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MOLYBDENUM CONTENT IN SEA WATER AND SEAWEEDS FROM SAURASHTRA COAST*

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ABSTRACT

Molybdenum content has been estimated in sea water and 27 marine algal species. The ranges of Mo in sea water and seaweeds was found to be 9.86-10.87 $\mu g.kg^{-1}$ and 0.08-1.01 mg. kg^{-1} dry wt. respectively. Molybdenum to salinity ratios (Mo: S‰) in sea water are in the range of 0.280-0.305. The observed differences in Mo: S‰ is attributed to the biological utilisation of Mo. Its narrow range of distribution in sea water and in seaweeds presumably indicate the relatively less biogeochemical reactivity of this micronutrient in marine environment. The three green algae *Caulerpa scalpelliformis. Uva lactuca* and *Codium dwarkense* investigated do not show any definite trend in the bioaccumulation of Mo with their age.

Key-words: Molybdenum, seaweeds, geobiochemical reactivity, Saurashtra coast.

Knowledge of molybdenum levels in sea water and its biological utilisation is essential for a better understanding of its geobiochemical cycles in marine environment. Mo is an essential micronutrient for algae and its role in nitrogen metabolism is well established (Weissner, 1962). Though the distribution of micronutrient trace metals such as Cu, Zn, Mn, Co etc. in coastal waters and seaweeds of Saurashtra coast is well documented (Rao and Indusekhar, 1986), distribution of Mo has not been investigated so far. Recently Mo content of coastal waters of Visakhapatnam has been determined by Kanna Babu, Krishna Murthy and Satyanarayana (1984). In the present study an attempt has been made to estimate Mo content in 27 species of marine algae and sea water from Diu (lat. 20° 43'N; long. 71° 02'E) Porbandar (lat. 21° 38'N; long. 69° 37'E) and Okha (lat. 22° 28'N long. 69° 05'E) along the Saurashtra coast.

Sea water samples were collected with clean plastic buckets and transferred into acid cleaned 10 litre capacity polythene cans. In the laboratory, sea water was filtered through Whatman GF/C filter paper. From the filtered samples known amount of water with a pH adjusted to 5.2, was preconcentrated by passing through chelax-100 ion-exchange resin (50-100 mesh mixed with

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pyrex glass powder in the ratio 1:1) and eluted with 2 N ammonia solution. After treating the eluant with reducing and complexing reagent (ascorbic acid, citric acid and thiourea respectively in 1:5:5 ratio) and dithiol, Mo was extracted into n-butyl acetate and the absorbance of the extract was measured spectrophotometrically at 670 nm (Riley and Taylor, 1968). Salinity of sea water was estimated by Knudsen's method (Strickland and Parsons, 1972).

Green, brown and red seaweeds were collected from different parts of the intertidal region during the lowest low neap tide periods. The samples were hand picked, washed off extraneous material and epiphytes in sea water and then rinsed with tap and distilled water resply. These were then dried at 105°C, homogenised and sieved through muslin cloth and subjected to acid digestion under reflux. The acid residue was diluted and filtered through Whatman 44 filter paper. Filterate was adjusted to a pH of 5.2, preconcentrated and Mo was estimated as per the method mentioned above for sea water.

Molybdenum content and its monthly variation in sea water & seaweeds, together with Mo: S‰ ratios in the former are shown in Tables I and II. In the determination of Mo, observed coefficient of variation is about 4% in sea water and varied between 4-7% in seaweeds.

Molybdenum in the form of a molybdate is a minor dissolved constituent of sea water with a concentration of approximately 11 $\mu g.\ kg^{-1}$ It seems to exhibit conservative distribution with little variation either spatially or with depth gradient (Head and Burton, 1970; Jones, 1974; Morris, 1975). Recently Kanna Babu, Krishna Murthy and Satyanarayana (1984) have reported an average concentration of 9.6 $\mu g.\ kg^{-1}$ of Mo in the coastal waters of Visakhapatnam. The value obtained in the present study ranged from 9.86-10.87 $\mu g.kg^{-1}$).

Head and Burton (1970), Jones (1974) have observed a linear relationship between Mo and S‰ contents of estuarine and coastal waters. They opined that river water inflow which dilutes sea water would be the major factor controlling the Mo concentration. The different levels of biological utilisation of Mo observed by these workers in marine flora may also be one of the causative factors for the deviations in Mo: S‰ value. In the present study, where no fresh water inflow is encountered, the observed low Mo: S‰ may be only due to the biological utilisation of Mo by the marine flora. These waters are reported to possess high productivity. The value of Mo: S‰ in the present study (0.280-0.305) was more or less similar to those reported by Kanna Babu, Krishna Murthy and Satyanarayana (1984) and Morris (1975) for coastal waters of Visakhapatnam (0.315) and Irish Sea water (0.298 $\pm$ 0.016) respectively.

According to Phillips (1977) during the accumulation process of trace elements (Zn, Pb, Cu, Fe, Al, etc.) the trace metals are irreversibly held with organic matrix and this increases with the age of the seaweed. But in the present study Mo content of *Caulerpa scalpelliformis, Ulva lactuca* and *Codium dwarkense* from Porbandar reef showed no such trend with the age of the algae (Table II).

Table I. Molybdenum content of sea water ($\mu g.\ kg.^{-1}$) and seaweeds (mg. kg^{-1} dry wt.) and Mo: S‰ in Sea water.
(*Oct.-Nov.* 1981)

Sample	*Place of collection*	*Molybdenum content*
Sea water	D	10.25
	P	9.86
	O	10.83
Mo: S‰	D	0.292
	P	0.280
	O	0.302
Green seaweeds		
Enteromorpha intestinalis (Linn.) Link	D	0.48
	P	0.49
	O	0.45
Enteromorpha sp.	D	0.51
	P	0.47
Ulva fasciate Delile	D	0.28
	P	0.35
	O	0.37
Chaetomorpha antennina (Bory) Kuetz.	D	0.23
	P	0.27
	O	0.19
Cladophora fasicularis (Martens) Kuetz	D	0.20
	P	0.13
	O	0.17
Bryopsis plumosa (Huds.) Ag.	D	0.37
	P	0.45
	O	0.33
Caulerpa racemosa (Forssk.) Weber V Bosse	D	0.15
	P	0.23
	O	0.15
Valoniopsis pachynema (Martens) Boergs.	D	0.53
	P	0.61
Brown seaweeds		
Dictyota dichotoma (Huds) Lamour	D	0.25
	P	0.19
	O	0.19

Sample	*Place of collection*	*Molybdenum content*
Padina tetrastromatica Hauck	D	0.37
	P	0.33
	O	0.29
Padina sp.	D	0.41
Spatoglossum asperum J. Ag.	D	0.13
	P	0.09
	O	0.15
Cystoseira indica (Thiry *et* Doshi) Mairh	D	0.73
	P	0.59
	O	0.65
Sargassum johnstonii Setchell and Gardner	O	0.41
S. swartzii (Turn) C. Ag.	P	0.37
	O	0.31
S. tenerrimum J. Ag.	D	0.47
	P	0.59
	O	0.53
Red seaweeds		
Gelidella acerosa (Forsk.) Feldman *et* Hamel	D	0.29
	P	0.37
	O	0.31
Amphiroa anceps (Lamk.) Decsne	D	0.47
	P	0.38
	O	0.50
Sarconema filiforme (Sond) Kylin.	P	0.89
	O	1.01
Hypnea musciformis (Wulf.) Lamour	D	0.46
	P	0.53
	O	0.39
Gracilaria corticata (Agadh) J. Ag.	D	0.23
	P	0.26
	O	0.37
Acanthophora spicifera (Vahl.) Boergs	D	0.50
	P	0.39
Chondria armata (Kuetz.) Okamura Var *Plumaris* Boergs.	P	0.39
	O	0.48
Laurencia sp.	D	0.51
	P	0.47
	O	0.55

D-Diu; P-Porbandar; O-Okha

Table II. Molybdenum content of sea water ($\mu g. g.^{-1}$) and of green seaweeds* ($mg. kg^{-1}$) of Porbandar reef with Mo: S%o of sea water during different months.

	Dec., 1981	*Jan.,* 1982	*Feb.,* 1982
Sea water	10.33	10.87	10.51
Mo: S%o	0.293	0.305	0.297
Caulerpa scalpelliformis (R. Br) Web. V. Bosse	0.17	0.25	0.25
Ulva lactuca Linn.	0.32	0.27	0.33
Codium dwarekense Boergs	0.08	0.13	0.11

* These algae completed their life during the study period

Molybdenum content in seaweeds interestingly show a consistent value (Tables I and II), whereas other micronutrient trace metals such as Cu, Zn, Co, Mn etc. exhibit wide range of values (Rao and Indusekhar, 1986). The concentration factor of Mo in seaweeds is of the order of 36 while for the above metals it is of the order of 2-4 magnitude (Rao and Indusekhar 1986). Thus the conservative nature of distribution of Mo in sea water and its narrow range in seaweeds presumably indicate its less biogeochemical reactivity than that of the other trace metals in marine environment.

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REFERENCES

Head, P. C. and J. D. Burton, 1970. Molybdenum in some ocean and estuarine waters. *Journal of Marine Biological Association of United Kingdom*, **50**: 439-448.

Jones, G. B., 1974, Molybdenum in a nearshore and estuarine environment, North Wales. *Estuarine and Coastal Marine Science*, **2**: 185-189.

Kanna Babu, S., M. V. Krishna Murthy and D. Satyanarayana, 1984. Preconcentration and photometric estimation of molybdenum in sea waters, particulate matter and sediments of Visakhapatnam (Bay of Bengal). *Marine Environmental Research*, **11**: 305-317.

Morris, A. W., 1975. Dissolved molybdenum and vanadium in the northeast Atlantic Ocean. *Deep-sea Research,* **22**: 49-54.

Phillips, D. J. H., 1977. The use of biological indicator organisms to monitor trace metal pollution in marine and estuarine environments — a review. *Environmental Pollution* **13**: 281-317.

Rao Kesava, Ch. and V. K. Indusekhar, 1986. Manganese, zinc, copper, nickel and cobalt contents in seawater and seaweeds from Saurashtra coast. *Mahasagar-Bulletin of the National Institute of Oceanography,* **19**: 129-136.

Riley, J. P. and D. Taylor, 1968. The use of chelating ion-exchange in the determination of molybdenum and vanadium in sea water. *Analytica Chemica Acta.* **41**: 175-178.

Strickland, J. D. H. and T. R. Parsons, 1972. *A practical handbook of sea water analysis,* Fisheries Research Board of Canada, Bulletin No. 167, Ottawa, 311 pp.

Weissner, W., 1962. Inorganic micronutrients. In: *Physiology and bio-chemistry of algae* (edited by R. A. Lawin). Academic Press, New York. 267-286.