's wet weight was as follows: shell>pallial fluid>soft tissues>foot>byssus. However, the order for percentage of ^{125}I content of each part in total body's ^{125}I content was different: byssus>soft tissues>pallial fluid>shell>foot. Although the wet weight of byssus was no more than 1% of whole body's wet weight, the content of ^{125}I accumulated in it accounted as high as 75% of total ^{125}I content.

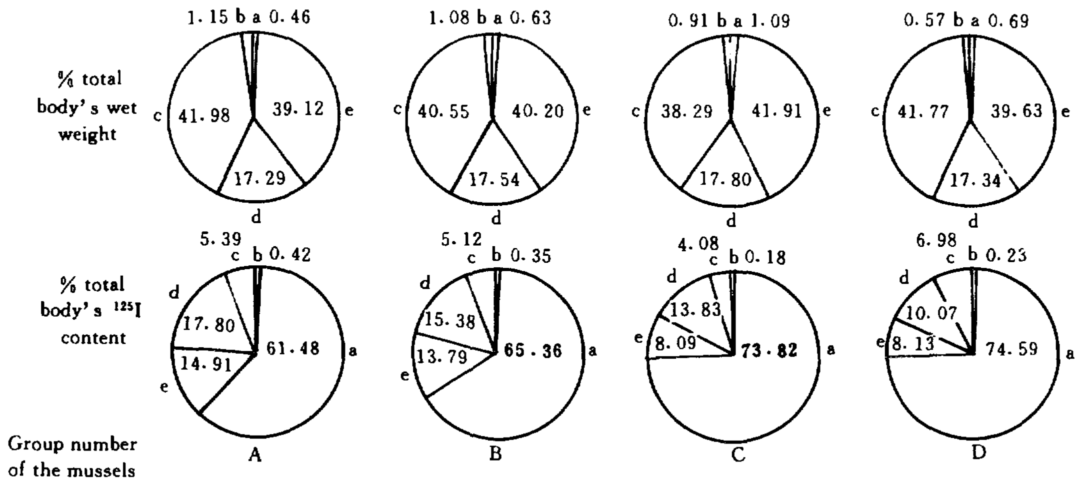

Fig. 1 Percentage of total body's wet weight and percentage of total body's ^{125}I content on the sixth day of the accumulation experiment

a: byssus; b: feet; c: pallial fluid; d: soft tissues; e: shells.

Table 2 Whole Body's Wet Weight of the Mussels in the Accumulation Experiment/g

Group number of the mussels	Exposure time/d					
	1	2	4	6	8	10
A	4.844	5.167	4.969	4.682	5.840	5.546
B	7.526	7.615	7.142	6.983	7.055	7.248
C	11.864	11.585	10.463	10.856	11.217	11.210
D	18.811	15.411	16.320	20.637	17.361	18.152

There is a simple relation between concentration factor (see Table 1), and whole body's wet weight (see Table 2). The computer-optimized curves are given in Fig. 2. From Table 3 and Fig. 2, we can describe the relationship between concentration factor for ^{125}I in byssus (Y) and whole body's wet weight of the mussels (X) by the following function:

$$Y = A \cdot X^{-B} \quad (1)$$

where, A and B are positive constants.

The results of Chen Shunhua et al. (1996) demonstrated the power relationship between whole body's wet weight (X) and shell length (Z):

$$X = a \cdot Z^{b} \quad (2)$$

where, a and b are positive constants.

Table 3 The Best Fit Functions between Concentration Factors (Y) and Whole body's Wet Weight (X) during the Bioaccumulation Experiment

Exposure time/d	The best fit function	Curve in Fig. 2
1	$Y=2925.99\ X^{-0.8181}$	1
2	$Y=2025.71\ X^{-0.6038}$	2
4	$Y=3021.47\ X^{-0.5734}$	3
6	$Y=4178.68\ X^{-0.6543}$	4
8	$Y=4630.02\ X^{-0.7367}$	5
10	$Y=3710.32\ X^{-0.6360}$	6

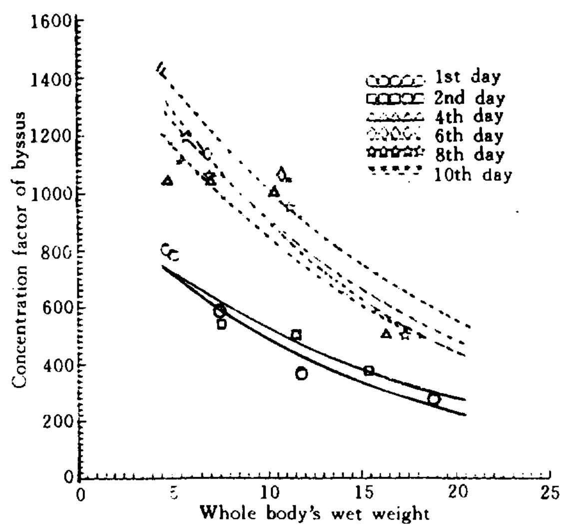

Fig. 2 Relationship between concentration factor of byssus and whole body's wet weight

Substituting (2) into (1), we obtain:

$$Y = A \cdot (a \cdot Z^{b})^{-B} = (A \cdot a^{-B}) \cdot (Z^{-Bb}) = C \cdot Z^{-D} \qquad (3)$$

where, C and D are positive constants.

That is to say, with regard to byssus, concentratin capacity to ^{125}I of smaller mussels is higher than larger ones.

It is well established that the radioiodine content of the mussels, *Perna viridis*, is related to their size. Therefore, we accepted that in any monitoring programme using the mussel, either a size collection procedure or a size normalization procedure must be used if the results are to be effectively interpreted.

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