# ACCUMULATION OF CAESIUM BY SOME MARINE PHYTOPLANKTERS

Galli, C. and Zattera, A.*

Summary - Data on $^{134}Cs$ uptake in some phytoplankters are presented. The concentration factors estimated range from 2 to 9. The growing of Phaeodactylum tricornutum in artificial sea water with different amounts of potassium gives an increase in caesium concentration factors with a decrease of potassium content.

Resumé - L'accumulation du $^{134}Cs$ à été etudiee dans quelques espèces d'algue plantonique. Les facteurs de concentration obtenues sont compri entre 2 et 9. Cultures du Phaeodactylum tricornutum dans l'eau de mere synthetique à différentes concentrations en potassium ont montré une augmentation du facteur de concentrations pour le caesium en correspondance de la diminution du teneur en potassium.

Introduction - $^{137}Cs$ is one of the most important fission products in waste effluents from nuclear power reactors and atomic fallout because of its long half life (33y).

Data on isotope accumulation in marine algae are of relevance for algal physiology and inshore contamination by coastal reactors and nuclear explosions. From the radioecological point of view knowledges on concentration and elimination of caesium isotope by marine algal species are needed. It is a known fact that benthic marine algae can strongly discriminate between the different members of the alkali metal group with, for example, high concentration of potassium at expense of sodium although sodium is present in sea water at a higher concentration. At present we have not enough evidences of similar facts for unicellular algae although some similarity could be expected.

From summary data already published in literature (see for example Polikarpov 1966) one can note that caesium for unicellular algae exhibits concentration factors of 1 - 2 while benthic species show values also of 50 as maximum. Investigation in caesium accumulation at concentrations comparable to those found normally in nature (Goldberg (1965) give a figure of 0.5 µg Cs/l in sea water) is practically impossible without radioisotopes due to its occurence in seawater and in algal tissues in spectrometrically undetectable amount.

Since caesium is chemically similar to potassium it may be expected to enter the solute complex, engage ionic antagonism, permeability,

*Laboratorio per lo Studio dell'Ambiente Marino - 19030 Fiascherino La Spezia (Italy).

preservation and/or maintenance of colloidal state, regulation and similar or other physiological phenomena. As consequence caesium can be considered as tracer for potassium. As noted by Scott (1954) for Fucus vesiculosus by decreasing the K content in seawater the uptake of caesium increases.

Open seawater could be considered stable in composition but estuarine waters do not have such a stability. With regard to potassium content in estuarine environment one should expect concentrations changing from one site to another. Just to give a figure the mean content of potassium in continental waters of the globe is 2.7 mgK/l (Dussart 1966) against 380 mgK/l in "Normal" seawater (Goldberg 1965).

The aim of the present preliminary investigations was the estimation of the concentration capacity of caesium by some phytoplankters in natural and artificial seawater media considering for the latter different amounts of potassium. For the present work $^{134}Cs$ was employed in the form of chloride with an approximate specific activity of 0.5 Ci/μg Cs.

Materials and methods - Algae in experiences with natural seawater media were Chaetoceros affinis, Phaeodactylum tricornutum and Platymonas suecica isolated from the Ligurian Sea selected among our stock cultures which is routinely transfered, maintained under controlled conditions and cultured with Erdschreiber media (Foyn 1934) prepared according to Galli and Zattera (1978). After preparation the media were contaminated with appropriate quantities of $^{134}Cs$ (300 μCi/l) inoculated with algae species and placed in standard conditions (i.e. 18°C temperature and illumination with two Philips lamps, type $T_L$ W/33 placed at 20 cm above the culture flasks). After inoculation samples were taken time after time to evaluate the accumulation of $^{134}Cs$ till to equilibrium.

Phaeodactylum tricornutum has been used to evaluate differential assumption of $^{134}Cs$ in relation to different amounts of potassium. For this purpose artificial seawater media, prepared according to Bernhard and Zattera (1975), with different amounts of potassium was used. The potassium concentrations checked via atomic adsorption spectrometry range from 30 mg/l (30/380 = 0.079 time of the content in "Normal" seawater) to 670 mg/l (670/380 = 1.76 time of the K content in "Normal seawater). After preparation the different artificial seawater media were treated as already said for natural seawater media. To detect the activity taken up with time the algae were separated from the media by centrifuging at about 24000 g. The activity was checked with a NaI (Tl) cristall, 33 mmm diameter, both, in algae and in supernatant.

Results and conclusions - Once the algae have been inoculated they are placed to grow till to equilibrium (i.e. when the algae in the batch stop to grow and reach a plateau). The activity at that point per unit biomass compared to the activity per unit volume of media allows the evaluation of the concentration factors.

The concentration factors estimated for the algae under experiment were 4.4 for Chaetoceros affinis, 1.9 for Platymonas suecica and 9.2 for Phaeodactylum tricornutum.

The results on relation between potassium content in various artificial seawater media and the corresponding $^{134}Cs$ concentration factors for Phaeodactylum tricornutum are on Fig. 1. The values reported there are average values between three determinations. From Fig. 1 one can observe that concentration factors range from 8 at a K concentration of 670 mg/l to 8.5 at K content near to the content in "Normal" seawater till to 36.5 in the artificial media with about 30 mgK/l. Comparing the concentration factor of Phaeodactylum tricornutum (9.2) grown in natural seawater media with the K content in an artificial seawater similar to that in natural seawater we observe that no great difference exists among the two values (9.2 against 8.5); but, as Fig. 1 demonstrates, the lowering of the K concentration increases the concentration factors.

In estuarine environments one should expect different degrees of magnification of caesium in algae when the K content increases from the content in the river to the one in the open "stable" seawater. Such differential uptake should be of interest and should be taken in special consideration since phytoplankters may be an important source of caesium in the food chains. So that these facts can give rise to different magnifications in different trophic levels of the food chains when comparing food chains typical of estuaries to those typical of seawater.

Since we consider Cs as tracer for potassium one should expect that uptake of caesium is due to an active transport across the membrane against a potential gradient. This fact, although it has to be confirmed, allows to conclude that the caesium uptake should be distributed in the cytoplasm and that surface phenomena can reasonably be excluded. Therefore samples must be taken only with organisms in Log-phase of growth or a short time after the Log-phase since when in batch culture the organisms die and the cells will loose caesium (and potassium).

References

Bernhard, M. and Zattera, A., 1975 - Radiotracer experiments with phytoplankton. pp 35-62 In: "Design of Radiotracer Experiments in Marine Biological Systems". International Atomic Energy Agency. Technical Report Series N° 167.

Dussart, B., 1966 - Limnologie. L'etude des eaux Continentals. Gauthier-Villars-Paris.

Foyn, B., 1934 - Lebenszyklus, cytologie und sexualitaet der chlorophycee cladophora suriana kutzing. Arch. Protistenk, 83, 1-56.

Galli, C. and Zattera, A., 1978 - Temperature as Pollutant-Long Term Effect and Thermal Shocks on some Marine Phytoplankters. RT/BIO (78) 31, pp. 1-13.

Goldberg, E.D., 1965 - Minor Elements in Sea Water. pp. 163-194. In: "Chemical Oceanography" Riley J.P. and Skirrow, G. (Eds.). Vol. 1 - Academic Press, London and New York.

Polikarpov, G.G., 1966 - Radioecology of Aquatic Organisms. pp 314 - North-Holland Publishing Company, Amsterdam.

Scott, R., 1954 - A study of caesium accumulation by marine algae. pp 373-380. Radioisotope Conference VI. Medical and Physiological Application. Proc. 2nd Conference, Oxford, 1954.

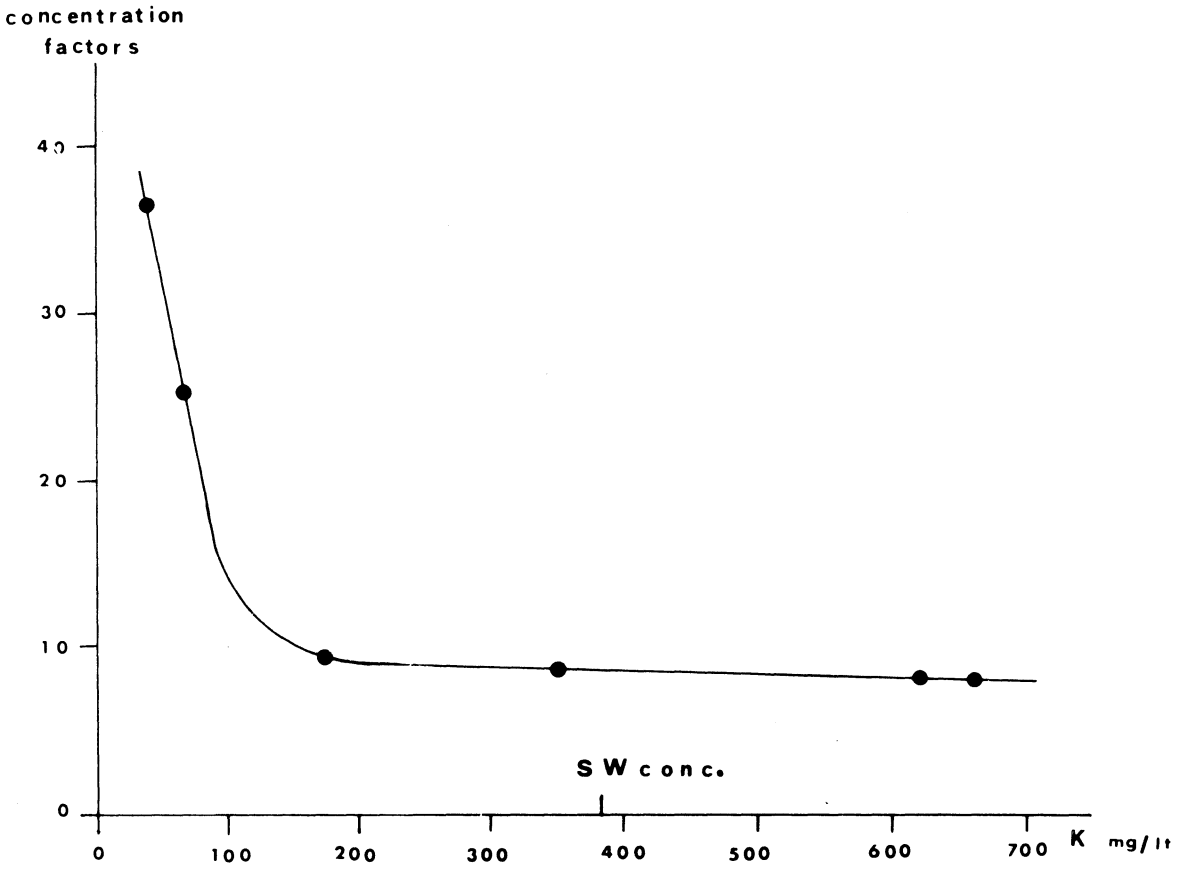


Fig. 1 - $^{134}Cs$ uptake by Phaeodactylum tricornutum. The figure gives the relation between caesium concentration factors and potassium content in artificial seawater media.

GALLI, C., ZATTERA, A.

*"Accumulation of caesium by some marine phytoplankters"*

Paper presented by E.H. Schulte (Italy)

## Discussion

No comment.