FALLOUT RADIOACTIVITY IN THREE BRACKISH WATER MOLLUSCS FROM KERALA*

K. V. K. NAIR, (THE LATE) Y. M. BHATT AND G. R. DOSHI
Health Physics Division, Bhabha Atomic Research Centre, Trombay, Bombay-85

THE spread of radioactive fallout from nuclear weapon testing and from release of radioactive waste from shore-based atomic installations has led to a world-wide search for indicator organisms. This is based on the known ability of some organisms to concentrate specific chemical elements by very high orders of magnitude. Molluscs in general assume special significance in this connection since many of them concentrate elements such as manganese and zinc to significantly high levels.[1-3]

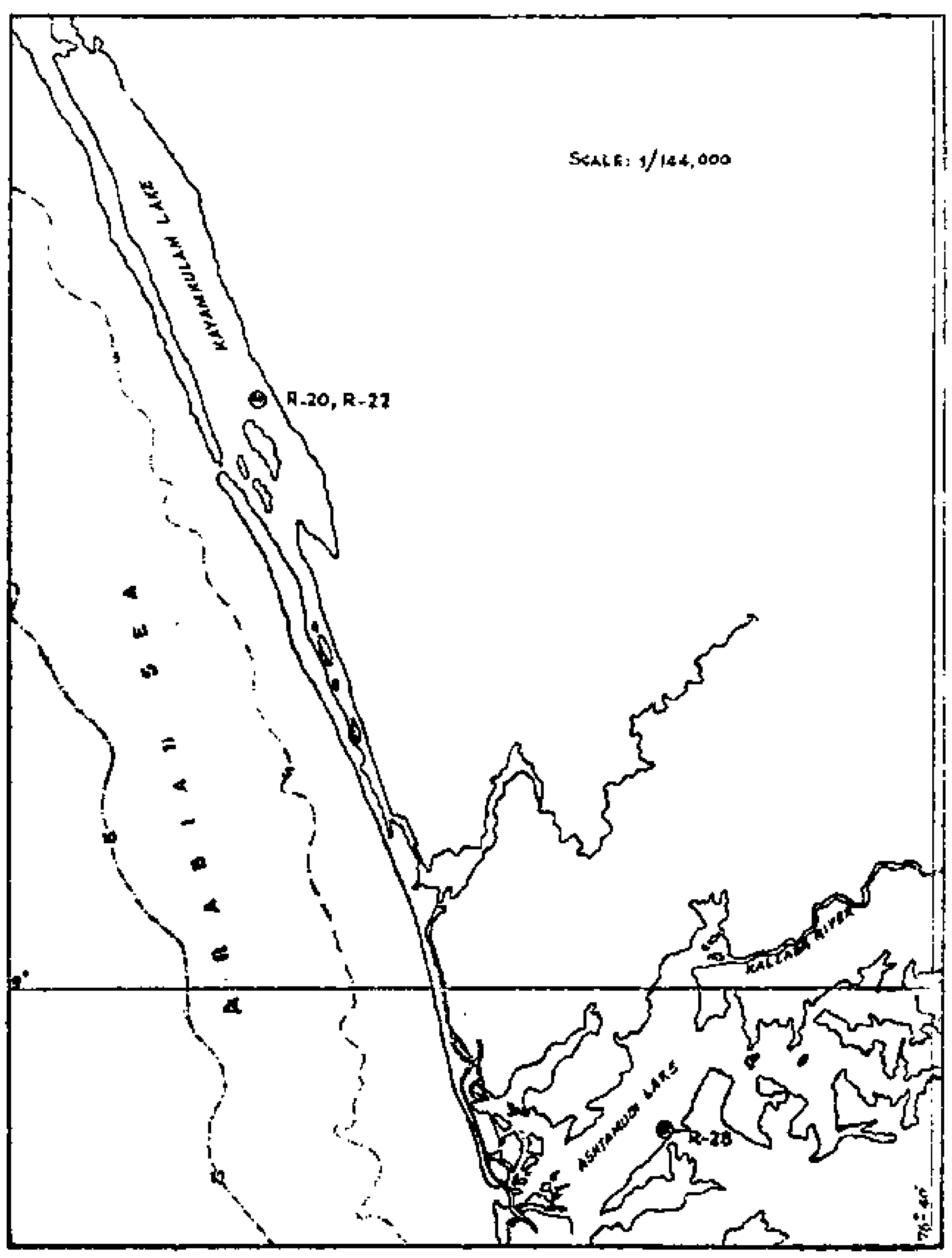

FIG. 1. Location of sampling sites.

The chain of backwaters running parallel to the Kerala Coast (Fig. 1) is inhabited by several species of molluscs many of which are eaten by the local population. In the present investigation three species of molluscs, *viz.*, *Ostrea madrasensis*—the common backwater oyster from Ashtamudi lake, *Villorita cochinensis*—a backwater clam and *Pila globosa*—a freshwater snail from the Kayamkulam lake have been chosen for radioactivity determination, and stable element analyses. Ashtamudi and Kayamkulam are brackish water lakes, the former connected to the sea throughout the year and the latter for about 8 months in a year (for about 4 months between January and May the bar-mouth is closed).

Methods.—Samples of the three species mentioned above were collected during the period, January-February 1964. After washing free of extraneous matter and removing the shells, the soft parts were dried to constant weight at 100° C. and ashed in a muffle furnace at 400° C.

About 10 g. of the ash was filled in a 1" diameter polythene tube and counted in a gamma-spectrometer using a NaI (Tl) well crystal as the detector. The samples were recounted after a time lapse to follow the radioactive decay and confirm the identification of radionuclides. The quantities of individual radionuclides in the three samples were determined by spectrum stripping using calibrated standard sources.

For chemical analysis about 0·05 g. of the ash was dissolved in concentrated HCl and the volume made up to 50 ml. in a standard flask. The elemental composition was determined by Atomic Absorption Spectrophotometry.[4]

Results and Discussion.—The gamma-ray spectra of sample Nos. R-28 (*Ostrea madrasensis*), R-20 (*Villorita cochinensis*) and R-22 (*Pila globosa*) are given in Fig. 2. The concentrations of the radionuclides, their specific activities and the stable zinc and stable manganese contents are given in Table I.

The gamma-ray spectra of the three samples given in Fig. 2 show zinc-65 in all the species. Zinc-65 ($T_{\frac{1}{2}}$—245 days) is a neutron-induced radionuclide which enters the environment from global fallout and as part of radioactive waste from atomic installations. Since there is no nuclear installation close to the Kerala Coast, the zinc-65 in these samples must owe its origin to global fallout.

As seen from Table I the zinc-65 and stable zinc content of *Villorita cochinensis* (100·5 μg./g. dry weight) is the highest among the three species. This value is higher than those reported by Sastry and Bhatt[2] for similar clams from Bombay (54–74 μg./g.). The lowest zinc-65 and stable zinc content is seen in *Ostrea madrasensis*. This is rather surprising

* This work forms part of IAEA/BARC Research Agreement No. 155/R-5/CF.

since all reported data indicate higher zinc content in oysters than in clams.[2,5,6]

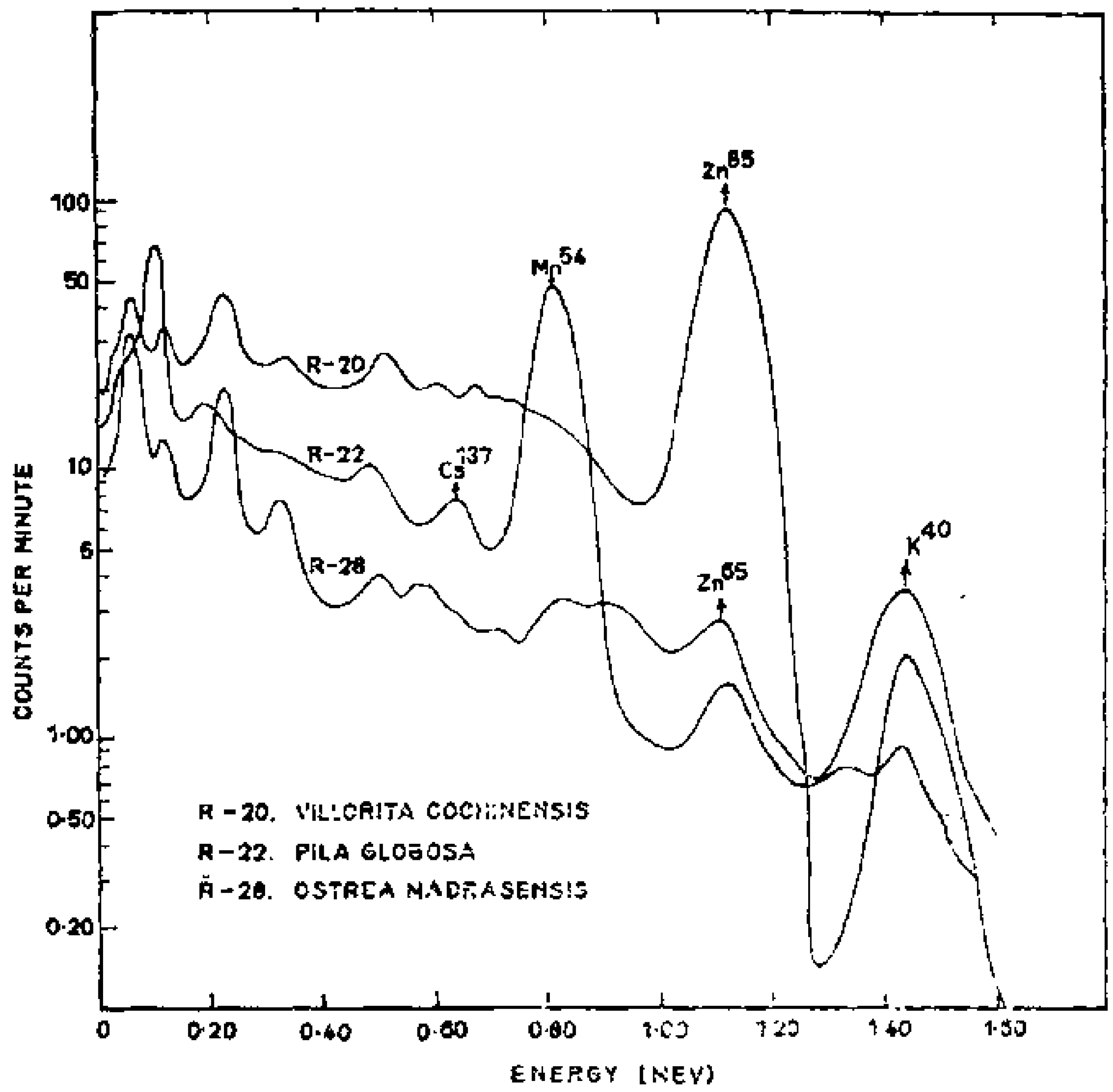

FIG. 2. Gamma-spectra of three brackish water molluscs from Kerala.

considerably high compared to that reported by Vinogradov[8] for other gastropods.

The results discussed above indicate that *Villorita cochinensis* and *Pila globosa* can be considered as indicators of zinc and manganese respectively. The presence of fallout zinc-65 in all the species examined is particularly significant in view of the lack of similar data for freshwater organisms from other areas. To our knowledge the only report of zinc-65 in ground level air has come after the Chinese nuclear tests of 1967.[9]

The gastropod *Pila globosa* shows higher manganese content than the bivalve *Villorita cochinensis,* although freshwater bivalves are well-known concentrators of manganese.

Merlini *et al.*[10] reporting on manganese-54 concentration in freshwater organisms find high concentration of manganese-54 in *Unio mancus,* a bivalve while *Viviparus ater* a gastropod from the same area, showed no appreciable concentration.

TABLE I

Radioactivity and stable element data for three brackish water molluscs from Kerala

Sample No.	Species	Ash wt. per 100 g. dry wt.	Stable element (μg./g. dry wt)		Radioactivity (uuc/g. dry wt.)			Specific activity (uuc/μg.)	
			Zn	Mn	Zn^{65}	Mn^{54}	Cs^{137}	Zn	Mn
R-20	*Villorita cochinensis* ..	11·72	100·5	18·3	118·20	nd	nd	1·176	nd
R-22	*Pila globosa* ..	10·40	80·1	303·4	1·17	11·06	1·46	0·014	0·039
R-28	*Ostrea madrasensis* ..	6·30	29·9	4·4	1·07	nd	nd	0·039	nd

nd = not detected.

The specific activities for zinc-65 in the three species show significant variations. It is worth mentioning in this connection the work of Bernhard and Zattera[7] who have shown that the rate of uptake of the stable isotope does not necessarily follow that of the radioactive isotope if the two are present in different physico-chemical states. Moreover zinc-65 being not a particularly long-lived isotope the specific activity in the tissue can vary with the age of the organism.

While zinc-65 is present in all the three species manganese-54 and caesium-137 are present only in *Pila globosa.* Manganese-54 ($T\frac{1}{2}$—280 days) is formed by the neutron activation of iron and occurs in radioactive fallout from nuclear tests. Caesium-137 ($T\frac{1}{2}$—30 years) also a common constituent of global fallout is a fission product radionuclide. Table I clearly demonstrates the highest manganese-54 and stable manganese content in *Pila globosa.* The manganese content, 303·4 μg./g. dry weight is

ACKNOWLEDGEMENTS

Our thanks are due to Dr. A. K. Ganguly, Head, Health Physics Division, for his helpful guidance.

1. Falsom, T. R., Young, D. R., Johnson, J. N. and Pillai, K. C., *Nature*, October 26, 1963, **200, 327.**
2. Sastry, V. N. and Bhatt, Y. M , *Ind. Chem. Soc.*, 1965, **42,** 121.
3. Gaglione, P. and Ravera, O., *Nature*, 1964, **204,** 1215.
4. Perkin-Elmer, *Analytical Methods for Atomic Absorption Spectrophotometry*, Parkin Elmer Corpn., Norwalk, Connecticat Publ., 1964.
5. Murthy, G. K., Goloin, A. S. and Campbell, J. E., *Science*, 1959, **130**, 3384, 1255
6. Watson, D. G., Davis, J. J. and Hanson, W. C., *Ibid.*, 1961, **133**, 3467, 1826.
7. Bernhard, M. and Zattera, A., *Proc. of Symposium on Radioecology* Michigan, USA, May 1967, 389.
8. Vinogradov, A. P., *The Elementary Chemical Composition of Marine Organisms*, Sears Foundation for Marine Research, Memoir II, New Haven, Yale University. 1953, p 647.
9. Kolb, W., *Nature*, October 16, 1968, **220.**
10. Merlini, M , Girardi, F., Pietra, R. and Brazzelli, A., *Limnology and Oceanography*, 1965, **10** (3), 371.