were prepared as per the procedure of Comar.[5] To examine the radioactivity in the anionic fractions, the Dowex resin column was leached with 100 ml. of 5N HCl and the eluant evaporated *in vacuo* and the activity monitored.

The results on the distribution of activity in the C^{14} and P^{32} treated plants are summarized in Table I. The chromatographic assays followed by autoradiograms revealed that glucose, fructose and another unidentified carbohydrate and glutamic acid, aspartic acid and another ninhydrin-positive compound were labelled through the C^{14} treatment. In the P^{32}-treated plants the activity was retained in the leaf, shoot and root and only the inorganic (anionic) fraction of the root exudate carried the activity. Chemical tests also confirmed the presence of phosphate in the inorganic fraction of the root exudate.

TABLE I

Detection of foliar applied radioactivity in the various plant parts and root exudate fractions of sorghum

(Activity expressed as *c p m* recorded 36 hr. after application; results represent activity in 1 g. of moisture-free samples and average of 20 counts for each sample)

Sample	C^{14}	P^{32}
Leaf ..	1550	630
Shoot ..	396	360
Root ..	612	450
Root exudate fractions :		
Amino-acids ..	648	*
Sugars ..	864	*
Inorganic substances ..	*	720

* No detectable activity.

Though the fate and metabolism of the foliar applied nutrients have been studied using tagged chemicals by several workers, little work has been carried out on the passage of activity into the root exudates. The present studies indicate that C^{14}-glucose and P^{32}-phosphate when applied on the leaves of sorghum plants, are readily absorbed and translocated to other plant parts and also exuded through the roots. Earlier, Rangaswami and Govindarajan[6] reported on the detection of radioactivity in the root exudates of tomato plants treated with C^{14} glucose on the foliage. The incorporation of C^{14} activity in glucose, fructose, glutamic acid, aspartic acid and two other unknown molecules indicates ready utilization of the foliar applied glucose for different biochemical processes by the plant. The results with P^{32} confirm the report of Wittwer and Teubner[7] on the utilization of phosphate in sugar, lipid and protein metabolisms by the plant. The retention of P^{32} in various plant parts and release of the activity through inorganic phosphate have been reported by other workers using different plant species.[8,9]

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University of Agri. Sci., G. RANGASWAMI.
Bangalore-24,
November 13, 1967.

1. Mitchell, J. W., Linder, P. J. and Robinson, M. B., *Plant Physiol.* (Suppl.), 1961, **36**.
2. Rovira, A. D., In : *Ecology of Soil-borne Plant Pathogens*, Eds. K. F. Baker, and W. C. Snyder, Univ. Calif. Press, Berkeley, U.S.A., 1965.
3. Balasubramanian, A. and Rangaswami, G., *Mysore J. Agric. Sci.*, 1967, **1**, 233.
4. — and —, *Plant and Soil* (sent for publication).
5. Comar, C. L., *Radioisotopes in Biology and Agriculture*, McGraw-Hill Book Co., New York, 1955.
6. Rangaswami, G. and Govindarajan, T. S., *Curr. Sci.*, 1964, **33**, 138.
7. Wittwer, S. H. and Teubner, F. G., *Plant Physiol.*, 1959, **10**, 13.
8. Oliver, W. F., *Sci. Agri.*, 1952, **32**, 427.
9. Nikolaev, G. V., *Fiziol. Rast.*, 1963, **10**, 441.

A NEW RECORD OF *PETALOPHYLLUM INDICUM* KASH. FROM WESTERN GHATS

FIVE species of *Petalophyllum* are known in literature and their distribution is as follows : *P. indicum* Kash., Northern India, Pakistan, *P. ralfsii* (Wilson) G., Britain, Hibernia, *P. lamellatum* Lindb., Britain (Stephani, considered it as synonym of *P. ralfsii*),[1] *P. presiqsi*, Australia, and *P. bolivianum* Schiffn., Bolivia.

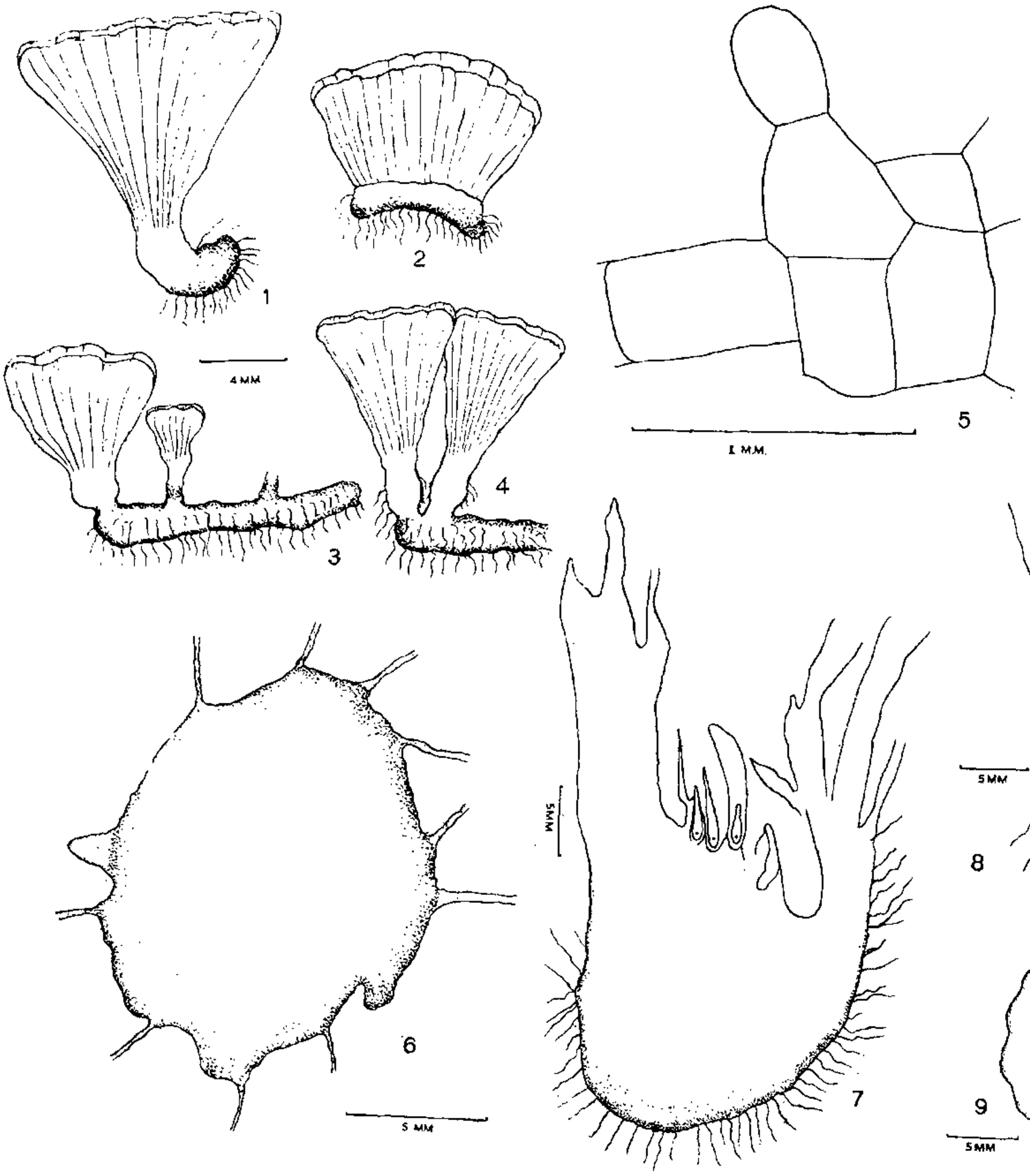
Till the present collection was made, *P. indicum* was only reported from the banks of the Ravi at Lahore and the Beas at Beas, in the Punjab. Kachroo (in lit.) has suggested that the species may be also present higher up in the catchment areas of these two rivers, basing his experience on *Riccia frostii* (*R. sanguinea*) which has followed similar river dispersal in the Kashmir valley and the Assam plains.

Purandhar, a hill 40 km south-east of Poona, *ca* 1387 m. high in the Western Ghats, has a deciduous type of vegetation. *Petalophyllum indicum* grows here luxuriantly in association with grasses, mosses and *Anthoceros*. The other common genera of hepaticæ

are *Asterella*, *Plagiochasma*, *Targionia*, *Cyathodium*, *Riccia*, *Fossombronia*, *Phæoceros*, etc.

The average rainfall is 139–150 cm. (June to September) and the relative humidity is 90% during the monsoons and about 70% in the dry months. The annual maximum temperature is 28° C and the minimum 16° C.

The thalli of *Petalophyllum indicum* growing at Purandhar are bright green, in dense cluster, or patches, rarely singly on damp shady places, on slopes. The plants appear in the first week of June. They are diœcious; male thalli (5–8 mm. long and 4–6 mm. broad) are smaller than the female ones (8–14 mm. long and 6–12 mm. broad). The plants (Figs. 1, 3) have on the posterior side a solid subterranean cylindrical stalk growing horizontally or obliquely. The stalk is generally 2–5 mm. long and 1-2 mm. in diameter, may be branched (Fig. 3); branches negatively geotropic, usually arises in one plane almost at right angle to the axis of stalk. Occasionally some of these branches may become thickened and bear wings (Fig. 3). The apical region of the stalk



FIGS. 1–9. *Petalophyllum indicum*. Fig. 1. Simple funnel-shaped plant with curved cylindrical stalk, Fig. 2. Plant with flattened stalk prominently projected ventrally with ascending wings. Fig. 3. Horizontal underground branched stalk bearing two funnels. Fig. 4. Stalk forked at the apex, each fork bearing a funnel. Fig. 5. Terminal cell of the lamella. Fig. 6. T.S. subterranean stalk showing peripheral mycorrhiza (shaded). Fig. 7. Section of the plant in Fig. 2 in vertical plane showing archegonia on the anterior and basal mycorrhiza (shaded). Fig. 8. V.S. plant in Fig. 3 showing the basal region with mycorrhizæ (shaded). Fig. 9. T.S. stalk of plant in Fig. 1, just below the wing.

turns upward, becomes thick rounded, cylindrical or gradually flattens and bears lateral wings. Sometimes the stalk forks at the apex and each fork bears ascending fan-like wings (Fig. 4). Rhizoids are smooth-walled, present all round the stalk, though more numerous on basal region. The wings are found mostly ascending from the thickened region; consequently, plants often appear as erect, radial and funnel-shaped (Fig. 1). In very few cases wings prostrate. The margin of the wings is undulate. The wings bear on its dorsal surface numerous erect lamellæ. The orientation of lamellæ is similar to that described by Mehra and Vashisht.[2]

The presence of subterranean stalk suggests that the plants have developed from tubers—the perennating organs.

The cylindrical stalk in cross-section is 20–25 cells across, of uniform parenchymatous cells; those in the peripheral region bear mycorrhiza as in *Petalophyllum ralfsii*.[1] In the underground stalk, the fungal hyphæ attack many layers of peripheral cells however, the central region is devoid of any hyphæ (Fig. 6). The thickened region below the wings have micorrhizæ in one or two outermost layers of the periphery (Fig. 9). The hyphæ are not found in the anterior portion and the wings. The wings are many-layered (6–8) at base and one-celled at margin. The wing cells are polygonal but slightly elongated near the midrib, average size being 31–47 $\mu \times$ 51–57 μ. Lemellæ one-celled thick, 10–18 cells high with undulating free margin. The terminal cell of the lamella oval-papilliform (Fig. 5) measuring 28–30 $\mu \times$ 25–42 μ. Antheridia scattered on anterior side. Archegonia in groups of 3–8 on midrib surrounded by involucral bracts. Sporophytes not observed.

The Purandhar form comes very near *P. indicum* but shows some ecological differences from the Beas form (Table I) as described by Mehra and Vashisht.[2] A comparative study of the various species of the genus *Petalophyllum* is in progress with a view to define properly the taxonomic limits of the various species; and also comment on Schuster's[3] proposal to separate *Petalophyllum* from *Fossombronia* into a new family Petalophyllaceæ.

It is of interest that the species has not been collected from Pachmari by Pande who visited the place several times. The present record extends southwards the range of this species in India.

TABLE I

	Purandhar form	Beas form
1.	Plants large (upto 1·4 cm.)	Plants smaller (upto 1cm.)
2.	Stalk prominent (1–2 mm. diameter)	Not prominent
3.	Wings normally erect	Wings usually prostrate
4.	Grows in clusters or patches, very rarely singly	Normally singly, rarely in patches
5.	Perennating by tuberous stalk	Also by tubers.
6.	Stalk without internal differentiation but mycorrhiza confined to peripheral cells as in *P. ralfsii* (Cavers, 1911)	Stalk without internal differentiation but all cells may be mycorrhizal
7.	Apical cell of lamellæ oval-papilliform	Shape not described

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Udaipur (India), *July* 11, 1967.

1. Cavers, F., *New Phytol.* (Reprint), **1911**, **4**, 1.
2. Mehra, P. N. and Veshisht, B. K., *Bryologist*, **1950**, **53**, 89.
3. Schuster, . M., *Amer. Midl. Nat.*, **1953**, **49** (2), 575.
4. Stephani, F., *Species Hepaticarum* (1900), **1924**, **1**, 6, Geneva.

PRECOCIOUS GERMINATION OF SPORES IN *HAPLOCLADIUM SUBULACEUM* (MITT.) BROTH. AND *FORSTROEMIA INCLUSA* CARD. AND DIX.

PRECOCIOUS germination of spores is known to occur in a few mosses, such as, *Cleistostoma ambigua*, *Cryphæa macrospora*, *Synodontia cochlearifolia* and *Cinclidotus fontinaloides*. While studying Kumaon mosses, the authors came across two more instances, one in *Haplocladium subulaceum* and the other in *Forstrœmia inclusa*. Spores in these mosses were found germinating within their open capsules on green plants. In *F. inclusa*, the protonemal filaments remained short and unbranched (Fig. 1, A), but in *H. subulaceum* these were short to quite long, uniseriate, branched or unbranched. Branches in the latter could arise anywhere and every filament ended in a short elliptical cell containing more prominent and larger number of chloroplast bodies than in the rest of the cells (Fig. 1, B). Fate of these cells has not yet been ascertained.