Cercetări marine	I.R.C.M.	Nr.14	193-2oo	1981

PRELIMINARY DATA ON UPTAKE EXPERIMENTS OF ^{131}I, ^{134}Cs AND ^{89}Sr BY *Cystoseira barbata* AT THE ROMANIAN COAST OF THE BLACK SEA

Alexandru S.Bologa[1] and Doina Balaban[2]

1) Romanian Marine Research Institute - Constanţa
2) Antiepidemic Sanitary Center - Constanţa

ABSTRACT:

The following maximum concentration factors were experimentally determined in the brown alga Cystoseira barbata: for ^{131}I, CF = 321 (August);for ^{134}Cs, CF = 30 (June); and for ^{89}Sr, CF = 9 (June, August).

It is known that, of the marine algae, the phaeophyceae are very rich in chemical elements, iodine inclusively (11). Iodine is generally found in proportion of o.1%, but it may reach 1% of the dry weight in some algae (1). The common marine algae along the Romanian coast have iodine contents between 5.8 - 72.2 mg % dry substance (13). Iodine content is variable firstly as a function of species, anatomo-morphological structure, site of collection and season (12). In larger sized brown algae, iodine content of the lamina is richer than that of the stipe, while the young thalli contain more iodine than the old plants (4). Nevertheless, the study of 6o species of phaeophyceae of the Mediterranean Sea has showed that the maximum values of the iodine content do not coincide with the period of maximum growth and are independent of the habitat (6).

Iodine, present in the sea water as iodide, is accumulated by algae, but the way of its penetration into the cells is still uncertain. After some authors, it forms inorganic combinations (7); after others, it is organically bound in the cell (10, 11). Anyway, it is considered that iodine present in the cell as iodide id liberated when the external covers are slightly injured (4), as a result of the action of oxydase in presence of O_2 (12). It has been also found that the phaeophyceae capture iodine in excess over their metabolic requirements (9).

Of the iodine isotopes, ^{131}I is one of the critical isotopes which may be disseminated into the aquatic medium as a result of the working nuclear electric power stations. This radioisotope is quite rapidly absorbed from the sea water (11) and incorporated both by whole thalli and tissular homogenates. Till now, ^{131}I served for establishing the determinative agents for accumulation of large quantities of halogens (12) and for explaining the ways of iodine metabolization.

But ^{131}I is also interesting as regards the radioactive contamination of the ambient by its concentration in some aquatic organisms. The aim of the present work is to determine experimentally the uptake of ^{131}I by *Cystoseira barbata* (GOOD. et WOOD.) J. AG., the main perennial phaeophycea of the Romanian coastal waters. Though this species is in regress at present because of numerous coastal engineering works inducing modification of living conditions of the medium, it is still present with multiple implications in the coastal shallow water ecosystem (2).

^{90}Sr and ^{137}Cs are other fission products, which may result from utilization of the nuclear energy. Because of their toxicity, experiments are conducted especially with ^{84}Sr, ^{85}Sr and ^{89}Sr, and respectively, with ^{134}Cs. Thus, beside ^{131}I, the uptake of other two critical radioisotopes, ^{89}Sr and ^{134}Cs, which are also virtual contaminators of the marine environment, was followed herein.

MATERIAL AND METHODS

Specimens of *Cystoseira barbata* collected at Jupiter (Mangalia) in June-August 1980 were studied; the algal material was cleared of epibiosis (<u>Ceramium</u> sp.,<u>Dermatolithon cystoseirae</u>).

Laboratory experiments were performed in aquaria, continuously aerated,containing 7 l sea water,filtered before using. ^{131}I, ^{134}Cs and ^{89}Sr were used as water-soluble salts: $Na^{131}I$, $^{134}CsCl$ and $^{89}Sr(NO_3)_2$. Duration of experiments was 4-5 days. Measurements were carried out at 24-hour interval. In contrast with the previous year experiments (3),larger quantities of algal material were radioassayed. The controls gave values near the natural background.Illumination (lx) and temperature(°C) conditions were measured daily (a.m.) during the experiments.

The procedures followed in determining the concentrations of the three radioisotopes in <u>C.barbata</u> differed as a function of radioisotope and laboratory equipment (Table 1).

Table 1

Outlines of experimental patterns for determination of ^{131}I, ^{134}Cs and ^{89}Sr uptake by <u>Cystoseira barbata</u>

Radioisotope	Period of experiment (months)	Duration of experiment (days)	Procedure	Measuring equipment
^{131}I	JUN, JUL, AUG	5	aquarium → washing → weighing → measuring of alga	-VAS-968 sounder with NaI(Tl) scintillation crystal - model 22o24 counter
^{134}Cs	JUN, JUL, AUG	4-5	aquarium → washing → weighing → measuring of alga	-VAS-968 sounder with NaI(Tl) scintillation crystal - model 22o24 counter
^{89}Sr	JUN, JUL, AUG	5	aquarium → water evaporation → water residue measurement	-VAZ-52o proportional counter - model 2oo26 counter

^{131}I and ^{134}Cs were assayed directly(in the alga).1oo g of fresh algal material was sampled and washed until the rinse water showed background values. The samples were measured in Marinelli geometry boxes.

^{89}Sr was assayed indirectly (in the water).1 l of water was evaporated and the residue was measured on the targit.

The samples inoculated with ^{131}I and ^{134}Cs were radioassayed with an equipment consisting of a VAS-968 sounder fitted with a NaI/Tl scintillation crystal,with an efficiency of 8%(^{131}I standard) or 9% (^{134}Cs standard), and a RFT model 22o24 counter.

The samples inoculated with ^{89}Sr were radioassayed with a VAZ-52o proportional counter, with an efficiency of 28% (^{90}Sr standard), and a RFT model 2oo26 counter.

The concentration factor (CF) was calculated for each isotope:

$$CF = \frac{pCi\ g^{-1}\ alga}{pCi\ ml^{-1}\ solution}\ .$$

RESULTS AND DISCUSSION

The growth cycle of the brown alga Cystoseira barbata - characteristic for the Black Sea due to the particular hydrobiological conditions of this basin - includes two periods of most active vegetation and fructification: the first, more intensive one, in spring (March - June) and the second, during autumn (September - November) (5).First results obtained in 1979 regarding the uptake of ^{131}I,on material collected in August and November, proved rising concentration of this radioisotope in the organoids of the thallus as follows: cauloid $<$ assimilation branches I $<$ assimilation branches II (3). At the same time,more stressed metabolization of ^{131}I was found in all the organoids during the period of less active vegetation (August) as compared to the cold season (November); a tendency towards higher ^{131}I concentrations was also noticed at the beginning of the experimental period (the first 24 - 72 hours) in the assimilation branches in both seasons and in the cauloid, in the cold season.

In 198o, as concerns ^{131}I, the concentration factor was low in June; it was null after the first 24 hours and reached a maximum of 23 after 72 hours. In July, the concentration factor reached the maximum after the first 24 hours (42) and decreased gradually down to 13 after 96 hours. In August, the concentration factor had the highest value over the entire period, ranging between 248 - 321 and reaching the maximum after 72 hours (Table 2); these results are in agreement with the literature data, which indicate CF = 300 for C.barbata in the Black Sea (8).

Table 2

Variation of the concentration factor (CF) of ^{131}I uptake by Cystoseira barbata in experimental conditions (June-August 1980)

Month	Duration (hours)	Quantity (g)	Concentration of initial solution pCi l^{-1}	Concentration of initial solution Bq l^{-1}	Concentration in alga pCi l^{-1}	Concentration in alga Bq l^{-1}	CF
VI	24	100	85,70	3,17	0	0	0
	48	100	80,76	3,00	0,06	0,002	0,7
	72	100	74,54	2,76	1,50	0,05	23
	120	100	63,50	2,35	0,90	0,05	11,2
VII	24	100	67,44	2,49	2,89	0,10	42,8
	48	100	62,24	2,30	2,46	0,09	39
	72	100	57,45	2,12	1,70	0,06	32
	120	100	53,00	1,96	0,70	0,02	13
VIII	24	100	65,50	2,42	16,30	0,60	248,8
	48	100	60,50	2,24	17,00	0,63	280,9
	72	100	55,60.	2,06	17,90	0,66	321,9
	120	100	51,36	1,90	13,40	0,49	260,9

The values above confirm that the uptake of ^{131}I by C.barbata from the Romanian coastal waters - like by the species from the Mediterranean Sea (6)- does not coincide with the period of its intensive growth; thus, the highest values of the concentration factors were determined in August, when there is a conspicuous biomass decrease in this species (assimilation branches rarifying).

As concerns ^{134}Cs, the concentration factor was considerably lower during all the three summer months. In June, it ranged between 1-30, with the highest value after 72 hours. In July, it reached a maximum of 29 after 48 hours and decreased after 120 hours to 0. In August, the concentration factor ranged between 12-22, with a maximum after 72 hours (Table 3). These values also coincide with the literature data, which indicate CF = 27 for this species in the Black Sea (8).

Table 3

Variation of the concentration factor (CF) of ^{134}Cs uptake by *Cystoseira barbata* in experimental conditions (June-August 198o)

Month	Duration (hours)	Quantity (g)	Concentration of initial solution pCi l^{-1}	Bq l^{-1}	Concentration in alga pCi l^{-1}	Bq l^{-1}	CF
VI	24	loo	85,oo	3,14	1,oo	o,o3	1,1
	48	loo	85,oo	3,14	1,85	o,o6	21
	72	loo	85,oo	3,14	2,6o	o,o9	3o,5
	12o	loo	85,oo	3,14	2,oo	o,o7	23,5
VII	24	loo	85,oo	3,14	o,9o	o,o3	1o,5
	48	loo	85,oo	3,14	2,5o	o,o9	29
	72	loo	85,oo	3,14	o,6o	o,o2	7
	12o	loo	85,oo	3,14	o	o	o
VIII	24	loo	85,oo	3,14	1,3o	o,o4	15
	48	loo	85,oo	3,14	1,4o	o,o5	16,4
	72	loo	85,oo	3,14	1,9o	o,o7	22
	12o	loo	85,oo	3,14	1,1o	o,o4	12,9

In the case of ^{89}Sr, the concentration factor values were still lower. In June,it ranged between 2-9, having a maximum after 72 hours. In July,the factor was very low, reaching 0 after the first 24 hours and only 4-5 after 48-72 hours, respectively.

Table 4

Variation of the concentration factor (CF) of ^{89}Sr uptake by *Cystoseira barbata* in experimental conditions (June-August 198o)

Month	Duration (hours)	Quantity (g)	Concentration of initial solution pCi l^{-1}	Bq l^{-1}	Concentration in alga pCi l^{-1}	Bq l^{-1}	CF
VI	24	loo	34,65	1,28	o,29	o,o1	8,5
	48	loo	34,12	1,26	o,32	o,o1	9,5
	72	loo	33,6o	1,24	o,33	o,o1	9,8
	12o	loo	3o,oo	1,11	o,o8	o,oo3	2,8
VII	24	loo	24,95	o,92	o	o	o
	48	loo	24,7o	o,91	o,12	o,oo4	5
	72	loo	24,45	o,9o	o,o9	o,oo3	4
	12o	loo	24,2o	o,89	o,o4	o,oo2	2
VIII	24	loo	34,65	1,28	o,2o	o,oo8	6
	48	loo	34,3o	1,27	o,3o	o,o1	8,8
	72	loo	33,96	1,25	o,3o	o,o1	9
	12o	loo	33,6o	1,24	o,11	o,oo4	3,4

In August, its values ranged between 3-9, with a maximum after 72 hours (Table 4). These values are lower than those in the literature, which indicate CF = 4o for the same species in the Black Sea (8), possibly owing to the indirect measuring procedure which was available.

CONCLUSIONS

1. The relation CF ^{131}I > CF ^{134}Cs > CF ^{89}Sr was finally established between the concentration factors of the investigated isotopes in Cystoseira barbata.

2. The following maxima of the concentration factors were experimentally determined: for ^{131}I, CF = 321 (August); for ^{134}Cs, CF = 3o (June), and for ^{89}Sr, CF = 9 (June and August).

3. The larger capacity for the uptake of ^{131}I by C.barbata is due to the taxonomic belonging of this species to the brown algae.

4. Generally, maximum values of the concentration factors were recorded after 72 hours from isotope addition.

5. The uptake of ^{131}I, especially, as expressed by the concentration factor points C.barbata as a possible bioindicator of radio-iodine contamination of the coastal marine ecosystem.

ACKNOWLEDGEMENT

We thank sincerely Dr B.Nereuţă (C.S.A. Constanţa) and Dr T.Pop (Unified Hospital Constanţa) for their help in approaching the preliminary research.

REFERENCES:

1. BLACK W.A.P.,1948 - The seasonal variation in chemical constitution of some of the sublittoral seaweeds common to Scotland. 1.Laminaria cloustonii; 2.Laminaria digitata; 3.Laminaria saccharina and Sacchorhiza bulbosa. J.Soc. Chem. Ind., 67: 165 - 176.

2. BOLOGA A.S.(in press)-Implicaţii ecologice ale algoflorei bentale de la litoralul românesc al Mării Negre. Probleme de fiziologie si ecologie acvatică, Ed.Acad., Bucureşti.

3. BOLOGA A.S., BALABAN D.,198o - Date preliminare asupra concentrării ^{131}I de către Cystoseira barbata de la litoralul românesc al Mării Negre. Progr.în fizică, Cluj-Napoca.
4. BONEY A.D., 1966 - A Biology of Marine Algae. Hutchinson Educ. Ltd., London.
5. CELAN M., 1935 - Notes sur la flore algologique du littoral roumain de la mer Noire. I. Sur les Cystoseira. Bull. Sect.Sci.Acad.Roum., 17, 5-6: 1 - 14.
6. CHAPMAN V.J., 1962 - The Algae. Mac Millan & Co.Ltd., London.
7. KYLIN H.,193o - Uber die jodidspaltende Fähigkeit der Phäophyceen. Z.physiol.Chem., 191: 2oo - 21o.
8. POLIKARPOV G.G., 1966 - Radioecology of aquatic organisms. North Holland Publ.Comp., Amsterdam-Reinhold Book Div.- New York.
9. ROUND F.E.,1968 - Biologie der Algen.G.Thieme Verl.,Stuttgart.
1o. SHAW T.I., 1959 - The mechanism of iodide accumulation by the brown sea wead Laminaria digitata. I.The uptake of ^{131}I. Proc.Roy.Soc., 15o: 356 - 371.
11. SHAW T.I., 1962 - Halogens. Physiology and Biochemistry of Algae. R.A.Lewin (Ed.),Acad.Press,New York-London: 247-253.
12. SIMIONESCU C., RUSAN V., POPA V., 1974 - Chimia algelor marine. Ed.Acad., Bucureşti.
13. TEODORU V., DRAGHICI M., STADNICIUC M., 1978 - Conţinutul în iod al unor specii de alge din Marea Neagră. Igiena,27: 47 - 49.