Study of Element Balance in a Marine Ecosystem

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Abstract

Discharge of small amounts of various radionuclides into the natural environment accompanies the operation of a spent nuclear fuel reprocessing plant. The Closed Hydrosphere Experiment Facility (CHEF) was developed as a part of the Closed Ecology Experiment Facilities (CEEF) to study circulation and accumulation of radionuclides in the hydrosphere ecosystem. A mathematical model to elucidate carbon cycling in the sea grass ecosystem was developed. This model can be described as a network consisting of 4 sub-models: sea bed and sea water sub-model, sea grass sub-model, sea urchin sub-model, and sea cucumber sub-model. Parameters in each sub-model were determined based on the results of laboratory experiments. So far, only the sea grass sub-model has been verified through cultivation experiments by using the CHEF. The verification of other sub-models will be accomplished in future experiments. The accumulation of tritium (^{3}H) in marine animals was examined by the culture experiment using deuterium (D) as a tracer. The exchange velocity constants of heavy water (HDO) between seawater and marine animals were estimated to be varying large, being from 0.06 to 0.29 per hour in 6 kinds of fish and from 0.87 to 3.37 per hour in non-fish animals, such as scallop, sea cucumber and others.

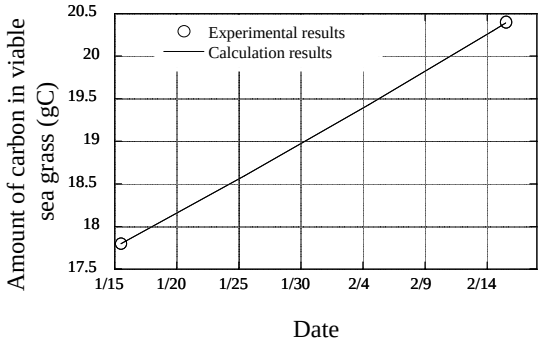

Fig. 1.1 Temporal variation in the amount of carbon in viable sea grass

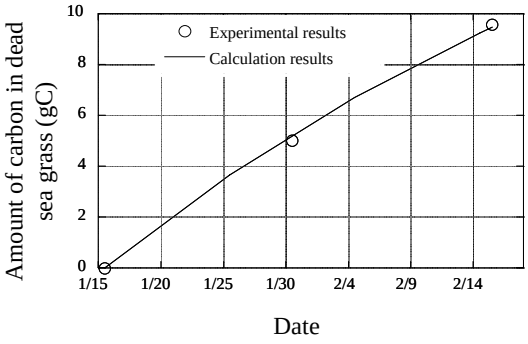

Fig. 1.2 Temporal variation in the amount of carbon in dead sea grass

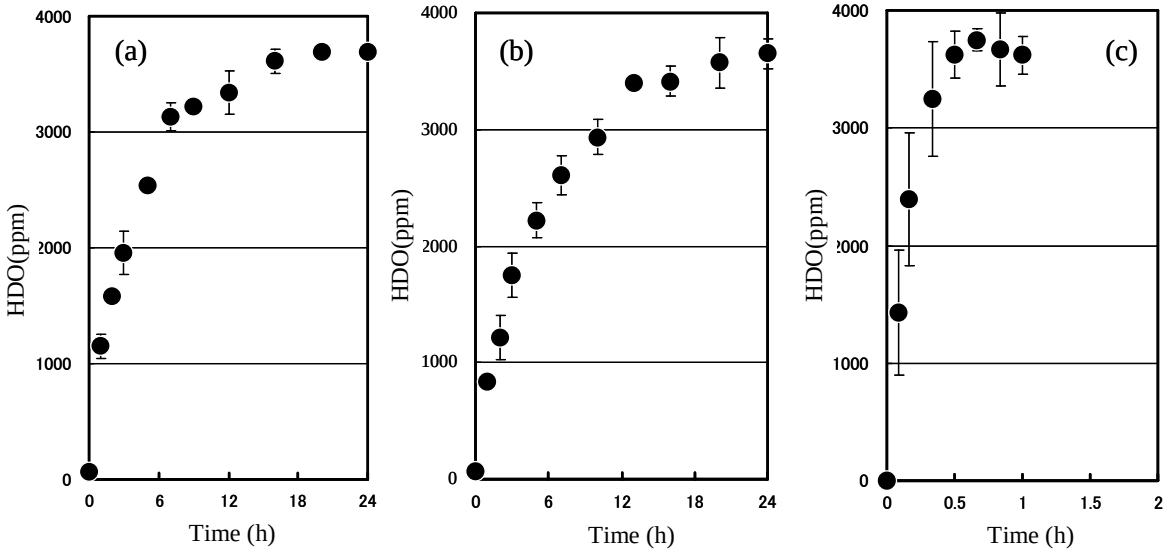

Fig.2 Heavy water (HDO) concentration in marine animals.
(a) *Sebastes schlegeli*, (b) *Paralichthys olivaceus*, (c) *Patinopecten yessoensis*

Table 1 Exchange velocity constants of HDO in marine animals.

Species (body weight)		Inflow velocity constent	Outflow velocity constant
		k (h^{-1})	k (h^{-1})
Hexagrammos otaki	(180–580 g)	0.18 – 0.26	—
Seriola quinqueradiata	(110–700 g)	0.25 – 0.27	—
Kasreius bicoloratu	(60–1330 g)	0.10 – 0.16	—
Sebastes schlegeli	(60–100 g)	0.22 – 0.25	0.22 – 0.24
Paralichthys olivaceus	(10–1580 g)	0.06 – 0.20	0.04 – 0.19
Sebastes thompsoni	(4–24 g)	0.18 – 0.29	—
Strongylocentrotus nudus	(40–80 g)	1.71	1.64
Strongylocentrotus intermedius	(40–150 g)	0.87	—
Todarodes pacificus	(410–470 g)	2.71	—
Patinopecten yessoensis	(190–210 g)	3.32	—
Stichopus japonica	(50–80 g)	1.18	—