

OIL-BODIES IN SOME INDIAN METZGERIALES*

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ABSTRACT

Oil-bodies in 15 liverwort taxa belonging to eight genera of Metzgeriales have been described. *Fossombronia cristula* has been reported for the first time from the eastern Himalayas.

INTRODUCTION

In India considerable attention has been given to the studies of Indian Metzgeriales and several contributions have been made on various aspects of this group. These include contributions to the taxonomy of the order including the discovery of a number of new taxa (KASHYAP, 1928 ; SCHIFFNER *et al.*, 1959 ; S. C. SRIVASTAVA, 1976 ; UDAR & S. C. SRIVASTAVA, 1970, 1973, 1974) ; some new reports from the country (K. P. SRIVASTAVA, 1972 ; S. C. SRIVASTAVA & UDAR, 1975a ; UDAR & S. C. SRIVASTAVA, 1969) ; taxonomic descriptions of certain taxa (PANDE & K. P. SRIVASTAVA, 1953, 1958) ; and three comprehensive monographs on the genus *Fossombronia* and the families Metzgeriaceae and Aneuraceae from India (S. C. SRIVASTAVA & UDAR, 1975, 1975b, 1976) ; morphological studies of several taxa (KASHYAP & PANDE, 1922 ; MEHRA & KHANNA, 1950 ; PANDE *et al.*, 1954, 1955 ; PANDE & UDAR, 1956 ; K. P. SRIVASTAVA, 1960, 1961) ; cytological studies in some members of the family Codoniaceae (MEHRA, 1938) ; studies on the sporeling pattern in *Fossombronia cristula* (UDAR & SRIVASTAVA, 1972) and *F. kashyapii* (S. C. SRIVASTAVA & UDAR, 1975c) and discovery of certain morphological abnormalities in the genus *Metzgeria* (UDAR & SRIVASTAVA, 1967).

Metzgeriales are represented in India by twelve genera and a number of species (SRIVASTAVA, 1969), and their oil-bodies have not been investigated so far though, in recent years, accounts of the oil-bodies in the foliose forms of liverworts from the different parts of the country have been presented (UDAR *et al.*, 1970 ; UDAR & NATH, 1971, 1976 ; see also UDAR, 1976).

The present paper is an attempt to provide the details of oil-bodies in 15 taxa of Metzgeriales from India which could be freshly collected. The structure of the oil-bodies in several other members of the Metzgeriales could not be ascertained due to the non-availability of the fresh plant materials. However, the description of the oil-bodies in *Apotreubia nana* has been given after HATTORI AND INOUE (1954) and INOUE AND HATTORI (1955).

Apotreubia has recently been described as new genus by HATTORI *et al.* (1966) on the basis of an earlier known taxon : *Treubia nana* instituted by HATTORI AND INOUE (1954) from Central Japan and subsequently collected by A. J. SHARP, E. SHARP AND IWATSUKI from India near Sandakphu (Darjeeling) in April 1965 (HATTORI *et al.* 1966).

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The plant materials for the present investigation were collected from Madhya Pradesh (Chhindwara, April 1, 1968 : P. C. SHARMA), Nilgiri and Palni Hills, South India (Ootacamund, Coonoor and Kodaikanal, December-January, 1965-66 : R. Udar and S. C. Srivastava), Eastern Himalayas (Darjeeling, October, 1966 : Dr. B. S. Trivedi ; December-January, 1969-70 : R. Udar and S. C. Srivastava ; April 25, 1976: D. K. Singh), Khasi and Jaintia Hills (Shillong, Jowai, October, 1975 ; April, 1976: D. K. Singh) and Western Himalayas (Mussoorie and Deoban, September-October, 1976 : D. K. Singh and J. C. Joshi). The observations were recorded from fresh plants within two weeks after the date of collection. The voucher specimens have been deposited in the Lucknow University Hepatic Herbarium, Lucknow (India).

DESCRIPTION

TREUBIACEAE

1. *Apotreubia nana* (Hattori & Inoue) Hattori & Mizut. (Fig. 1). The oil-bodies, in this taxon, occur in oil-cells which are scattered in leaves and stem. They are dark-greyish brown, one per cell, rotundate or rarely subquadrate consisting of numerous dense spherules. They are very large almost filling the cell lumen, $40-45 \times 30-35 \mu\text{m}$ (or sometimes smaller) in the middle of the lateral leaf and $20-35 \times 20-30 \mu\text{m}$ along the margin of the lateral leaf. Such type of oil-body is very unique in this as well as in a species of the allied genus *Treubia* (*T. insignis*) and differs from that of all liverworts (see HATTORI & INOUE, 1954; INOUE & HATTORI, 1955). Since it has not been possible to collect this plant the above account is based on the descriptions given by HATTORI AND INOUE (1954) and INOUE AND HATTORI (1955).

FOSSOMBRONIACEAE

2. *Fossombronia cristula* Aust. (Figs. 2, 3). Oil-bodies are 2-numerous in each cell throughout the leaf except in marginal cells towards the distal portion of the leaf where they are absent. These are usually spherical ($4-6.75 \mu\text{m}$ in diameter) but sometimes they may be elliptical also ($4 \times 8.1 \mu\text{m}$), faintly granular with more or less irregular outline.

Specimen No. 1014R/SH, Leg. D. K. S., Loc. Pologround Road, Shillong (Meghalaya), October 16, 1975.

This species was recently reported from Kodaikanal, South India (UDAR & SRIVASTAVA, 1969 ; SRIVASTAVA & UDAR, 1975). The present communication constitutes the first record of this species from North Eastern Hill regions (Shillong).

3. *Fossombronia himalayensis* Kash. (Fig. 4). Oil-bodies are 3-25 per cell throughout the leaf. These are oval ($2.7-5.4 \times 4.7-5.4 \mu\text{m}$)—spherical ($4.05-8.1 \mu\text{m}$ in diameter), sometimes more or less hexagonal also, granules obscure with smooth outline.

Specimen No. 1101 R/WH, Leg. D. K. S./J. C. J., Loc. Deoban, September 29, 1976.

The structure of the oil-bodies in the above two species of *Fossombronia* are clearly distinct though these are more or less similar in their size and number.

4. *Sewardiella tuberifera* Kash. (Figs. 5, 6). Oil-bodies numerous in each cell on both the surfaces of thallus and may be aggregated in small groups or scattered throughout the cell lumen. These are usually spherical ($4.05-8.1 \mu\text{m}$ in diameter) to sometimes oval also ($4.05-6.75 \times 5.4-8.1 \mu\text{m}$), faintly granulose, bluish with light brown, irregular outline.



Specimen No. 1102 R/WH, Leg. D. K. S./J. C. J., Loc. Mussoorie, September 26, 1976.

PALLAVICINIACEAE

5. *Pallavicinia lyellii* (Hook.) Gray (Figs. 12-17). Oil-bodies in this taxon usually vary from 2-25 per cell throughout the thallus but the usual number is 8-15 per cell except in the marginal cells where only 6-12 oil-bodies are present. These are variously shaped, $2.7-10.8 \times 5.4-35.9 \mu\text{m}$. Oil-bodies are prominently granular, sometimes grape-cluster like, with irregular outline.

Specimen No. 1039 R/SH, Leg. D. K. S., Loc. Jowai-Jarain Road, Jowai (Meghalaya), April 18, 1976.

The genus *Pallavicinia* presents the maximum variation in the shape and size of the oil-bodies within the same species and even in a single cell. However, the oil-bodies are distinctive from those of other taxa at least at the generic level.

PELLIACEAE

6. *Calycularia* sp. (Fig. 10). Oil-bodies are numerous in each cell throughout the dorsal epidermis of the thallus. They are more or less spherical ($2.7-4 \mu\text{m}$ in diameter)—oval elliptical (ca $1.35 \times 4 \mu\text{m}$) with obscure granules, irregular in outline with a prominent granular projection in the centre.

Specimen No. 1030 R/SH, Leg. D. K. S., Loc. Upper Shillong Road, Shillong (Meghalaya), October 14, 1975.

7. *Calycularia crispula* Mitt. (Fig. 11). Usually 10-25 oil-bodies are present in each cell throughout the dorsal epidermis of the plant. These are subglobose-globose, ($5.4-6.7 \mu\text{m}$ in diameter), rarely elliptical also and faintly granular.

Specimen No. 1037 R/EH, Leg. D. K. S., Loc. Teesta Valley Road from Ghoom, Darjeeling, April 25, 1976.

The oil-bodies in the two species of the genus *Calycularia* described here distinctly differ from each other in their shape, size and number and obviously represent two distinct species. This aspect is under investigation at present.

8. *Pellia epiphylla* (L.) Lindb. (Figs. 7, 8). Number of oil-bodies in this taxon varies from 17-20 per cell throughout the dorsal surface of the plant. They are usually oval-elliptical ($5.4-9.4 \times 5.4-13.4 \mu\text{m}$), sometimes spherical also ($5.4-6 \mu\text{m}$ in diameter), faintly granular with irregular outline.

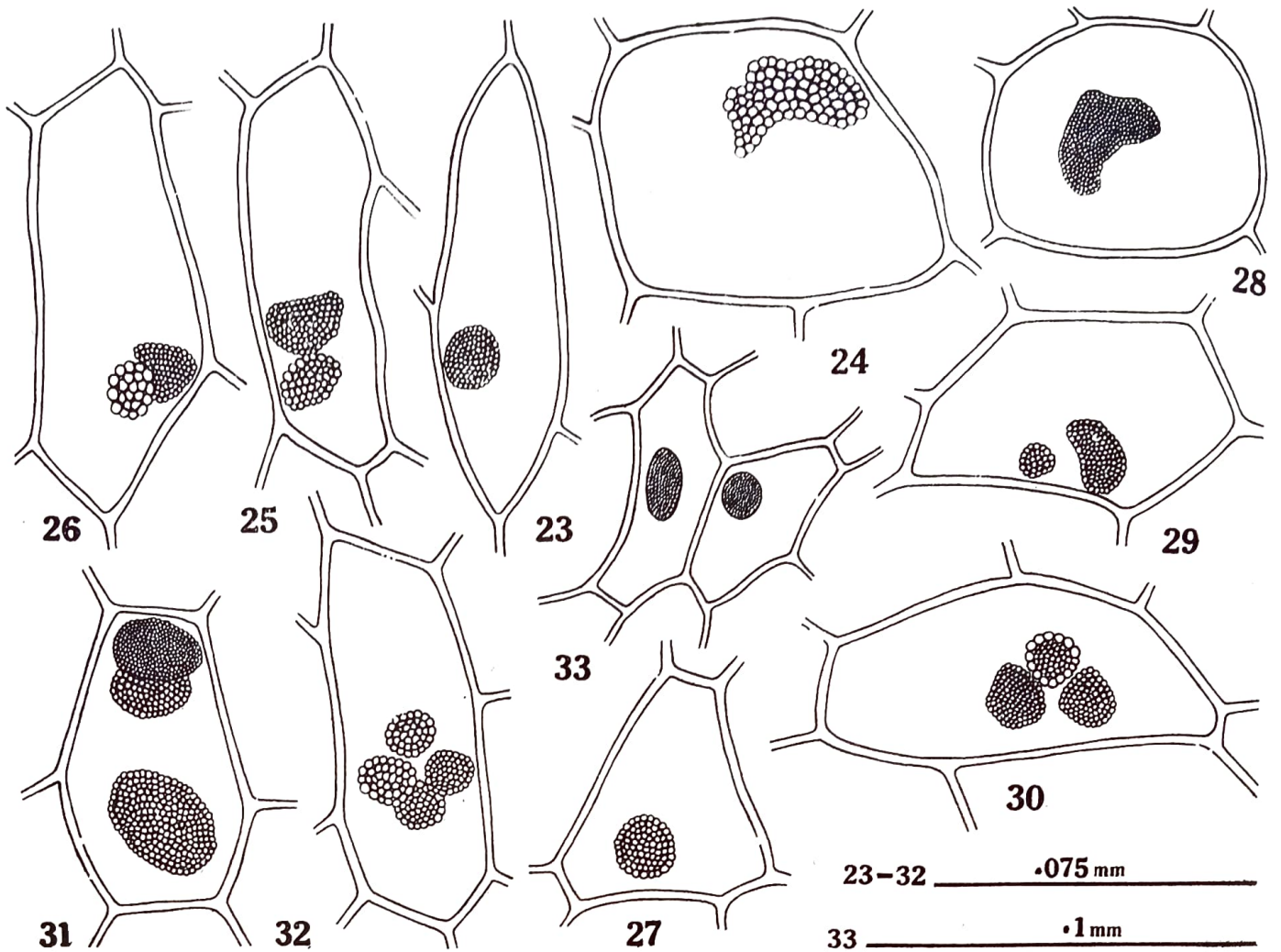
Specimen No. 1020 R/SH, Leg. D. K. S., Loc. Elephant Falls, Shillong (Meghalaya), October 14, 1975.

9. *Pellia endivaeifolia* (Dicks.) Dum. (Fig. 9). Oil-bodies numerous in each cell on both the surfaces of the thallus. These are oval ($2.7 \times 4.05 \mu\text{m}$)—spherical ($2.7-5.4 \mu\text{m}$ in diameter), simple and homogeneous with smooth outline.

Specimen No. 1041 R/EH, Leg. D. K. S., Loc. Teesta Valley Road from Ghoom, Darjeeling, April 25, 1976.

The above two species of the genus can be easily distinguished on the basis of their oil-bodies as they distinctly differ in their shape, size and number.

Figs. 1-22. 1. *Apotreubia nana* (Hattori & Inoue) Hattori & Mizutani (after INOUE & HATTORI, 1955); 2, 3. *Fossombronia cristula* Aust.; 4. *Fossombronia himalayensis* Kash.; 5, 6. *Sewardiella tuberifera* Kash. (6. oil-bodies highly magnified); 7, 8. *Pellia epiphylla* (L.) Lindb.; 9. *Pellia endivaeifolia* (Dicks.) Dum.; 10. *Calycularia* sp.; 11. *Calycularia crispula* Mitt.; 12-17. *Pallavicinia lyellii* (Hook.) Gray; 18. *Aneura pellicides* (Horik.) Inoue (after SRIVASTAVA & UDAR, 1975a); 19. *Aneura pinguis* (L.) Gray; 20-22. *Riccardia santapauli* Udar et Srivastava (after UDAR & SRIVASTAVA, 1973).



Figs. 23-33. 23-26. *Riccardia levieri* Schiffn.; 27-32. *Riccardia multifida* (L.) Gray; 33. *Riccardia sikkimensis* (St.) Pande *et* Srivastava (after SRIVASTAVA & UDAR, 1976).

ANEURACEAE

10. *Aneura pellioides* (Horik.) Inoue (Fig. 18). The oil-bodies are numerous, usually 70 or more in each of the epidermal cells. They are simple, globose or subglobose, homogeneous and small, 1.8—3.6 μm in diameter.

Specimen Nos. 48A/66, 49A/66, 51A/66, 61A/66, 78A/66, Leg. R. U./S. C. S., Loc. Kodaikanal (Between Perumalmalai & Silver Cascade) January, 1966; Nos. 52A/66, 71A/66, Leg. R. U./S. C. S., Loc. Ootacamund, December, 1965.

11. *Aneura pinguis* (L.) Gray (Fig. 19). The oil-bodies vary from 10-15 in each of the epidermal cells. They are simple, globose or slightly oval, 2.3—3.4 μm in diameter, granules obscure with smooth outline.

Specimen Nos. 67A/66, 68A/66, 72A/66, 103A/66, Leg. R. U./S. C. S., Loc. Bandishola : On way to Kotagiri from Coonoor, January, 1966; Nos. 50A/66, 56A/66, 57A/66, 70A/66, Leg. R. U./S. C. S., Loc. Kodaikanal, January, 1966 ; Nos. 41A/66, Leg. B. S. T., Loc. Darjeeling, October, 1966.

The structure of the oil-bodies in the above two species of *Aneura* is more or less similar. However, they tend to differ in number.

12. *Riccardia levieri* Schiffn. (Figs. 23-26). Usually 1-2 oil-bodies are present in each cell throughout the plant. They are oval-elliptical (10.67 \times 21.34—16 \times 37.4 μm) or globose (10.67—21.34 μm in diameter), sometimes lobed also, grape-cluster like, some with uniform granules while others with peripheral granules larger, having irregular outline.

Specimen No. 1008 R/SH, Leg. D. K. S., Loc. Pologround Road, Shillong (Meghalaya), October 16, 1975 ; No. 1010 R/SH, Leg. D. K. S., Loc. Elephant Falls, Shillong (Meghalaya), October 14, 1975.

The above species presents considerable diversity in form in its oil-bodies as in some cells these are with larger granules while in others they have smaller granules. In some other cells both types of oil-bodies are found to be present.

13. *Riccardia multifida* (L.) Gray (Figs. 27—32). Oil-bodies are usually 2-3 (4) per cell throughout the upper surface of the plant except at the margins where only one oil-body is present in each cell. These are spherical (10.7—13.4 μm in diameter)—elliptical (10.67 \times 13.4—17.24 \times 29.4 μm), grape-cluster like with smaller granules and irregular outline.

Specimen Nos. 34R/66, 35R/66, 36R/66, Leg. B. S. T., Loc. Darjeeling, October, 1966 ; No. 1011 R/SH, Leg. D. K. S., Loc. Pologround Road, Shillong (Meghalaya), October 16, 1975 ; No. 1038 R/EH, Leg. D. K. S., Loc. Teesta Valley Road from Ghoom, Darjeeling, April 25, 1976.

The species presents the maximum variation as regards the number of oil-bodies per cell.

14. *Riccardia santapau* Udar *et* Srivastava (Figs. 20-22). The number of oil-bodies in the present taxon varies from 1-3 per cell. They are rounded and granular ranging from 10.65 μm —14.4 μm in diameter. Usually the number of oil-bodies being recorded is 3 in most of the cells. Rarely the cells have also been found having 1 or 2 oil-bodies. They are easily seen in the marginal cells of the thallus.

Specimen Nos. 105 R/68, 105Ra/68, 105Rb/68, Leg. P. C. S., Loc. Tamia, Distt. Chhindwara (M. P.), April, 1968.

15. *Riccardia sikkimensis* (St.) Pande *et* Srivastava (Fig. 33). Usually only one oil-body is present in each cell. They are spherical (7.4—11 μm in diameter) or sometimes elliptical also (9.6 \times 18.09 μm), granular with very small granules and irregular outline.

Specimen No. 31R/66, Leg. B. S. T., Loc. Darjeeling, October, 1966.

The oil-bodies in the different species of *Riccardia* presented here differ from each other in their shape, size and number. Sometimes it is the number of the oil-bodies which makes the distinctive feature while in others it may be the size or the shape of the oil-bodies or the nature of granules.

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REFERENCES

- HATTORI, S. & INOUE, H. (1951). On a new liverwort of Fam. Treubiaceae. *J. Hattori bot. Lab.* **11** : 99-102.
- HATTORI, S., SHARP, A. J., MIZUTANI, M. & IWATSUKI, Z. (1966). The systematic position and distribution of *Treubia nana*. *The Bryologist* **69** : 488-492.
- INOUE, H. & HATTORI, S. (1955). On the oil-bodies of *Treubia nana*. *J. Hattori bot. Lab.* **12** : 116.
- KASHYAP, S. R. (1928). A new species of *Pelatophyllum*, *P. indicum* Kash. *J. Indian bot. Soc.* **7** : 14.
- KASHYAP, S. R. & PANDE, S. K. (1922). A contribution to the life history of *Aneura indica* St. *J. Indian bot. Soc.* **3** : 79-89.
- MEHRA, P. N. (1938). A study of the chromosome number in some Indian members of the family Codoniaceae. *Proc. Indian Acad. Sci.* **8B** : 1-7.
- MEHRA, P. N. & KHANNA, A. L. (1950). Embryology of the *Sewardiella tuberifera* Kash. *Bot. Gaz.* **112** : 31-42.

- PANDE, S. K., MAHABALE, T. S., RAJE, Y. B. & SRIVASTAVA, K. P. (1954). Studies in Indian Metzgeriaceae I. *Fossombronia himalayensis* Kash. *Phytomorphology* **4** : 365-368.
- PANDE, S. K. & SRIVASTAVA, K. P. (1953). The genus *Pallavicinia* Gray in India I. *Pallavicinia canarus* St. *J. Indian bot. Soc.* **32** : 179-185.
- PANDE, S. K. & SRIVASTAVA, K. P. (1958). The genus *Riccardia* Gray in India I. *Riccardia levieri* Schiffn. *J. Indian bot. Soc.* **37** : 417-421.
- PANDE, S. K., SRIVASTAVA, K. P. & MISRA, R. N. (1955). Studies in Indian Metzgeriaceae II. *Sewardiella tuberifera* Kash. *Phytomorphology* **5** : 57-67.
- PANDE, S. K. & UDAR, R. (1956). Studies in Indian Metzgeriaceae III. *Calycularia crispula* Mitt. *Phytomorphology* **6** : 311-346.
- SCHIFFNER, V., PANDE, S. K. & SRIVASTAVA, K. P. (1959). The genus *Riccardia* Gray in India II. *Riccardia palmatifomis* Schiffn. and *R. decolyana* Schiffn. *J. Indian bot. Soc.* **38** : 538-542.
- SRIVASTAVA, K. P. (1950). Studies in Indian Metzgeriaceae IV. *Riccardia levieri* Schiffn. *J. Indian bot. Soc.* **39** : 537-547.
- SRIVASTAVA, K. P. (1961). Studies in Indian Metzgeriaceae V. *Pallavicinia lyellii* (Hook.) Gray. *Bull. Bot. Soc. Univ. Sagar* **13** : 83-101.
- SRIVASTAVA, K. P. (1972). The genus *Riccardia* Gray in India III. *Riccardia platyclada* Schiffn. *J. Hattori bot. Lab.* **36** : 90-92.
- SRIVASTAVA, S. C. (1969). Studies in Indian Metzgeriaceae. Ph. D. Thesis, Lucknow University, Lucknow (India).
- SRIVASTAVA, S. C. (1976). A new *Metzgeria* from Assam, India. *J. Indian bot. Soc.* **55** : 294-297.
- SRIVASTAVA, S. C. & UDAR, R. (1975). Indian Metzgeriaceae—A monographic study. *New Botanist* **2** : 1-57.
- SRIVASTAVA, S. C. & UDAR, R. (1975a). On the occurrence of *Aneura pellioides* (Horik.) Inoue in India. *Miscell. Bryol. et Lichenol.* **7**(2) : 30-32.
- SRIVASTAVA, S. C. & UDAR, R. (1975b). The genus *Fossombronia* Raddi in India with a note on the Indian taxa of the family Fossombroniaceae. *Nova Hedwigia* **26** : 799-845.
- SRIVASTAVA, S. C. & UDAR, R. (1975c). Sporeling development in *Fossombronia kashyapii* Srivastava & Udar. *Geophytology* **5**(1) : 33-38.
- SRIVASTAVA, S. C. & UDAR, R. (1976). Indian Aneuraceae. A monographic study. *Biol. Mem.* **1** (1 & 2) : 121-154.
- UDAR, R. (1976). *Bryology in India*. Chronica Botanica Co., New Delhi.
- UDAR, R. & NATH, V. (1971). Oil-bodies in South Indian liverworts. *Curr. Sci.* **40** : 638-640.
- UDAR, R. & NATH, V. (1973). Oil-bodies in West Himalayan liverworts. *J. Indian bot. Soc.* **55**(1) : 80-83.
- UDAR, R. & SRIVASTAVA, S. C. (1967). A remarkable *Metzgeria*. *Trans. Br. bryol. Soc.* **5** : 338-340.
- UDAR, R. & SRIVASTAVA, S. C. (1969). *Fossombronia cristula* Aust. A taxon new to Indian Flora. *Curr. Sci.* **38** : 348-350.
- UDAR, R. & SRIVASTAVA, S. C. (1970). A new species of *Metzgeria* from India. *Revue bryol. lichen.* **37** : 361-365.
- UDAR, R. & SRIVASTAVA, S. C. (1972). Sporeling development in the genus *Fossombronia* Raddi 1. *F. cristula* Aust. *J. Palynol.* **8** : 1-7.
- UDAR, R. & SRIVASTAVA, S. C. (1973). On a species of *Riccardia*, *R. santapau* Udar et Srivastava from Chhindwara (Madhya Pradesh), India. *Revue bryol. lichen.* **39** : 155-159.
- UDAR, R. & SRIVASTAVA, S. C. (1974). A new species of *Fossombronia* Raddi, *F. foreau* Udar et Srivastava from Kodaikanal (Palni Hills), South India. *Nova Hedwigia* **47** : 463-468.
- UDAR, R., SRIVASTAVA, S. C. & KUMAR, D. (1970). Oil-bodies in Indian liverworts. *Curr. Sci.* **39** : 458-459.