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SHORT COMMUNICATION

RE-COLLECTION, EXTENDED DISTRIBUTION, AND AMPLIFIED DESCRIPTION OF *VACCINIUM PAUCICRENATUM* SLEUMER (ERICACEAE) FROM THE ARUNACHAL HIMALAYA IN INDIA

Subhasis Panda

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Re-collection, extended distribution, and amplified description of *Vaccinium paucicrenatum* Sleumer (Ericaceae) from the Arunachal Himalaya in India

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Abstract: *Vaccinium paucicrenatum* Sleumer has been re-collected from three different districts of Arunachal Pradesh approximately after 91 years subsequent to I.H. Burkill's collection (no. 36976, K) from Ripsing of outer Abor Hills (presently a part of East and West Siang districts nearby Pashighat area) of Arunachal Pradesh on 8 March, 1912. Due to poor description by the earlier workers, the present paper provides amplified description based on field and herbarium data including leaf anatomy (leaf stomata and vein-islets), detailed extended distribution, live and herbarium images and distribution map for easy identification in the field.

Keywords: Arunachal Pradesh, leaf anatomy, northeastern India.

The genus *Vaccinium* L., consisting of about 140 species (Mabberley 2008), is distributed in tropical Asia, Europe, southeastern Africa, Madagascar, and north and south America. Of these, 28 species are reported to occur in India (Panda & Sanjappa 2014) and are distributed in the eastern Himalaya, northeastern India (except Tripura) and the hill tops of the southern Western Ghats.

vander Kloet et al. (2003), merged Airy Shaw's new species, *Vaccinium setipes*, under *V. paucicrenatum* Sleumer in *Vaccinium* sect. *Aethopus* Airy Shaw based

on average-linkage dendrogram calculated from raw data for 76 *Vaccinium* OTU's (Operational Taxonomic Unit) using the dissimilarity form of Gower's co-efficient for mixed data, principal coordinates analysis, and partitioning analysis (vander Kloet et al. 2003). They re-circumscribed *Vaccinium* sect. *Aethopus* Airy Shaw not only merging *V. setipes* under *V. paucicrenatum* but also included other four species as valid and another four species as synonyms under these valid species transferring from *Vaccinium* sect. *Vitis-idaea* (Moench) W.D.J. Koch. These species are *V. nummularia* Hook.f. & Thomson ex C.B. Clarke (*V. chaetothrix* Sleumer as a synonym), *V. retusum* (Griff.) Hook.f. ex C.B. Clarke (*V. haitangense* Sleumer as a synonym), *V. moupinense* Franch. (*V. dendrocharis* Hand.-Mazz. and *V. merrillianum* Hayata as synonyms), and *V. delavayi* Franch.

Shaw (1948) erected a new species, *V. setipes*, from "Assam population of outer Abor Hills, Ripsing" (Arunachal Pradesh in India) of *V. paucicrenatum* Sleumer based on I.H. Burkill collection (no. 36976, K photo!) which was cited by Sleumer (1941) as *V. paucicrenatum* in the protologue. Shaw (1948) distinguished "Assam"

Editor: Anonymity requested.

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population of *V. paucicrenatum* as *V. setipes* due to the presence of unique hispid-setose pedicels and axillary fascicled raceme which are not found in *V. paucicrenatum* Sleumer. Therefore, Shaw (1948) erected a new species, *V. setipes* under *Vaccinium* sect. *Aethopus* Airy Shaw.

As a result of taxonomic revisionary work on the Indian Ericaceae under “Flora of India Project” of the Botanical Survey of India (1999–2004), as well as other national projects (UGC) on Indian Ericaceae (2009–2011) and a project (2014–16) to supervise national scholar (Rajiv Gandhi Fellow, UGC), extensive field visits were done during these periods at different localities of the eastern Himalaya including a major part of Arunachal Pradesh by the author.

From the visits, specimens from three interesting epiphytic *Vaccinium* populations from three different districts of Arunachal Pradesh were collected on 24 April 2003 from Lohit (S. Panda 30881, CAL), 25 February 2010 from Kurung Kumey (S.S. Dash 31690, ARUN-Arunachal Pradesh Herbarium, Botanical Survey of India at Itanagar), and 21 November 2014 from Lower Subansiri (S. Panda, P. Roy & D.S. Mahanty, 55, DGC-Darjeeling Govt College Herbarium). Number of individual plants

were counted at Lohit population (7) and Lower Subansiri population (6). Based on these exomorphological and leaf anatomical data, specimens of *Vaccinium* L. are identified as *V. paucicrenatum* Sleumer. According to Airy shaw (1948), *V. paucicrenatum* was not reported from India. But according to vander Kloet et al. (2003), *V. paucicrenatum* had been reported by Sleumer (1941) based on I. H. Burkill collection (no. 36976, K) from Outer Abor Hills in 1912.

MATERIALS AND METHODS

The present work is the result of an extensive field visit in different districts of Arunachal Pradesh in 2003–2014 as well as herbarium consultations in Indian herbaria (CAL, DD, ASSAM, ARUN). This work also recorded GPS points (used GARMIN eTrex 10 model) data (latitude-longitude and altitudes) during field visits. The work was carried out partly in Central National Herbarium (Voucher specimen deposited: S. Panda 30881: Lohit population) and partly in the laboratory of Angiosperm Taxonomy & Ecology, Barasat Govt College (S. Panda 30881: Lohit population-leaf anatomy), Darjeeling Govt. College (Lower Subansiri Population

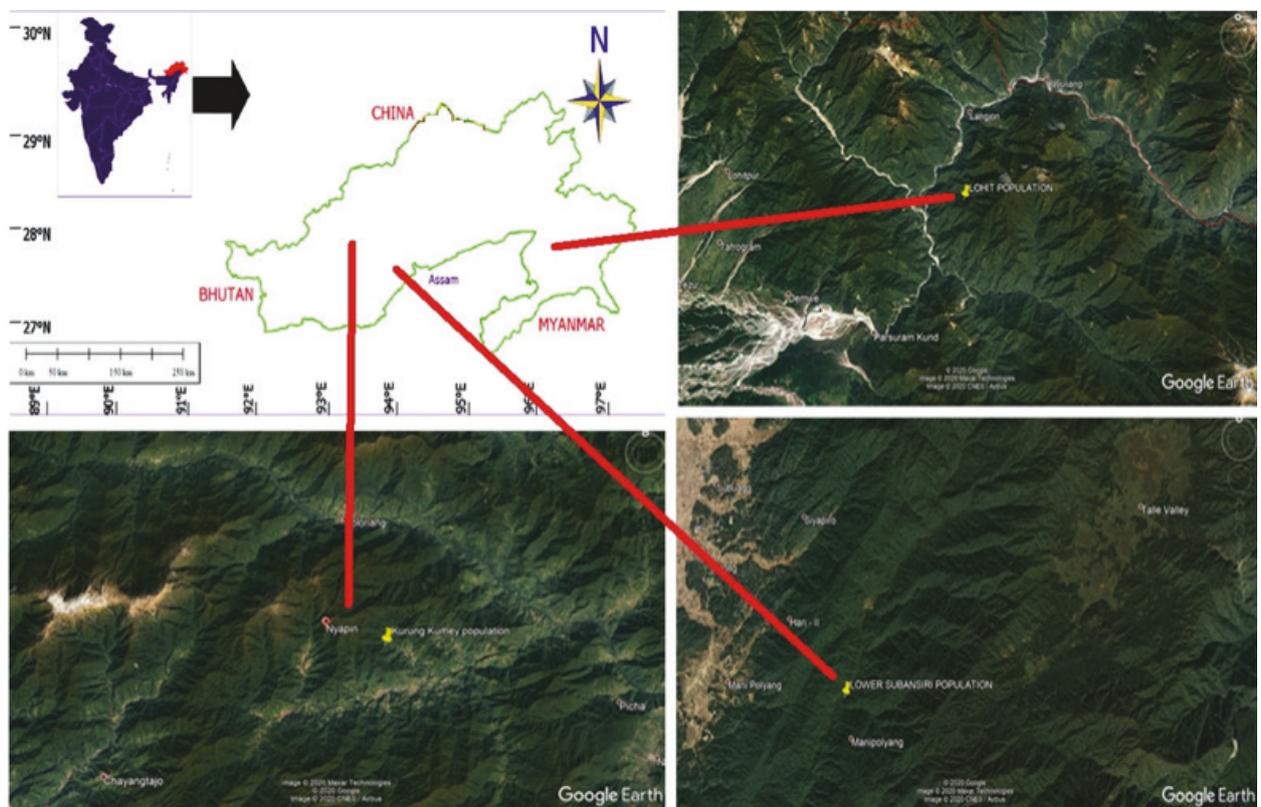


Image 1. Distribution of *Vaccinium paucicrenatum* Sleumer in Arunachal Himalaya in India (collection sites of Kurung Kumey, Lower Subansiri and Lohit districts with magnified Google Earth imagery). Indian map with Arunachal Pradesh <www.maphill.com>.



Panda et al. 55: Darjeeling Govt College Herbarium). Fruiting materials of *V. paucicrenatum* belonging to S.S. Dash 31690 (ARUN: Arunachal Herbarium, Botanical Survey of India) was consulted in November, 2014 at Arunachal Herbarium by the author. Botanical identity was confirmed with consultation of Type images (BM!; K!) as well as consultation of relevant literature including protologue. Amplified description of *V. paucicrenatum* is based on all three field collections (S. Panda 30881, S.S. Dash 31690, & S Panda et al. 55) as well as type images (Kingdon-Ward 13560, BM; Burkill 36976, K).

Stomatal slide preparation

Small cubical pieces of leaf blades were excised from the base, middle and apex. Several existing methods viz., 10% HNO₃-boiling for 10 minutes, 5% KOH overnight (12–24 hours) treatment without boiling and with boiling were done. Pieces were ringed in sterilized water until clear. After clearing, pieces were dehydrated in an ethanol series followed by staining with 10% safranin and mounted onto a microscope slide in DPX (pieces of basal, middle and apical regions on one slide). The slide was examined under Olympus (Tokyo: Model no. SAI740) light microscope using 10X and 40X objectives and camera lucida drawings were made with the help of a drawing prism. The slides (5 for each) are deposited in the Laboratory of Angiosperm Taxonomy, Post Graduate Department of Botany, Barasat Government College (2010) & Darjeeling Govt College (2016). The descriptive terminology follows Dilcher (1974) and Carpenter (2005).

Methodology of leaf clearing for venation study (areoles)

Entire mature leaves were immersed in 2.5% NaOH solution until clear (closed condition). In the present study, most of the leaves were cleared after eight days of NaOH treatment. After eight days, these NaOH-treated leaf samples were again immersed in 2.5% NaOH solution for 2–3 days followed by one drop chloral hydrate treatment overnight. Leaf samples were then washed in distilled water. After clearing, one good sample (entire leaf) was dehydrated in an ethanol series followed by staining with 1% safranin and mounted onto a microscope slide in DPX (entire leaf in one slide). The slides are deposited in the laboratory of Angiosperm Taxonomy, PG Department of Botany, Barasat Govt. College (2010) & Darjeeling Govt College (2016). The descriptive terminology follows Hickey (1973) and Dilcher (1974).

Taxonomic treatment and amplified description

Vaccinium paucicrenatum Sleumer (Images 1–5; Figure 1)

in Engl., *Bot. Jahrb. Syst.* 71(4): 432–433. 1941; Merrill, *Brittonia* 4(1): 157. 1941; Airy Shaw, *Kew Bull.* 1948: 246. 1948; vander Kloet et al., *Acta Bot. Yunnanica* 25(1): 21. 2003; Panda & Sanjappa in Sanjappa & Sashtri, *Fasc. Fl. India (Ericaceae)* no. 25: 399–400. 2014. Type: Northern Myanmar, Nam Tamai valley, hills east of Putao, 27.753°N & 97.500°E, 1600 m, 09.xii.1937, Kingdon-Ward 13560 (BM, photo!).

Epiphytic trailing profusely branched shrub to 1m high; growing on a fallen *Quercus* tree with irregularly lobed basal lignotubers which are 5–7 × 4.5–6.5 cm, glabrous, pale brown; each lobe of lignotuber appearing like a potato tuber. Stem glabrous, lenticellate; old branches beset with sparsely blackish hispid-setose hairs while current season's branches (young twigs) beset with dense brown hispid-setose hairs (up to 4mm long), terete. Leaves closely appressed to branches, alternate to sub-opposite, lamina usually ovate-elliptic to elliptic (but Lohit population-S. Panda 30881 showed usual elliptic to rarely ovate-elliptic shape), 10–16 × 6–10 mm (Kurung Kumey-S.S. Dash 31690 and Abor Hill-Burkill 16976) populations showed larger leaves viz., 13–16 × 7–10.5 mm and 12–15 × 7–10 mm respectively, while Lohit population- S. Panda 30881 showed smaller leaves 9–13 × 7–9 mm), obscurely serrate at margin (5–6 obscure teeth on each side), serration found only on upper 3/4th half but basal 1/4th half entire, usually apiculate to rarely acute at apex (Lohit population S. Panda 30881 showed shortly acuminate apex, acumen up to 1mm long), broadly cuneate to subrotundate at base, glabrous on both surfaces, dark green and shiny adaxially while light green abaxially, apical leaves of current season's greenish with purple-red; venation conspicuously brochidodromous with 2–3 pairs of lateral veins, prominent on both surfaces, thinner veins adaxially but comparatively thicker abaxially (however, variations noticed in different populations, viz., Kurung Kumey population showed veins prominent adaxially and obscure abaxially; Lohit population showed veins prominent abaxially while obscure adaxially; Lower Subansiri population showed veins prominent on both surfaces including some leaves of adaxial surfaces showed obscure veins on the same branch). Petioles usually 1mm to rarely 1.5mm long; Lower Subansiri population showed petioles usually beset with tuft of brown hispid-setose hairs up to 3mm long, while dry herbarium materials showed glabrous or hair-scars on

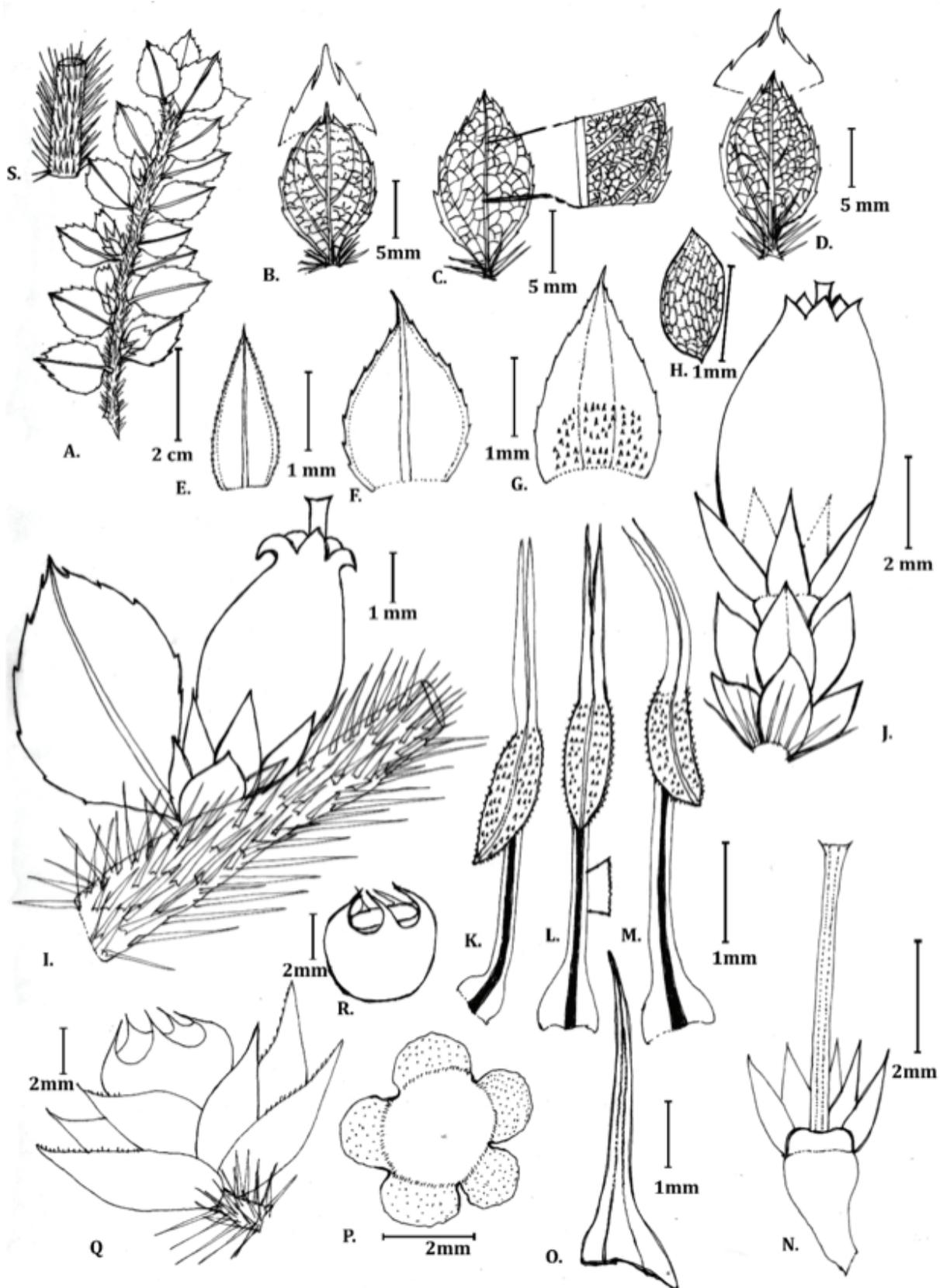


Figure 1. *Vaccinium paucicrenatum* Sleumer: A—habit | B–D—leaves | E—calyx lobe | F–G—bracts | H—seed | I–J—flowers | K–M—stamens | N—pistil | O—stem hair | P—corolla lobes (top view) | Q–R—fruit | S—stem part magnified. Scale bars: (2cm—A), (5mm—B–D), (1mm—E–I, K–M, O), (2mm—J, N, P–R). Drawn from S. Panda et al. 55, DGC (A–P, S) and S.S. Dash 31690, ARUN(Q–R, H).

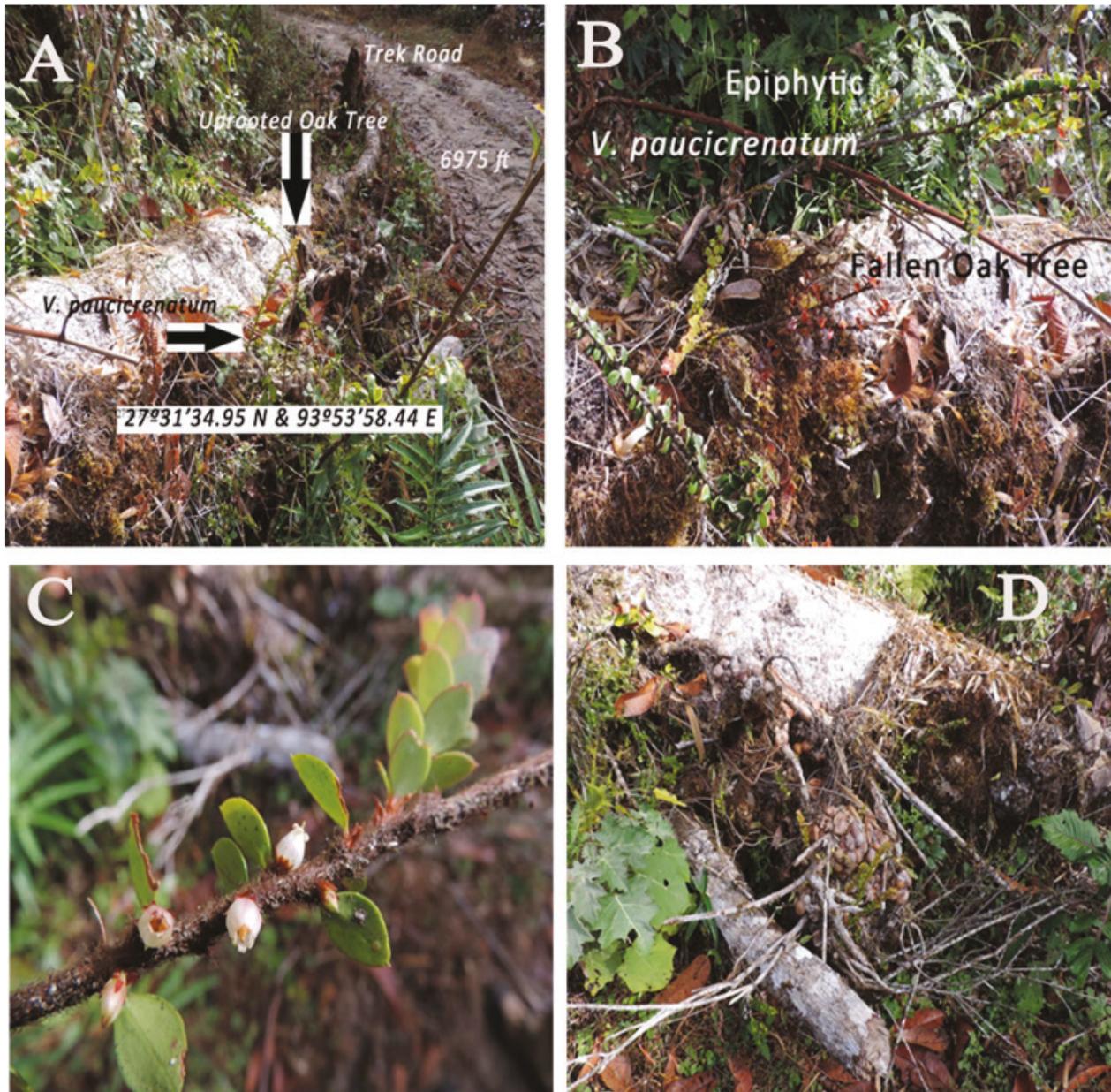


Image 2 . Live images of *Vaccinium paucicrenatum* Sleumer: A–B—epiphytic habit on fallen Oak tree | C—close up of current season twig | D—habit with lignotubers (S. Panda et al. 55, DGC): Lower Subansiri, Arunachal Pradesh). © S. Panda.

petioles (may be due to deciduous nature of hairs which fall off in dry materials). Racemes almost absent or much reduced and flowers solitary, axillary from middle to subterminal parts of current season's branch. Flowers pentamerous, c. 10mm long including 2–3 mm long short pedicels which are light green, basally hispid-setose with a tuft of brown hairs and encircled by 6–8 brown-purple bracts. Bracts persistent in fruits, ovate-deltoid to broadly ovate, acuminate at apex, 2–3 × 1–1.5 mm, glabrous except basal part of dorsal surface puberulous, obscurely serrate at margin. Calyx purplish-red-white,

obconical, persistent in fruits, c. 2.5mm long, glabrous, 5-lobed, basally connate, narrowly deltoid, 1.5–2 × 1 mm, shortly acuminate at apex. Corolla tubular-urceolate, white with longitudinal purple-red lines along 5-ridges, c. 6mm long (buds c. 4mm long), glabrous except apical lobes inside puberulous, 5-lobed, apical part 4mm in diam., each lobe minute or 0.5mm long, reflexed after anthesis, puberulous inside. Stamens 10, ecalcarate, c. 5mm long; filaments slender, light green, basally dilated, c. 1.5 mm long, glabrous, filament wall wavy at margin with a prominent median vertical vein

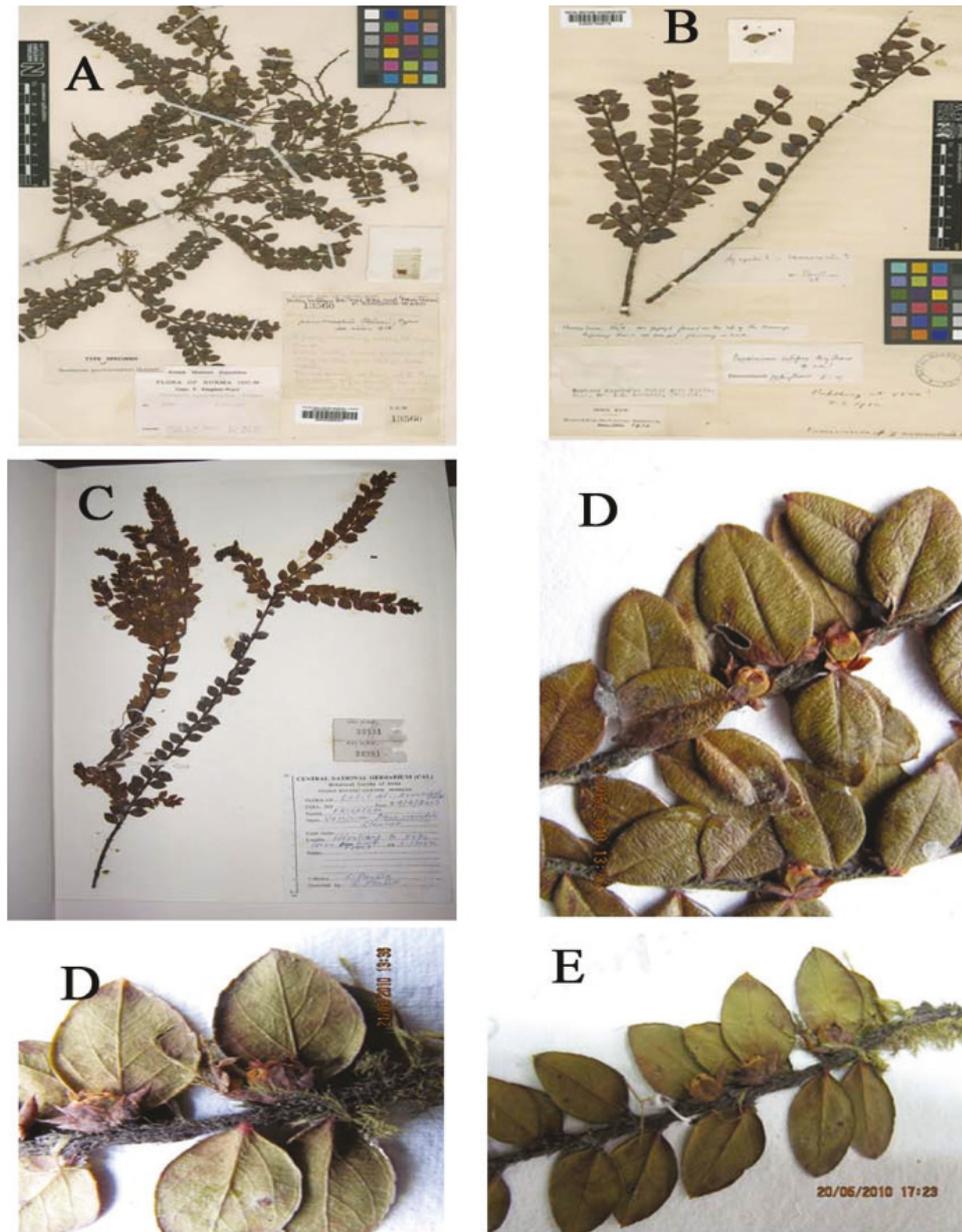


Image 3 . *Vaccinium paucicrenatum* Sleumer: **A**—original type image Nam Tamai Valley (Kingdon-Ward 13560, BM) | **B**—original type image Abor Hills (Burkill 36976, K) | **C**—S. Panda 30881, CAL (Lohit population) | **D–F**—fruiting twigs from Kurung Kumeey (S.S. Dash 31690, ARUN). © S. Panda.

seen; anther lobes (thecae) oblong to linear-oblong, brown, c. 1.5mm long, verrucate, appendiculate (c. 0.5mm long at the base of thecae), at the apex of thecae c. 2mm long two linear pale yellow tubules seen. Pistil c. 8mm long; ovary glabrous, 1 × 1.5 mm, subglobose, light green, 5-locular on axile placentation; style filiform, light green, c. 5mm long, glabrous, obscure several vertical ridges seen, protruded up to 1mm out of mature flower; stigma truncate. Berries greenish with pinkish tinged apex and 3 × 2.5 mm (immature) to purple-black and 4 × 3.5 mm (mature), encircled with persistent 6–8 purple-

brown bracts and five purple-red calyx. Seeds several, obconical, 1.5 × 1 mm, pale brown, scariosus. Floral formula: Br., Brl., ⊕, ♀, $K_{(5)}$, $C_{(5)}$, $A_{(10)}$, $\bar{G}_{(5)}$.

Leaf anatomy: Stomata (Image 5G–I): The study of Light Microscopic stomatal architecture (40X, 100X) includes number, form and arrangement of specialized epidermal cells associated with the stomatal guard cells. Stomata are distributed more or less evenly over the entire abaxial leaf surface in between the veins, but generally not over the finer veins and main veins. The stomata are uniformly distributed in abaxial surface only,



Image 4. *Vaccinium paucicrenatum* Sleumer: branches, flower, dissected floral parts of lowers Subansiri population (S. Panda et al. 55). © S. Panda.

they are widely separated from each other by epidermal cells.

Stomata type: The investigated species shows only one type, amphiparacytic (Dilcher 1974). Average dimension of stomata is $22.5 \times 20 \mu\text{m}$. Average dimension of guard cells: $10.3 \times 2.4 \mu\text{m}$. Epidermal cells are variable ranging from polygonal, pentagonal, rectangular to irregular and mostly isodiametric, some are elongated to deltoid. The epidermal walls in surface view are slightly arched to rarely straight. The epidermal walls in the adaxial surface are mostly straight. The maximum length of epidermal cell is $39.5\mu\text{m}$ and breadth is $22.5\mu\text{m}$, while minimum length is $18\mu\text{m}$ and breadth is $14\mu\text{m}$.

Leaf areoles (vein islets) (Image 5 A–F): Quadrangular, pentagonal to rarely triangular in shape. Larger areole: $974 \times 614 \mu\text{m}$. Smaller areole: $374 \times 112 \mu\text{m}$. Areoles: 3 (average) per 1mm^2 . Vein endings: 24 (average) per 1mm^2 ; veinlets simple unbranched to branched (once). Branched and unbranched veinlets occur in the same areole. Vein ends: pointed to bifurcated.

Extended distribution: India: Eastern Himalaya (Arunachal Pradesh: outer Abor Hills-Ripshing 1,676m (Adi dominated part of East and West Siang districts)); Lohit District between Tezu & Hayuliang 1,300m 27.972°N & 96.440°E ; Lower Subansiri district-between Manipolyang & Pange 2,100m, 27.526°N & 93.899°E ;

Kurung Kumei district-above Nyapin 1,570m, 27.719°N & 93.375°E ; N Myanmar (Burma-Tibet Frontier: Nam Tamai Valley, Hills east of Putao-899–1,600 m, 27.753°N & 97.500°E). vander Kloet et al. (2003) erroneously reported this species from China (SE Tibet) based on the specimen, Kingdon-Ward 9124 (BM, GH). However, Merrill (1941) and Airy Shaw (1948) reported this specimen from Nam Tamai Valley of N Myanmar.

Habitat: A trailing profusely branched epiphytic shrub up to 1m long growing in the higher branches in the canopy, mostly on *Quercus* trees at altitudes ranging from 1,295–2,126 m in Arunachal Himalaya while 899–1,600 m in the hills of Myanmar (Image 1).

Phenology: Flowering in early November to late January, peaking in late November to late December (but rarely in March in Abor Hill population collected by I.H. Burkill 36976). Fruiting: early February to late March, peaking in late February.

Specimens examined: 30881 (CAL, veg), India: eastern Himalaya: Arunachal Pradesh: Lohit District, 45km from Hayuliang toward Tezu, near Salangam, 1,300m, 27.972°N & 96.440°E , 24.iv.2003, coll. S. Panda; 55 (DGC, fl.), Lower Subansiri District, 4km from Manipolyang toward Pange, 2,125m, 27.526°N & 93.899°E , 21.xi.2014, coll. S. Panda et al.; 31690 (ARUN, fr), Kurung Kumei District, above Nyapin, 1,570m, 27.719°N & 93.375°E , 25.ii.2010, coll. S.S. Dash.

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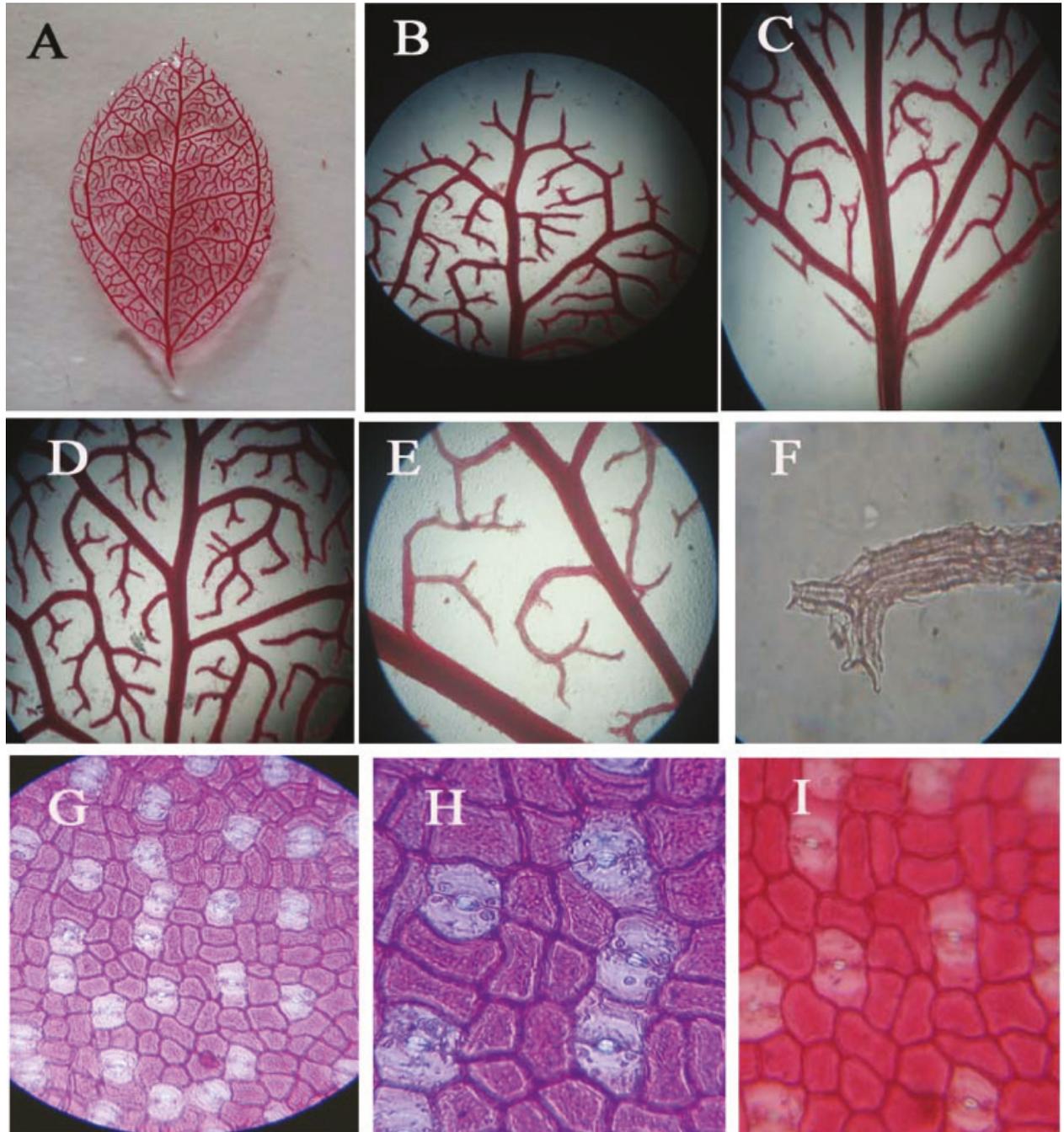


Image 5. Leaf anatomy of *Vaccinium paucicrenatum* Sleumer (S. Panda et al. 55, DGC): A—NaOH-treated entire leaf | B—leaf areole at apex (5X) | C—leaf areoleat base (5X) | D—leaf areole at middle (5X) | E—leaf areole at middle (10X) | F—vein ending (40X) | G—I—stomatal complex (40X) | H—stomatal complex (100X). © S. Panda.



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Communications

Persistence of *Trachypitecus geei* (Mammalia: Primates: Cercopithecidae) in a rubber plantation in Assam, India

– Joydeep Shil, Jihosuo Biswas, Sudipta Nag & Honnavalli N. Kumara, Pp. 18679–18686

Population assessment of the endangered Western Hoolock Gibbon *Hoolock hoolock* Harlan, 1834 at Sheikh Jamal Inani National Park, Bangladesh, and conservation significance of this site for threatened wildlife species

– M. Tarik Kabir, M. Farid Ahsan, Susan M. Cheyne, Shahrul Anuar Mohd Sah, Susan Lappan, Thad Q. Bartlett & Nadine Ruppert, Pp. 18687–18694

Assessment of changes over a decade in the patterns of livestock depredation by the Himalayan Brown Bear in Ladakh, India

– Aishwarya Maheshwari, A. Arun Kumar & Sambandam Sathyakumar, Pp. 18695–18702

Habitat selection of Himalayan Musk Deer *Moschus leucogaster* (Mammalia: Artiodactyla: Moschidae) with respect to biophysical attributes in Annapurna Conservation Area of Nepal

– Bijaya Neupane, Nar Bahadur Chhetri & Bijaya Dhama, Pp. 18703–18712

Sero-diagnosis of tuberculosis in elephants in Maharashtra, India

– Utkarsh Rajhans, Gayatri Wankhede, Balaji Ambore, Sandeep Chaudhari, Navnath Nighot, Vitthal Dhaygude & Chhaya Sonekar, Pp. 18713–18718

Avian species richness in traditional rice ecosystems: a case study from upper Myanmar

– Steven G. Platt, Myo Min Win, Naing Lin, Swann Htet Naing Aung, Ashish John & Thomas R. Rainwater, Pp. 18719–18737

Conservation status, feeding guilds, and diversity of birds in Doroji Sloth Bear Sanctuary, Karnataka, India

– M.N. Harisha, K.S. Abdul Samad & B.B. Hosetti, Pp. 18738–18751

Birds of Surat-Dangs: a consolidated checklist of 75 years (1944–2020) with special emphasis on noteworthy bird records and bird hotspots from northern Western Ghats of Gujarat, India

– Nikunj Jambu & Kaushal G. Patel, Pp. 18752–18780

Identification of a unique barb from the dorsal body contour feathers of the Indian Pitta *Pitta brachyura* (Aves: Passeriformes: Pittidae)

– Prateek Dey, Swapna Devi Ray, Sanjeev Kumar Sharma, Padmanabhan Pramod & Ram Pratap Singh, Pp. 18781–18791

Underestimated diversity of *Cnemaspis* Strauch, 1887 (Sauria: Gekkonidae) on karst landscapes in Sarawak, East Malaysia, Borneo

– Izneil Nashriq & Indraneil Das, Pp. 18792–18799

***Aborichthys barapensis*, a new species of river loach (Cypriniformes: Nemacheilidae) from Arunachal Pradesh, the eastern Himalaya, India**

– P. Nanda & L. Tamang, Pp. 18800–18808

A study on the community structure of damselflies (Insecta: Odonata: Zygoptera) in Paschim Medinipur, West Bengal, India

– Pathik Kumar Jana, Priyanka Halder Mallick & Tanmay Bhattacharya, Pp. 18809–18816

New distribution and range extension records of geometrid moths (Lepidoptera: Geometridae) from two western Himalayan protected areas

– Pritha Dey & Axel Hausmann, Pp. 18817–18826

Butterfly diversity of Putalibazar Municipality, Syangja District, Gandaki Province, Nepal

– Kismat Neupane & Mahamad Sayab Miya, Pp. 18827–18845

New records and distribution extension of *Nassarius persicus* (Martens, 1874) and *N. tadjallii* Moolenbeek, 2007 (Mollusca: Gastropoda: Nassariidae) to India

– Sayali Nerurkar & Deepak Apte, Pp. 18846–18852

Flowering plants of Agumbe region, central Western Ghats, Karnataka, India

– G.S. Adithya Rao & Y.L. Krishnamurthy, Pp. 18853–18867

Population assessment and habitat distribution modelling of the threatened medicinal plant *Picrorhiza kurroa* Royle ex Benth. in the Kumaun Himalaya, India

– Naveen Chandra, Gajendra Singh, Shashank Lingwal, M.P.S. Bisht & Lalit Mohan Tewari, Pp. 18868–18877

Occurrence of gilled fungi in Puducherry, India

– Vadivelu Kumaresan, Chakravarthy Sariha, Thokur Sreepathy Murali & Gunasekaran Senthilarasu, Pp. 18878–18887

Short Communications

First photographic evidence and distribution of the Indian Pangolin *Manis crassicaudata* (Mammalia: Pholidota: Manidae) in Sariska Tiger Reserve, Rajasthan, India

– Hemant Singh, Gobind Sagar Bhardwaj, N. Gokulakannan, Saket Agasti & K. Aditya, Pp. 18888–18893

Population and conservation threats to the Greater Flamingo *Phoenicopterus roseus* (Aves: Phoenicopteriformes: Phoenicopteridae) at Basai Wetland and Najafgarh Jheel Bird Sanctuary, Haryana, India

– Amit Kumar & Sarita Rana, Pp. 18894–18898

First report on the occurrence of Sargassum Weed Fish *Histrio histrio* (Lophiliformes: Antennariidae) in Nigeria deep water, Gulf of Guinea

– Abdul-Rahman Dirisu, Hanson S. Uyi & Meshack Uyi, Pp. 18899–18902

A new distribution record of stomatopods *Odontodactylus japonicus* (De Haan, 1844) and *Lysiosquilla tredecimdentata* (Holthuis, 1941) from the Puducherry coastal waters, east coast of India

– S. Nithya Mary, V. Ravitchandirane & B. Gunalan, Pp. 18903–18907

New records of *Agriocnemis keralensis* Peters, 1981 and *Gynacantha khasiaca* MacLachlan, 1896 (Insecta: Odonata) from Maharashtra, India

– Yogesh Koli, Akshay Dalvi & Dattaprasad Sawant, Pp. 18908–18919

A new distribution record of the Horn Coral *Caryophyllia grandis* Gardiner & Waugh, 1938 (Anthozoa: Scleractinia) from the Karnataka Coast, India

– J.S. Yogesh Kumar & C. Raghunathan, Pp. 18920–18924

Re-collection, extended distribution, and amplified description of *Vaccinium paucicrenatum* Sleumer (Ericaceae) from the Arunachal Himalaya in India

– Subhasis Panda, Pp. 18925–18932

Notes

Photographic record of the Rusty-spotted Cat *Prionailurus rubiginosus* (I. Geoffroy Saint-Hilaire, 1831) (Mammalia: Carnivora: Felidae) in southern Western Ghats, India

– Devika Sanghamithra & P.O. Nameer, Pp. 18933–18935

Natural history notes on the highly threatened Pinto's Chachalaca *Ortalis remota* (Aves: Cracidae)

– Carlos Otávio Araujo Gussoni & Marco Aurélio Galvão da Silva, Pp. 18936–18938

Black-bellied Coral Snake *Sinomicrurus nigriventer* (Wall, 1908) (Elapidae): an extended distribution in the western Himalaya, India

– Sipu Kumar, Jignasu Dolia, Vartika Chaudhary, Amit Kumar & Abhijit Das, Pp. 18939–18942

First record of the Afghan Poplar Hawkmoth *Loathoe witti* Eitschberger et al., 1998 (Sphingidae: Smerinthinae) from India: a notable range extension for the genus

– Muzafar Riyaz, Pratheesh Mathew, Taslima Shiekh, S. Ignacimuthu & K. Sivasankaran, Pp. 18943–18946

The tribe Cnodalonini (Coleoptera: Tenebrionidae: Stenochiinae) from Maharashtra with two new records

– V.D. Hegde & D. Vasanthakumar, Pp. 18947–18948

Do predatory adult odonates estimate their adult prey odonates' body size and dispersal ability to proceed with a successful attack?

– Tharaka Suresh Priyadarshana, Pp. 18949–18952

Rediscovery of *Ophiorrhiza incarnata* C.E.C. Fisch. (Rubiaceae) from the Western Ghats of India after a lapse of 83 years

– Perumal Murugan, Vellingiri Ravichandran & Chidambaram Murugan, Pp. 18953–18955

Response

Comments on the "A checklist of mammals with historical records from Darjeeling-Sikkim Himalaya landscape, India"

– P.O. Nameer, Pp. 18956–18958

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