

PTYCHANTHUS NEES AND TUZIBEANTHUS HATT. IN INDIA

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Abstract

The details of the two closely related Indian taxa: *Ptychanthus* Nees and *Tuzibeanthus* Hatt., both represented by one species each have been provided. *P. striatus* (Lehm. et Lindenb.) Nees occurs throughout the country in montane areas but *T. chinensis* (St.) Mizut. has a restricted distribution in the western Himalayas.

Introduction

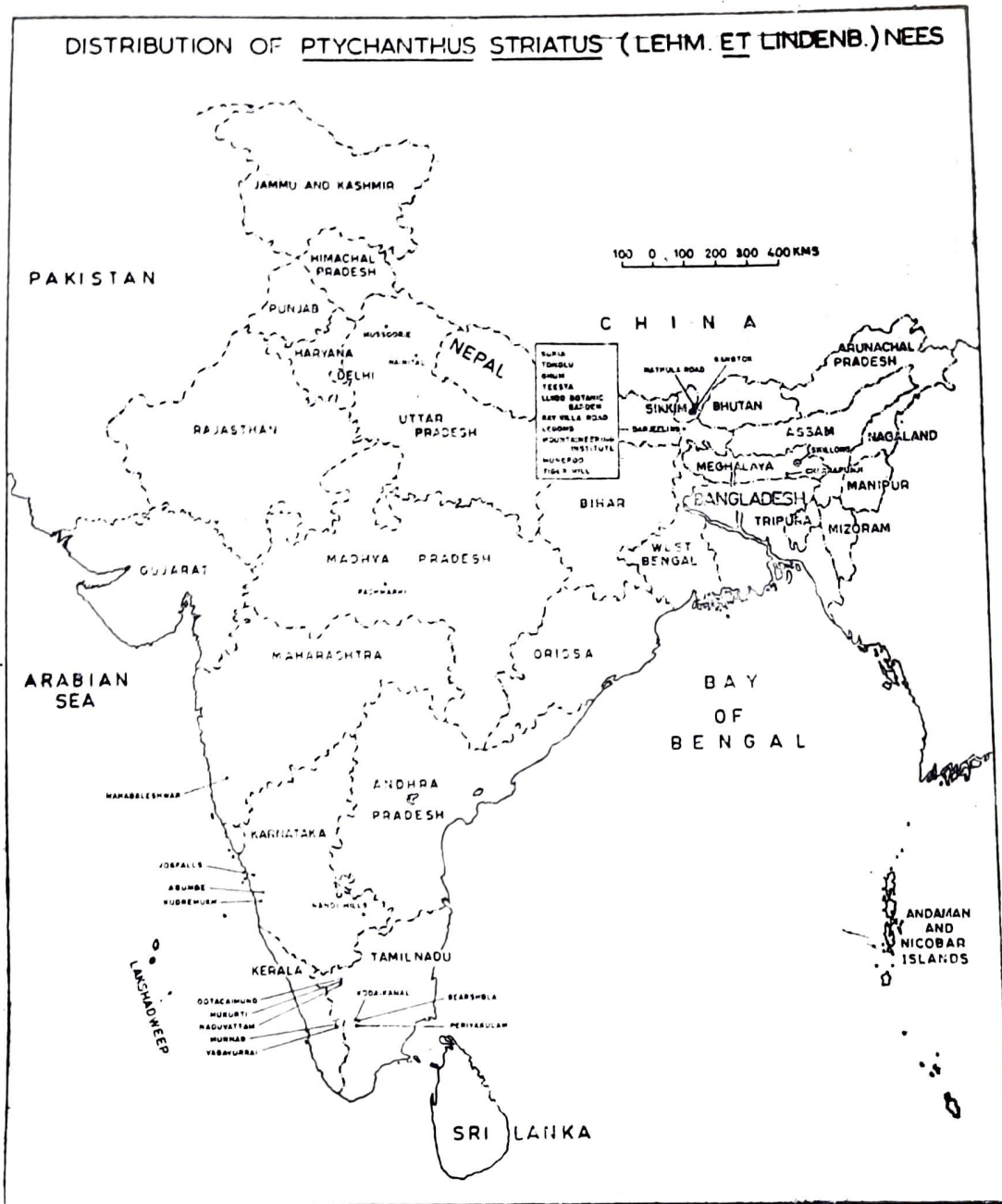
Ptychanthus Nees and *Tuzibeanthus* Hatt. are allied taxa of the subfamily Ptychanthoideae and each represented by single species in India. *Ptychanthus* is monoecious and *Tuzibeanthus* is dioecious. The leaves, underleaves, female bracts and bracteoles are dentate at margin in the former and entire in the latter. *Ptychanthus* is represented by two species in Asia of which *P. striatus* (Lehm. et Lindenb.) Nees, is a palaeotropic species, ranging from central Africa to the western Pacific and is also common in adjacent warm temperate regions of South Africa, Himalayas, Japan and Australasia (Gradstein & Inoue, 1980). *P. sulcatus* (Nees) Nees is known from Borneo, Java and Sumatra (Verdoorn, 1934). The former is pinnately branched by *Frullania*-type of branching, while the latter is irregularly branched by *Lejeunea*-type of branching (see Mizutani, 1969). In India there is only one species of *Ptychanthus*, *P. striatus*, which grows as the most dominant species in all the bryogeographic regions of the country (see Map 1). In contrast to this, *Tuzibeanthus* is monotypic with *T. chinensis* (St.) Mizut. known from China, Japan, Burma and India where it is restricted to western Himalayas. Both *Ptychanthus* and *Tuzibeanthus* have never been adequately known in Indian bryology and they have been described here for their details. The male plants of the latter from Naini Tal were investigated earlier (Udar & Awasthi, 1983). This population lacked female plants but natural regeneration from leaf surface and branching of the axis by *Lejeunea*-type branches, in addition to normal pinnate *Frullania*-type branches, were observed for the first time. The female plants, growing at Simla (western Himalayas) and obtained through the courtesy of Professor S. S. Kumar, have been described in the present paper. Both *Frullania*-type and *Lejeunea*-type branches have been observed in female plants as well.

Taxonomic description

Ptychanthus striatus (Lehm. et Lindenb.) Nees.

Naturg. Eur. Leberm. 3: 212 (1938). *Jungermannia striatus* Lehm. et Lindenb. in, Lehm. pugillus 4 : 16 (1832). *Ptychanthus argutus* St. Spec. Hepat. 4 : 742 (1912), *P. effusus* St. Spec. Hepat. 4 : 746 (1912), *P. perrotteti* St. Spec. Hepat. 4 : 750 (1912), *P. pyriformis* St. Spec. Hepat. 4 : 751 (1912), *Ptycholejeunea pyriformis* St. Hedwigia 35: 122 (1895),

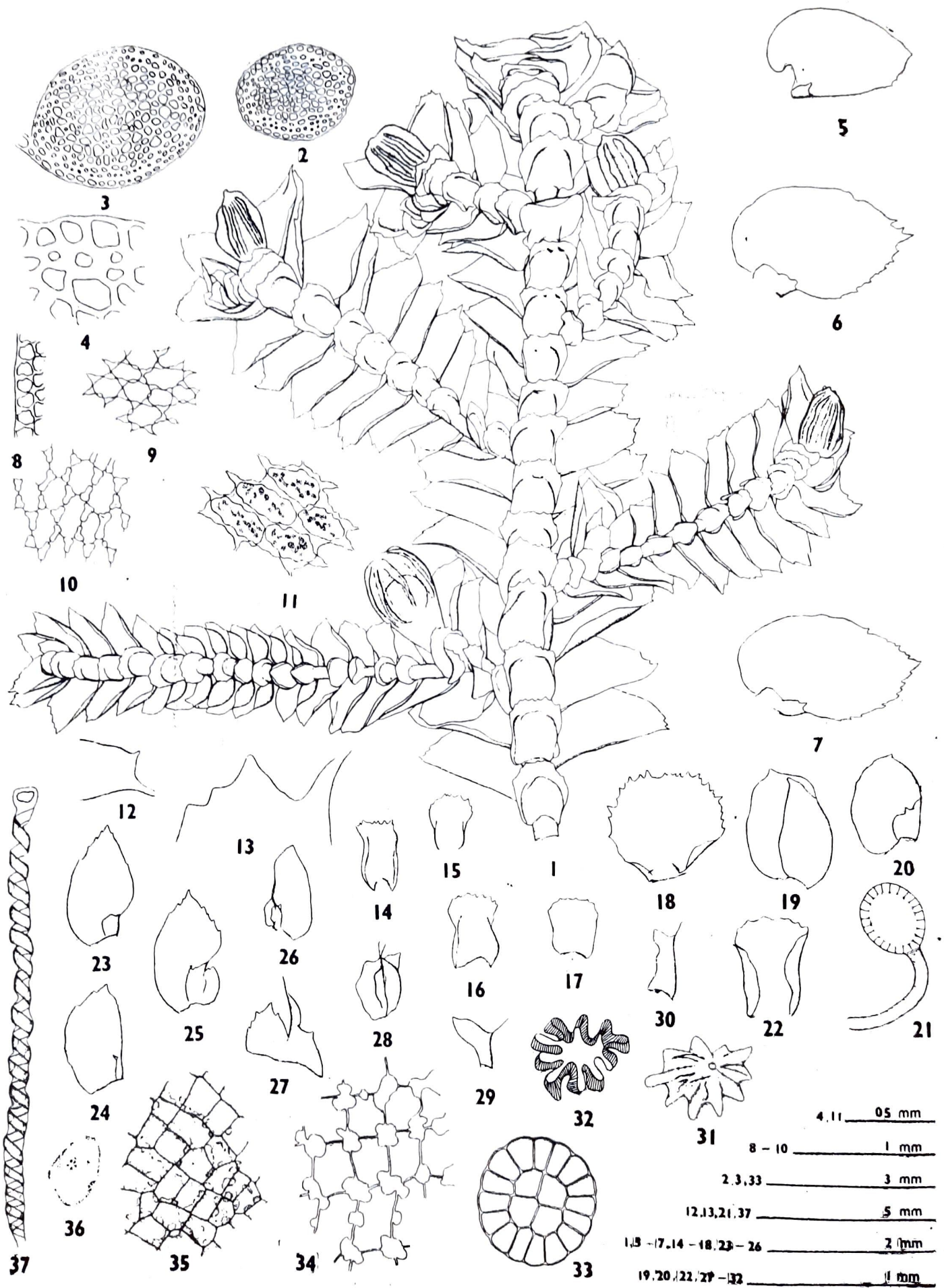
Geophytology, 17(1) : 12-20, 1987.



Map 1

Ptychanthus striatus var. *retusus* (R., Bl., N.) Verd. Ann. Bryol. (Suppl.) 4 : 121 (1934), *Brachiolejeunea andamana* St. Spec. Hepat. 5: 130 (1912). (Figures 1-42).

Monoecious. Plants green or brown in colour, pinnately branched by *Frullania* type of branching. Stem in cross-section (0.3-0.4 mm in diameter) with 35-55 cortical and several larger medullary cells, both cortical and medullary cells thick-walled with prominent trigones, peripheral cells deep brown. Leaves imbricated or distantly arranged, widely spreading, lobe ovate or oblong, 1.14-2.16 mm long, 0.80-1.30 mm wide, with dentate margin, antical margin convex, postical margin arched or almost straight, often involuted, apex acute or subacute, cells thick-walled, with prominent radiate trigones and intermediate nodular thickenings, basal cells $28-48 \times 20-28 \mu\text{m}$, median cells $24-40 \times 20-28 \mu\text{m}$, marginal cells $12-20 \times 8-20 \mu\text{m}$, oil-bodies segmented, oval or elliptical, $4-9 \times$



Text-fig. 1-37

4, 11	0.5 mm
8 - 10	1 mm
2, 3, 33	3 mm
12, 13, 21, 37	5 mm
1, 3 - 7, 14 - 18, 23 - 26	2 mm
19, 20, 22, 27 - 32	1 mm

3-5 μm , spherical (2-4 μm in diameter), 3-15 in each cell at base, 3-10 at middle, 2-5 at margin; lobule ovate, often ca 1/5 of the lobe length, 0.16-0.32 mm long, 0.09-0.29 mm wide, with 1-2(-3) teeth on its free margin. Underleaves imbricated distantly arranged, longer than wide, wider than long or as long as wide, 1.04-1.26 mm long, 1.04-1.23 mm wide, margin dentate, apex truncate or rounded, rhizoids rare. Male inflorescence terminal or intercalary; bracts hypostatic, strongly saccate, diandrous, lobe ovate, 0.48-0.64 mm long, 0.32-0.43 mm wide, with entire-wavy margin, apiculate or subacute apex; lobule 0.43-0.48 mm long, 0.16-0.27 mm wide, margin entire-wavy, apex acute or apiculate; antheridium with rounded head and uniseriate stalk; bracteole 0.32-0.40 mm long, 0.27-0.32 mm wide, with dentate margin and rounded apex. Female inflorescence terminal on primary or secondary lateral branches, with subfloral innovation, bract-lobe ovate-oblong, equal or slightly smaller than leaves, 1.12-1.44 mm long, 0.40-0.57 mm wide, margin dentate, antical margin convex, postical margin straight-convex, apex acute, apiculate or subacute; lobule rectangular with 1-2 teeth, entirely adnate with the lobe, sometimes with 1-2 appendages on keel, appendages wavy or dentate; bracteole similar but smaller than underleaves, longer than wide, ca 2/3 of the perianth length, 0.69-1.00 mm long, 0.50-0.72 mm wide, with dentate margin, apex truncate-rounded; perianth obovate-oblong, 1.52-1.60 mm long, 0.54-0.88 mm wide, pluriplicate, plicae smooth; seta with 16 peripheral and 4 central cells; capsule-wall bistratose, cells of the outer layer with nodular thickenings usually restricted at the corners, sometimes intermediate nodular thickenings also present, cells of the inner layer with fenestrate thickenings on inner tangential wall and sheet-like to nodular thickenings on radial walls; spores variously shaped, 40-60 \times 28-44 μm , minutely papillose with 4-5 'rosettes' of spines; elaters 0.72-1.25 mm long, ca 0.06 mm wide with one end wide and with a single spiral thickening band.

Habitat—On bark of tree, on shrubs or on fallen logs in pure growth or in association of other liverworts.

Type Locality—India (Himalayas).

Range—Asia: India (eastern India, western India, central India, South India and Andaman Is.) Amboina, Burma, Formosa, Japan, Madagascar, Malaya, Ryukyu, Tropical Africa.

Specimens examined—LWU No. 229C/69 Loc.: Tiger Hill, Darjeeling, alt. 2500 m, Dt.: December 27, 1969, Leg.: R. Udar and Party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi, LWU 245 D/69, 247 B/69, Loc.: Ray Villa Road, Darjeeling, alt. 2000 m, Dt.: December 31, 1969, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi, LWU 190 E/70, Loc.: Tonglu, Darjeeling, alt. 3500 m, Dt.: January 4, 1970, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi, LWU 209 A/70, 209 B/70, Loc.: Between Sukya and Tonglu, Darjeeling, alt. ca 3500 m, Dt.: January 4,

Figures 1-37. *Ptychanthus striatus* (Lehm. et Lindenb.) Nees. 1. Portion of the plant showing male and female inflorescences; 2, 3. Cross-sections of stem; 4. Portion of cross-section of the stem; 5-7 Leaves; 8. Marginal cells of the leaf-lobe; 9. Median cells of the leaf-lobe; 10. Basal cells of the leaf-lobe; 11. Median cells of the leaf-lobe with oil-bodies; 12, 13. Portions of the leaf-lobule; 14-18. Underleaves; 19-20. Male bracts; 21. Antheridium; 22. Male bracteole; 23-26. Female bracts; 27-28. Lobules of female bracts showing appendages at keel; 29, 30. Lobules of female bract lacking in appendages; 31. Apex of the perianth; 32. Cross-section of the perianth; 33. Cross-section of the seta; 34. Outer layer of the capsule-wall; 35. Inner layer of the capsule-wall; 36. Spore; 37. Elater.

1970, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 218 B/70, Loc.: Sukya, Darjeeling, alt. 3000 m, Dt.: January 4, 1970, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi, LWU 88/72, 89/72, Loc.: Lebung, Darjeeling, alt. 2000 m, Dt.: December 25, 1972, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 100/72, Loc.: Tiger Hill, Darjeeling, alt. 2500 m, Dt.: December 30, 1972, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi, LWU 150/75, 155/75, Loc.: Shillong, alt. 1600 m, Dt.: October 10, 1975, Leg.: D. K. Singh, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 3001/77, Loc.: Gangtok, alt. 1900 m, Dt.: December, 26, 1977, Leg.: S. C. Srivastava, U. S. Awasthi and A. Kumar, Det.: R. Udar, S. C. Srivastava, and U. S. Awasthi. LWU 3091/77, 3129/77, 3130/77, 3131/77, Loc.: On way to Nathula pass, Sikkim, alt. 2000 m. Dt.: December 28, 1977 Leg.: S. C. Srivastava, U. S. Awasthi and A. Kumar, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 3302/77, 3311/77, 3318/77, 3320/71, 3321/77, Loc.: Llyod Botanic Garden, Darjeeling, alt. ca 1000 m, Dt.: December 31, 1977, Leg.: S. C. Srivastava, U. S. Awasthi and A. Kumar, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi, LWU 3204/77, 3205/77, 3206/77, 3207/77, 3208/77, 3261/77, 3262/77, 3263/77, 3264/77, 3265/77, 3266/77, 3270/77, 3274/77, 3275/77, 3276/77, 3277/7, Loc.: Mountaineering Institute, Darjeeling, alt. 2000 m, Dt.: December 31, 1977, Leg.: S. C. Srivastava, U. S. Awasthi and A. Kumar, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 3370/78, 3395 B/78, 3477 A/78, 3477 C/78, 3478/78, Loc. Mungpoo; Darjeeling, alt. 2000 m, Leg.: S. C. Srivastava, U. S. Awasthi and A. Kumar, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 3400/78, 3425/78, 3425A/78, 3503/78, 3503A/78, 3503B/78, Loc.: Tiger Hill, Darjeeling alt. 2500 m, Dt.: January 2, 1978, Leg.: S. C. Srivastava, U. S. Awasthi and A. Kumar, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi, LWU 3755/77, Loc.: Cherapunji, alt. 1358 m, Dt.: November 8, 1979, Leg.: A. Kumar and U. S. Awasthi, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU No. 1100/43, Loc.: Mussoorie-Jamnotri, alt. 2000 m, Dt.: 1943, Leg.: S. K. Pande, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 5352/65 Loc.: Naini Tal, alt. 2000 m, Dt.: 1965, Leg.: R. Udar, Det.: R. Udar, S. C. Srivastava, and U. S. Awasthi. LWU 5353/81, Loc.: Naini Tal, alt. 2100 m, Dt.: March 30, 1981, Leg.: S. D. Tewari, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 1000/79, Loc.: Pachmarhi, alt. 1400 m, Dt.: October-November, 1979, Leg.: D. Kumar, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 12/67, 13/67, Loc.: Jogfall, alt. 1500 m, Dt.: March, 1967, Leg. R. Udar and S. C. Srivastava, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi, LWU 4/67, 17/67, 26/67, Loc.: Mahabaleshwar, alt. 1323 m, Dt.: March 3, 1967, Leg.: R. Udar and S. C. Srivastava, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 5773/82, 5776/82, 5781/82, Loc.: Munnar, alt. ca 2000 mt. Dt.: September 23, 1982, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 6049/82, 6062/82, Loc.: Vagavurrai, alt. 1900 m, Dt.: September 25, 1982, Leg. R. Udar, S. C. Srivastava and party, Det.: R. Udar and U. S. Awasthi. LWU 6236/82, 6237/82, 6239/82, Loc.: Agumbe, Shimoga, alt. 2000 m, Dt.: September 28, 1982, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 7104/83, Loc.: Mukurti, Ootacamund, alt. 2000 m, Dt. September 27, 1983, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 7515/83, Loc.: Lake Side, Kodai Kanal, alt. 2000 m, Dt.: September 30, 1983, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 7592/83, 7623/83, 7639/83, Loc.: Periakulam, Kodai Kanal, alt. 2000 m, Dt.: October 1, 1983, Leg.: R. Udar and party, Det.: R. Udar and U. S. Awasthi. LWU 7668/83, Loc.: Bear Shola,

Kodai Kanal, Dt.: October, 1983, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 7735/83, Loc.: Kodai Kanal, alt. 2000 m, Dt.: October, 1983, Leg.: R. Udar and party, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU 7929/83, 7933/83, 7939/83, Loc.: Nandi Hills, Bangalore, alt. ca. 100 m. Dt.: June 5, 1983, Leg. U. S. Awasthi and A. Asthana, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi.

Ptychanthus striatus grows under varied ecological conditions in different parts of the country which influences considerable plasticity in its morphology. The maximum differentiation, in relation to frequency of individuals and their variability, is found in eastern India. For example, the living specimens from Llyol Botanic Garden, Nathula Pass, Pachmarhi and Tiger Hill areas are green while those from Gangtok and Shillong are brown. The degree of exposure to sunlight or the extent of maturity of a population may possibly result in differential pigmentation. The stem, in plants from Gangtok, is most robust (Fig. 3) and less so in plants from Llyol Botanic Garden (Fig. 2) and Nathula pass and those from other localities show intermediate condition.

In majority of the plants the leaves are imbricated (Figs. 38-40) but in those from Nathula pass they tend to be distantly arranged (Fig. 41). The extent of development of dentitions at leaf margin is variable. These are clearly developed in plants from most of the localities (Figs. 1,6,7) but they are much less developed in those from Naini Tal (Fig. 5). The number of teeth of leaf-lobule normally ranges from 1-2 (Fig. 12) but it may be upto 3 in plants from Gangtok and Nathula pass (Fig. 13). The leaf cells show variation with regard to the development of trigones. The underleaves in most of the populations are variously folded and are usually longer than wide (Figs. 14-17) but in those from Gangtok are almost flat and as long as wide or wider than long and also comparatively more dentate (Fig. 18).

The female bracts normally do not show an appendage on keel (Fig. 23) but it is found in plants from Nathula pass and Naini Tal. The appendage may be one or two and also it may be entire or dentate (Figs. 25-28).

On the basis of external morphology three morphoforms are recognisable in this taxon: 1. The plants of Gangtok are brown, have robust stem, with leaves and underleaves highly dentate, large, flat and imbricate (Fig. 38). 2. The plants from neighbourhood of Nathula pass are green, have less robust stem, with leaves and underleaves smaller, variously folded, less dentate and distant (Fig. 41). 3. The plants from Shillong fall in between the above two morphoforms (Fig. 40). The plants from other localities basically resemble one or the other of these morphoforms.

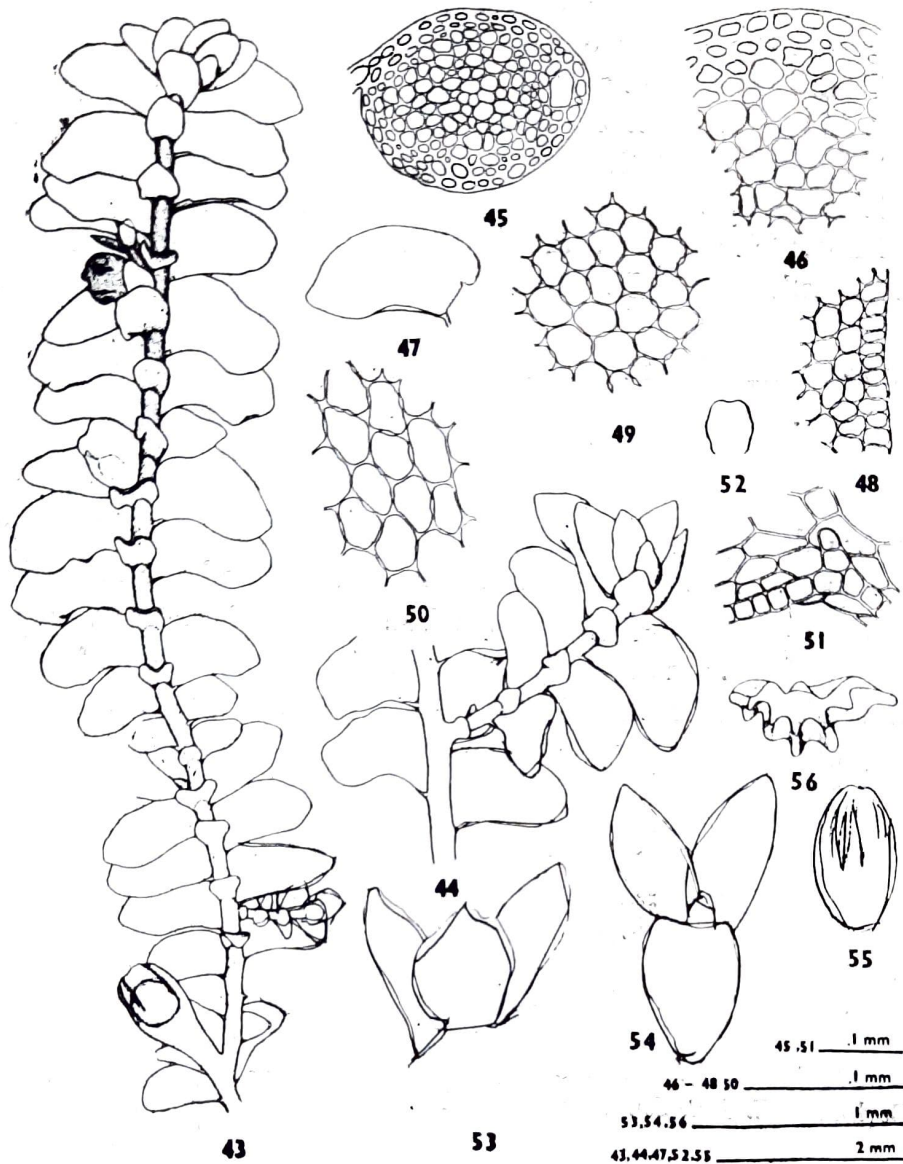
Tuzibeanthus chinensis (St.) Mizut.

J. Hattori bot. Lab. 24: 151 (1961). *Ptychanthus chinensis* St. Spec. Hepat. 4: 744 (1912). (Figures 43-56)

Dioecious. Plants green in colour, pinnately branched by *Lejeunea*-type of branching. Stem in cross-section (0.19-0.23×0.24-0.28 mm) with 34-36 cortical cells and several comparatively larger medullary cells, cortical cells and peripheral medullary cells thick-walled. Leaves imbricated widely spreading, lobe ovate or oblong, 1.76-1.95 mm long, 0.99-1.02 mm wide, with entire margin, antical margin convex, postical margin almost straight, apex obtuse, cells thick-walled with distinct trigones and intermediate nodular thickenings, basal cells 32-56×20-24 μ m, median cells 28-40×16-28 μ m, marginal cells



Figures 38-42. Photomicrographs of *Ptychanthus striatus*. 38. LWU No. 3001/77, $\times 1.5$; 39. LWU No. 1000/77, $\times 2$; 40. LWU No. 150/75, $\times 2$; 41. LWU No. 3091/77, $\times 2$; 42. LWU No. 7929/84, $\times 16$ (showing dehiscent sporophyte).



Figures 43-56. *Tuzibeanthus chinensis*. 43. Portion of the plant showing female inflorescences and a *Lejeunea*-type branch; 44. Portion of the plant showing *Frullania* type branch; 45. Cross-section of the stem; 46. Portion of cross-section of the stem; 47. Leaf. 48. Marginal cells of the leaf-lobe. 49. Median cells of the leaf-lobe; 50. Basal cells of the leaf-lobe; 51. Leaf-lobule; 52. Underleaf; 53,54. Female inflorescences showing enveloping perianth; 55. Perianth; 56. Cross-section of the perianth.

8-12×8-12 μ m, lobule small 1/12 of the lobe length, 0.08-0.09 mm long, 0.04 mm wide, without or with inconspicuous tooth. Male inflorescence on lateral branches, terminal or intercalary, bract-lobe ovate, 0.64-0.67 mm long, 0.40-0.48 mm wide, with subacute or obtuse apex and entire margin, lobule 0.40-0.57 mm long, 0.19-0.26 mm wide, with subacute apex and entire margin; bracteole 0.26-0.32 mm long, 0.27-0.35 mm wide, obovate-orbicular, raised from the axis and often recurved, margin entire. Female inflorescence with one subfloral innovation, bract and bracteole 1/2 of the perianth length, smaller than the leaf and underleaf respectively, bract-lobe oblong 0.80-0.85 mm long, 0.35-0.37 mm wide, margin entire, both postical and antical margins convex, apex obtuse, lobule small, ca 0.25 mm long, 0.16 mm wide; bracteole ovate or oblong, 0.68-0.77 mm

long, 0.45-0.48 mm wide, margin entire, apex obtuse, sometimes slightly notched; perianth oblong, 1.45-1.50 mm long, 0.50-0.75 mm wide, pluriplicate, rostrum small.

Habitat—On bark of tree or on wet rock.

Type locality—Mt. Kuan-tou-san, Schensi, China.

Range—India (Almora, Mussoorie, Naini Tal) China, Burma and Japan.

Specimen examined—LWU 7742, Loc.: Simla, alt. ca 2000 m Dt.: September 1982, Leg.: S. S. Kumar, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi. LWU No. 6672/82, 6684/82, Loc.: Dhobi Ghat, Nainital, alt. 1800 m, Dt.: November 8, 1982, Leg.: R. Udar, U. S. Awasthi and S. D. Tewari, Det.: R. Udar, S. C. Srivastava and U. S. Awasthi.

As compared to *Ptychanthus*, the genus *Tuzibeanthus* is less variable in its morphological and anatomical details.

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References

- MIZUTANI, M. (1969). Lejeuneaceae subfamily Ptyanθοideae from Sabah (north Borneo) *J. Hattori Bot. Lab.*, 32 : 129-139.
- UDAR, R. & U. S. AWASTHI (1983). Genus *Tuzibeanthus* Hatt. in India. *Bull. Bot. Surv. India*. (In press).
- VERDOORN, FR. (1934). Studien udber Asiatische Jubulae (De Frullaoniaceis XV) *Ann. Bryol. (Suppl.)*, 4(1) : 1-231.
- GRADSTEIN S. R. & INOUE, H. (1980). Studies on Lejeuneaceae subfam. Ptychanθοideae V. A review of the species from Ceylon. *Bull. Nat. Sci. Mus.*, 6(1) : 23-32.