

ECOLOGICAL STUDIES ON THE FLOATING WEED *SALVINIA*
AURICULATA IN COCHIN BACKWATERS AND
ADJACENT AREAS. I. ASSOCIATED FAUNA.

U. K. GOPALAN AND SREEKUMARAN NAIR, S. R.

*Regional Centre, National Institute of Oceanography,
Cochin - 682018. India*

ABSTRACT

As part of the ecological studies on the floating weed *Salvinia auriculata* Aublet in Cochin Backwaters and adjacent areas the associated fauna was investigated during 1973-'74. Eleven categories of organisms belonging to five phyla were found associated with the weed mat. Copepods mainly harpacticoids and cyclopoids were numerically the most abundant. Bivalves and amphipods seemed to contribute to the bulk of the biomass. Polychaetes, ostracods and gastropods were the other dominant groups. A general decline in the abundance of fauna from the lower reaches of the backwaters to the low saline areas was observed and the density of fauna reached the maximum during post-monsoon period. A comparison of the abundance of fauna of the level bottom with that of the weed mat revealed a tendency for the possible migration of bottom fauna to the floating weeds and the reasons for these are discussed. The association of detritus feeding organisms with the decaying weed indicates the role of *Salvinia* in the organic cycle of Cochin Backwaters.

INTRODUCTION

The water fern *Salvinia auriculata* Aublet locally known as *African Payal* is originally a native of Central and South America (Mitchell 1969). It has radiated to different parts of the world and in recent years has successfully colonised the Kerala waters to the extent of emerging as a serious aquatic weed problem (Menon 1971). Fresh water canals, paddy fields, ponds and reservoirs are the centres of its growth from where weeds are transported to the backwaters and lagoons particularly during the monsoon. In the post-monsoon months when the rivers run low, tidal water sweeps large quantities of the weed upstream, building up stagnant blankets over backwaters where they undergo decay due to salinity and get deposited at the bottom.

Ecological studies of the phytal association of animal communities have been gaining attention in recent years (Ida, Hiyama and Kusaka 1967;

Sarma and Ganapati 1972). As regards *Salvinia*, considerable research has been carried out on its ecology in Africa where the weed has caused heavy economic losses (Schelpe 1961; Hattingh 1962; Mitchell, 1960, 1963, 1965, 1967, 1969; Bowmaker 1969). Cytological studies relating to the propagation of this weed has been carried out in India (Loyal and Grewal 1966). Covering a large surface area of the fresh and brackish waters the *Salvinia* mat provides a new habitat for micro-fauna, meio-fauna and macrofauna of underlying waters. The present communication gives a preliminary account of the density of various categories of meio and macro fauna associated with *Salvinia auriculata* in Cochin Backwaters and adjacent areas.

MATERIALS AND METHODS

Samples from the drifting weed mat were taken once every month at different localities such as Cochin harbour (off Malabar Hotel), Aroor (near bridge), Chandiroor (Off church) and Thanneermukkom (near bund) i. e. from the barmouth towards the southern upper reaches close to river Pamba during November 1973 to October 1974. Representative samples were collected from fresh water area of Kuttanad (Pallathuruthy ferry). A square mouthed, No. 3 bolting silk net (0.25 m²) was lowered to a depth just below the weed mat and lifted suddenly. The weeds were then transferred to a trough containing filtered water and rinsed carefully to remove all the organisms. Total weight of the weed was noted after blotting with a towel. The contents of the trough were then sieved through a fine nylon netting and the material retained in the cloth was preserved. Larger organisms were picked from the whole sample and the smaller ones were sorted and counted from sub-samples under a binocular microscope.

Samples of the bottom fauna were taken using a Van - veen grab to enable a comparison of the abundance of the fauna associated with weed with that of the level bottom. Water samples from the bottom and surface of the weed covered areas as well as from adjacent open water were collected for the determination of oxygen concentration and salinity using standard procedure. Data have been pooled to calculate average numbers of various groups of organisms per unit area of weed mat surface and per unit weight of weed.

RESULTS

Abundance of organisms associated with weed mat at various stations has been expressed as numbers per square metre and presented in Table I. It shows that eleven categories of organisms belonging to five phyla mostly invertebrates constitute the fauna extracted from the weed samples. In all stations, copepods mainly harpacticoids and cyclopoids dominated, ranging

from 40772/m² at Cochin harbour to 2432/m² at Thanneermukkom. Bivalves dominated by the genus *Paphia* ranked second in numerical abundance with an average of 9708/m² and showing the highest density in Cochin harbour, 29368/m². They were followed by amphipods with an average number of 2138/m². Gammarids, corophids and photids constituted nearly 50, 20 and 15 per cent respectively of the amphipod fauna. Polychaetes, gastropods, ostracods, nematodes and decapods were the other groups of invertebrate denizens of the weed mat. Shrimps and young fishes, though observed in large numbers close to the weed mat, could not be sampled adequately as they avoided the sampling gear.

Table I

Fauna Associated with *Salvinia auriculata* in Cochin Backwater and adjacent area (in numbers per m²)

Groups of organisms	A. (Brackish water)			B. (Fresh water)	
	Cochin harbour	Aroor	Chandiroor	Thanneer-mukkom	Kuttanad
Nematodes	442	944	796	360	2436
Annelids	1760	892	1000	132	1628
Copepods	40772	6928	4740	2432	5240
Amphipods	3460	2772	1780	544	844
Isopods	4	24	—	—	—
Ostracods	2188	300	120	—	872
Decapods	—	20	8	8	4
Insect larvae	40	4	252	—	348
Bivalves	29368	6888	2572	4	348
Gastropods	2788	92	12	—	176
Fishes	—	4	4	—	4

Within the brackish water zone a general decline in the abundance of fauna from the lower reaches of the estuary to the low saline areas can be observed (Table I). Data from fresh water stations of Kuttanad shows comparatively denser association of organisms than that observed in the low saline areas like Thanneermukkom and Chandiroor. However, the species composition is different even though they come under the same broad categories. Another trend in the fresh water stations is the relatively larger numbers of insect larvae, nematodes, annelids and ostracods than their general average in the brackish water. Among the annelids, polychaetes

constituted 90 per cent in brackish water where as oligochaetes were more common in the fresh water zone. As regards the biomass of the associated fauna, bivalves and amphipods seemed to constitute the main bulk.

Table II

Fauna associated with *Salvinia auriculata* in numbers per Kg. of weed weight

Groups of organisms	Cochin Harborrh	Aroor	Chandiroor	Thanneer-mukkom	Kuttanad
Nematodes	47	137	185	164	290
Annelids	187	129	233	60	194
Copepods	4337	1004	1102	1105	624
Amphipods	368	402	414	247	105
Isopods	—	4	—	—	—
Ostracods	233	43	28	—	104
Decapods	—	3	2	4	—
Insect larvae	—	—	59	—	41
Bivalves	3124	968	598	2	41
Gastropods	297	13	2	—	21
Fishes	—	—	1	—	—

Table III

Seasonal changes in the abundance of fauna associated with *S. auriculata* in Cochin Backwaters (numbers/m²)

Groups of organisms	Pre-monsoon (February–May)	Monsoon (June–September)	Post-monsoon (October–January)
Nematodes	360	—	864
Annelids	92	1476	1764
Copepods	2432	8220	39772
Amphipods	544	772	3460
Isopods	16	—	8
Ostracods	12	1560	2184
Decapods	8	—	20
Insect larvae	—	336	60
Bivalves	4	—	29368
Gastropods	—	—	2716
Fishes	—	—	8

Table IV

Bottom fauna in numbers/m² of the level bottom of Mattancherry Channel (November 1973)

Groups of organisms	Upper weed mat	Adjacent open area
Nematodes	41	—
Polychaetes	63	499
Amphipods	41	6895
Isopods	—	20
Juvenile prawns	20	291
Alpheus	20	20
Bivalves	—	250
Gastropods	41	63

Numerical distribution of fauna per kilogram of weed is shown in Table II. It also reveals the trend that the density of organisms associated with the weed mat increases from the low saline areas to the lower reaches of the backwaters. Seasonal changes in the abundance of fauna shown in Table III indicate that the variety and number of organisms associated with the weed are at their maximum (80224/m²) during the post-monsoon period (Oct. - Jan.), when the surface salinities varied between 15-30‰ in Cochin Harbour, 10-28‰ in Aroor, and 1-12.85‰ in Chandiroor. The density of fauna was lowest (3468/m²) during the pre-monsoon (Feb. - May) when the weed mat gets thinner due to decaying and sinking. The variety of organisms was poorest during the monsoon when the fresh weed was being transported to the backwaters. During the post-monsoon months, grab samples were taken from a weed covered area as well as from the adjacent open water in Mattancherry channel and the data in terms of numbers/m² are presented in Table IV. It becomes clear from the table that the density of fauna of the level bottom under the weed mat is considerably poorer than that of the open area. This might be due to the possible migration of benthic organisms to the overlying weed mat. In the locality the oxygen level of bottom waters in the weed covered areas was 2.82 ml/litre where as that of adjacent open waters was 4.31 ml/litre in November. Similar conditions were observed in other stations also (data unpublished). In the shallow waters of Palluruthy (South of Cochin Harbour) there was practically no oxygen and the smell of hydrogen sulphide was noticed in water samples taken under the stagnant and decaying weed mats.

The most abundant organisms inhabiting the weed mat was a harpacticoid *Nitocra spinipes* Boeck which was found to tolerate a wide range of salinities between 5 and 40‰ in the laboratory (unpublished). Experimental feeding of this species on detritus prepared from decaying *Salvinia* was carried out using filtered water in lab. aquaria. The medium was kept mildly aerated and renewed once in a week. In this manner they could be maintained in the laboratory for more than 3 months during which time the population increased considerably. Similar feeding experiments were carried out on amphipods, polychaetes and ostracods.

Several species of food fishes like *Arius*, *Scatophagus*, *Apogon*, *Hemiramphus* and mullets were very often found in association with the weed mat. Organisms and detritus associated with *Salvinia* could be identified in the stomachs of *Arius*, *Scatophagus* and *Apogon*.

DISCUSSION

Results of the present investigation indicate that the floating mats of *Salvinia* provide a new habitat for a host of organisms especially invertebrates in the fresh water where they grow, and in the brackish water where they undergo decay. In the fresh water zone where they grow as permanent mats several categories of organisms are sheltered as well as nourished regularly by the decaying older plants. The profusely branching rhizoid system of this hydrophyte traps suspended matter in them and provides additional food source for the detritus, particulate and suspension feeding organisms. As mentioned earlier during the monsoon when the rivers run fast the weeds get transported to the backwaters. From the freshwater areas like Kuttanad when the weeds reach the low saline areas like Thanneermukkom and Chandiroor, majority of the fresh water organisms originally associated with the weeds (Table I) get detached due to their intolerance of salinity and this brings about a reduction in the density of associated fauna. But when the weed mats drift more towards the lower reaches of the estuary the numerical increase in the associated organisms is evident from the data from Aroor and Cochin harbour areas. A similar trend is reflected in the distribution of organisms attached to the weed in Cochin Backwaters during monsoon and post-monsoon months. During monsoon the weeds reaching the backwater remain fresh and do not attract more inhabitants. This is probably because fresh weed does not provide a ready source of food for most of the organisms as has been mentioned in the case of eel grass in Knysna Estuary of South Africa (Day, 1967).

The results of the feeding experiments indicate that the major groups of organisms inhabiting the weed mat utilize the *Salvinia* detritus as food. Thus

it could be deduced that the organisms associated with *Salvinia* mat might be mainly detritus feeders. Fager (1971) found that detritus derived from kelp supported population of invertebrates off La Jolla and Wieser (1960) found that the major component of the fauna including nematodes, ostracodes and copepods in Buzzards Bay are detrital deposit feeders.

The tendency for the upward migration of benthic organisms reveals the significant influence of weed mat on the underlying waters. Besides reducing the light penetration and photosynthetic oxygen production the decaying weed mat gradually sink to the bottom and thus reduce the oxygen level at the bottom. This might be one of the factors inducing the bottom fauna to migrate from the original habitat to the surface weed mat. However there is no evidence to suggest that the migration is exclusively towards the surface. Bowmaker (1969) reported that the bottom fauna was exceedingly sparse under the *Salvinia* mats in the river and estuary of Lake Kariba (South Africa) and has observed similar upward migrational pattern of the bottom living species.

It is difficult to make a comparison of the fauna associated with *Salvinia* with that of an identical habitat in India due to the lack of previous information. However, the recent work of Sarma and Ganapathi (1972) on the faunal association with algae in the intertidal region reveals that the major groups of meio and macrofauna of that association are similar to those inhabiting the *Salvinia* mat. As regards the abundance of fauna, the algal habitat, in general, is comparatively richer than *Salvinia* mat.

The significance of the role of vascular hydrophytes like *Salvinia* in the organic cycle of Cochin backwaters deserves detailed investigation. The net production of primary organic matter in Cochin backwater measured by Qasim *et. al.* (1969) amounts to 195 gc/m²/year. It would also be worthwhile to compare this with the organic matter contributed by the immigrant vascular hydrophytes in the form of detritus, which forms the basic source of food in the estuary (Darnell, 1967; Day 1967; Odum and de la Cruz 1967). Recently the application of a model to this estuarine system by Wyatt and Qasim (1973) did not work as there was no clear information on the entry of organic detritus into the system and the authors have also stressed the need for quantitatively assessing the role of detritus in Cochin backwaters.

ACKNOWLEDGMENTS

The authors wish to acknowledge with thanks the encouragement received from Dr. S. Z. Qasim, Director, National Institute of Oceanography, India and Dr. T. S. S. Rao, Officer-in-Charge, Regional Centre, National Institute of Oceanography, Cochin during the course of the investigation.

Thanks are also due to Dr. M. J. George for critically reading through the manuscript. One of us (S.R.S.N.) is thankful to the Council of Scientific and Industrial Research for the award of a fellowship during the period of this study.

REFERENCES

- Bowmaker, A. P. 1969 A study of the hydrobiology of Sinamwenda River and "Estuary" Lake Kariba. *The Nuffield Lake Kariba Research Station Report* 1962-63, 15-17.
- Darnell, R. M. 1967 Organic detritus in relation to estuarine ecosystem. *Estuaries*. G. H. Lauff (Ed) *Am. Ass. Advmt. Sci. Publ.* 83, 376-382.
- Day, J. J. 1967 The biology of Knysna Estuary South Africa. *Estuaries*. G. H. Lauff (Ed.) *Am. Ass. Advmt. Sci. Publ.*, 83, 757. pp.
- Hattingh, E. R. 1962 Report on the investigation into the control of *Salvinia auriculata* on Lake Kariba Part I. *Private report to Lake Kariba co-ordinating committee from Union weed killer service, Johannesburg.*
- Ida, H. Y., Hiyama and T. Kusaka 1967 Study on fishes gathering around floating weed-1. Abundance and species composition. *Bull. Japan. Soci. Scient. Fish.* 33 (10), 923-929.
- Loyal, D. S., and Grewal, R. K. 1966 Cytological study on sterility in *Salvinia auriculata* with a bearing on its reproductive mechanism. *Cytologia* 31, 213-338.
- Menon, M. V. K. 1971 The threatening weeds. *Science Today* 6 (20), 33-38.
- Mitchell, D. S. 1960 Report on the incidence of *Salvinia auriculata* on Lake Kariba. *Fed. Sci. Teachers J.* 1, 39-46.
- Mitchell, D. S. 1963 Biological explosion of *Salvinia auriculata* on Lake Kariba S. A. Institute of Sewage purification 1963 Conference (cyclostyled).

- Mitchell, D. S. 1965 Research on *Salvinia* the Kariba weed. *L. K. F. R. I. Kariba research Symposium* 51-56 (cyclostyled).
- Mitchell, D. S. 1967 *Salvinia auriculata* in the Estuaries of Lake Kariba. *Rhodesian Science Congress Abstracts*. 64.
- Mitchell, D. S. 1969 The ecology of vascular hydrophytes of Lake Kariba, *Hydrobiologia* 34 (3-4), 448-464.
- Odum, E. P., and Armado, A. de la Cruz 1967 Particulate organic detritus in a Georgia salt marsh estuarine system. *Estuaries*. G. H. Lauff (Ed). *Am. Ass. Advent. Sci. Publ.* 83, 383-388.
- Qasim, S. Z., S. Wellershaus, P. M. A. Bhattathiri, and S. A. H. Abidi 1969 Organic production in a tropical estuary *Proc. Indian Acad. Sci. B.* 69, 51-94.
- Sarma, A. L. N. and P. N. Ganapati 1972 Faunal association of algae in the intertidal region of Visakhapatnam. *Proc. Indian Nat. Sci. Acad. B* 38, 380-396.
- Schelpe, E. A. C. L. E. 1961 Ecology of *Salvinia auriculata* and associated vegetation of Kariba Lake *J. S. Afr. Prof.* 27, 181-187.
- Wyatt, T and S. Z. Qasim 1973 Application of a model to an estuarine ecosystem. *Limnol. and Oceanogr.* 18 (2), 301-306.

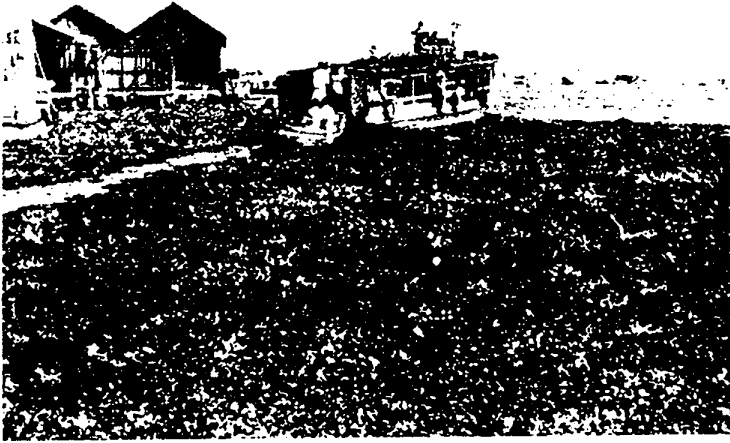


Fig. 1 A locality in Cochin Backwaters blanketed by the floating weed *Salvinia auriculata*.

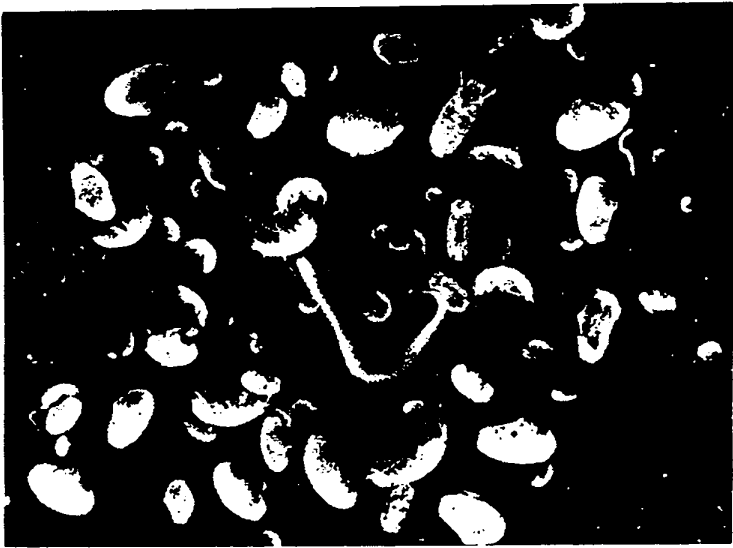


Fig. 2 Bottom fauna associated with *Salvinia auriculata* in Cochin Backwaters.