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## *Argostemma kamjongense* (Rubiaceae), a new species from Manipur, Northeast India

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**Abstract.** A new species, *Argostemma kamjongense* (Rubiaceae) confined to Kamjong District of Manipur (Northeast India) is described and illustrated. It is akin to closely allied species, *A. verticillatum* and *A. sarmentosum*, however can be easily distinguishable by the number of lateral veins on the leaves, size of the leaves, fewer number of bracts, slightly reflexed corolla lobes at maturity, style not exerted and enclosed within anther cone. The taxon's potential as a good ecological indicator is discussed along with its ecological adaptations for survival. The new species is also provisionally assessed here as Critically Endangered (CR) according to IUCN Red List Categories and Criteria.

**Keywords:** *Argostemma kamjongense*, new species, critically endangered, ecological indicator, Manipur (Northeast India).

### INTRODUCTION

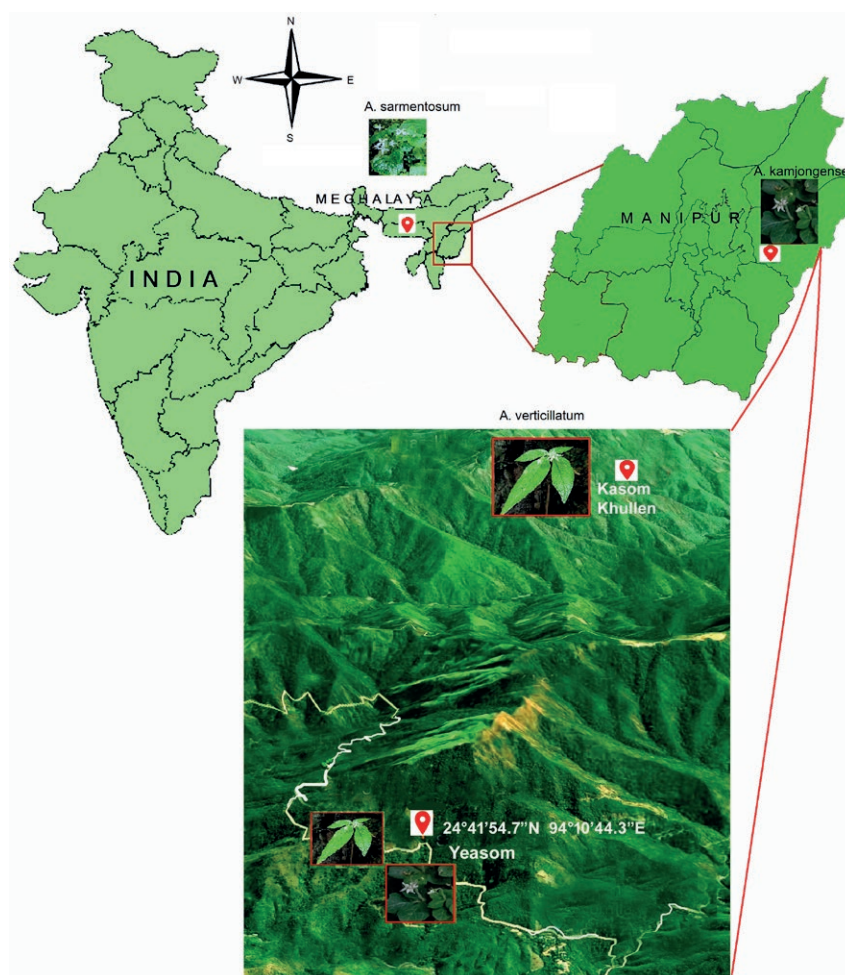
*Argostemma* Wall. (Wallich 1824) is a genus of Rubiaceae (Rubioidae-Argostemmatae) with about 178 species (POWO 2023). It is mainly distributed in the tropical and sub-tropical regions of Asian countries and few species in West Africa (Tanaka et al. 2010; Mabberley 2017). Most of the species are mainly lithophytes or occasionally epiphytes, and prefers to grow in shady areas with humid conditions, near streams, waterfalls, wet riverbeds with moss laden rocks, boulders etc. (Sridith and Puff 2000). In India, the genus is among the least studied member of Rubiaceae, mainly because of its small size. Altogether, twelve (12) species so far have been recorded from various parts of India, with maximum species diversity confined to Western Ghats and parts of Andaman and Nicobar Islands (Pandey and Diwakar 2008; Balan et al. 2021). From Northeast India, three (3) species have been described, viz *A. khasianum* C.B. Clarke in Hooker (1880: 43), *A. sarmentosum* Wall. in Roxburgh (1824:324) and *A. verticillatum* Wall. in Roxburgh (1824: 325).

In one of the botanical surveys conducted in the Kamjong District of Manipur (Northeast India) which is a part of the Indo–Burma Hotspot, the authors came across a waterfall hidden within a forest canopy. On further exploration, we came across a small epilithic species growing along the slimy rocks facing the waterfall. On critical examination, it was revealed that the taxon is a new species under the genus *Argostemma*. We also collected *A. verticillatum* from Manipur which is also a new State record. Another allied species, *A. sarmentosum* was also collected from Meghalaya State, and both were used for comparison with the new species.

#### MATERIALS AND METHODS

The new species was collected from Yeasom Hills of Kamjong District, Manipur (Northeast India) dur-

ing repeated field trips conducted from April 2021 to October 2022 (Figure 1). Relevant literatures and various herbaria (ARUN, ASSAM, CAL, K) were consulted to study the existing species and study the differences in their morphological parameters (Ridley 1927; Bremer 1989; Sridith 1999; Chen and Taylor 2011; Lanorsavanh et al. 2020; Vu et al. 2020). The new species is compared with two closely allied species, *A. verticillatum* Wall. and *A. sarmentosum* Wall. found in Northeast India (Table 1). Microphotographs of morphological characters were taken by using phase–contrast microscope (Motic BA 210), LED–USB Cooling Tech Microscope and Sony DSC–W610. All the voucher specimens were deposited at Botanical Survey of India (BSI), Eastern Regional Centre (herbarium code ASSAM), and Manipur University Museum of Plants (MUMP) and Mizoram University Herbarium (MZUH), the latter still under indexing process.



**Figure 1.** Map showing type locality of *A. kamjongense* B. S. Sadokpam, S. D. Khomdrum & S. D. Yumkham, Yeasom Hills at Kamjong District, Manipur (Northeast India) and sites showing distribution of *A. verticillatum* in Manipur & *A. sarmentosum* in Meghalaya.

## TAXONOMIC TREATMENT

*Argostemma kamjongense* B.S.Sadokpam, S.D.Khomdram & S.D.Yumkham, **sp. nov.** (Figure 2).

Type: India, Manipur, Kamjong District, Yeasom Hills, 24°41'54.7"N; 94°10'44.3"E, a.s.l. 950 m, 19 September 2022, *Bimolkumar Singh Sadokpam & Sanatombi Devi Yumkham 000998* (holotype ASSAM!; isotypes MUMP!, MZUH!).

### Diagnosis

*Argostemma kamjongense* differs morphologically from *A. verticillatum* and *A. sarmentosum* by having lesser pairs of lateral veins (3–4 pairs versus 4–7 pairs), generally smaller leaves (less than 2.5 cm versus more than 2 cm and up to 10 cm), fewer bracts (1–2 versus in groups of 4 or basally fused in *A. verticillatum* or more than 2 in *A. sarmentosum*), corollas yellowish at base (versus greenish at base), corolla lobes slightly reflexed at maturity (versus strongly reflexed at maturity in *A. verticillatum* and rarely reflexed in *A. sarmentosum*) and style not exerted and enclosed with anther cone (versus exerted).

### Description

Plants perennial, herbaceous, 4–6 cm tall, epilithic. Rhizome tuberous, globose, 0.2–0.4 cm, 4–7 roots arising from tuber surface. Stem erect, unbranched, 0.2–1.5 cm long, pubescent, green, terete. Leaves opposite, decussate, anisophyllous in 2 pairs, sometimes in pseudo-whorls, 0.5–2.5 × 0.3–1.5 cm, sessile, ovate to elliptic, leaf base oblique to cuneate, margin entire, apex acute to obtuse, pubescent on both side, 3–4 alternate lateral veins on each side, green, rudimentary leaves in pair present at nodes, acute, 0.1–0.2 cm long. Stipule linear, minute, deciduous, interpetiolar, entire. Inflorescence umbelliform, single, terminal, 1–8 flowered. Peduncle 1.5–3 cm long, pubescent. Bract 1–2, 0.2 × 0.1 cm, acute, pubescent, green, persistent. Flowers pedicellate, pubescent, 4–merous, rarely 5–merous, actinomorphic, 0.4–0.6 cm long, 0.6–0.8 cm in diameter. Calyx 4-lobed, ovate, gamosepalous, campanulate with short tube, 1/3 free, persistent, green, pubescent, 0.4 × 0.1 cm, sepals alternate to petals. Corolla star shaped, white, yellowish at base, broadly rotate, 4-lobed, rarely 5-lobed, lanceolate, apex acute, outer upper lobe pubescent, inner lobe glabrous, slightly reflexed at maturity, uncoiled tip, 0.5–0.6 × 0.25–0.3 cm, corolla tube short, ca. 0.1 cm long. Stamens 4, glabrous, white, basifixed, 0.3–0.4 cm long inserted to the base of corolla tube, filaments free, loosely agglutinated, anthers coherent into a cone, opens up widely at maturity, dehiscence poricidal. Ovary inferior, pubescent, 2-locular, 0.4–0.5 cm long, ovules

numerous, axile placentation, style filiform, up to 0.3 cm long, not exerted, enclosed within anther cone, stigma capitate (globular). Capsule small, 0.2 cm in diameter, locules 2, ca. 15–25 seeds per locule.

### Etymology

The specific epithet '*kamjongense*' refers to the type locality Kamjong District of Manipur State (Northeast India). It was previously a subdivision under Ukhrul district, and upgraded to the status of district on 8 December 2016.

### Phenology

Flowering from June to August; fruiting from late August to early October.

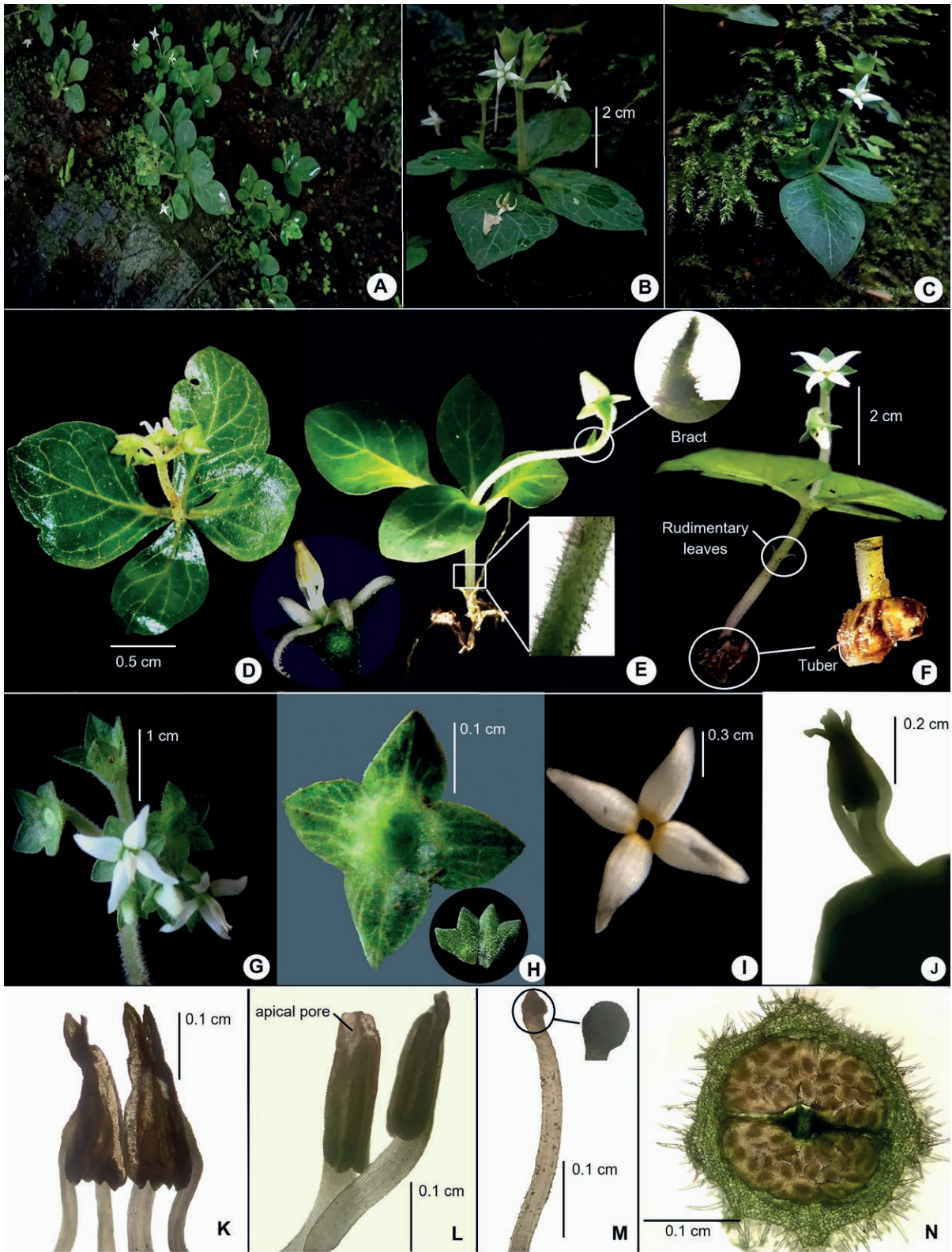
### Distribution and Habitat

The new species was collected from the type locality on Yeasom Hills located in Kamjong District, Manipur. It was found thriving as an epilithic herb on an isolated rough hilly terrain mainly composed of rocks and big boulders, near a small waterfall located at an elevation of 950 m. The main part of the study site was covered by a thick forest canopy and therefore blocks direct sunlight. This limits the vegetation of the area and only a few shade loving species which can endure the low light intensity like *Selaginella* P. Beauv., *Riccia* L., *Zingiber* Mill., *Adiantum* L. etc. were found growing. Moving a little further away from the waterfall site (ca. 5 meters), the forest canopy is opened (ca. 2 meters diameter) from where sunrays penetrated and directly illuminated the forest floor. At this spot, there grows a population of around 25 matured plants of the new species, and they tend to become dry and dehydrated when exposed to direct sunlight. This means the new species can thrive only in shady moist area or/and in partial sunlit area. Temperature (moderate), humidity, soil moisture content, rainfall and sunlight play a key role in the growth and survival of the new species (Figure 3).

### Preliminary conservation status

The new species is extremely delicate, small in size and currently collected only from its type locality (Yeasom, Kamjong District, Manipur). It grows in a very restricted small population within a radius of around 7 meters. The area is mainly composed of rocks, boulders, small gravels etc. with little or no humus deposition. At the present context, the species is assessed as Critically Endangered (CR) according to the criteria B2ab (i, ii, iii), D of IUCN Red List Categories and Criteria (IUCN Standards and Petitions Committee 2022).





**Figure 2.** *Argostemma kamjongense* A–C. Epilithic habit D. Anisophyllous leaves in 2 pairs with single flower in inset E. Habit with single flower showing pubescent stem & bract in inset F. Rudimentary leaves & tubers G. 6-flowered inflorescence H. Calyx I. Corolla, yellowish at base J–K. Agglutinated anthers L. Anther with poricidal dehiscence M. Filiform style with capitate stigma N. 2-locular ovary showing seeds.

*Species significance and uses*

The species remain isolated and confined beyond human detection. Also, because of their miniature size and unfriendly rough terrain habitat, these plants remain unnoticed and unexplored. According to Sridith, the genus *Argostemma* can act as a potential ecological indicator and as an indicator of phytogeographic patterns (Sridith 2007). This unique attribute is mainly because *Argostemma* usually grows only in intact or undisturbed forests and can never be relocated in secondary or disturbed habitats. During the course of the study, it was observed that this species has specific requirements like constant moisture availability, moderate temperature (15–20°C) and has narrow limit of tolerance for sunlight. These factors limits their distribution and therefore can act as a measure of existing environmental conditions. Hence, *Argostemma* can be a great ecological indicator.

DISCUSSION AND CONCLUSION

The new species, *Argostemma kamjongense* of Rubiaceae is collected from an isolated mountainous terrain growing as epilithic in between the wet crevices of

rocks and boulders near a waterfall. In general, most of the *Argostemma* usually grows near margin of streams and waterfalls. From the type locality, we also collected a few specimens of *A. verticillatum* growing sparsely along the rocky walls adjoining the waterfall, which is also recorded for the first time from Manipur State. We also assessed around 20 other locations with waterfalls within the type locality and areas adjoining the district. In many of these sites, we could collect only *A. verticillatum*. As such, the new species is placed under the Critically Endangered (CR) category B2ab (i, ii, iii), D of IUCN based on area of occupancy (<10 km<sup>2</sup>), location number (1), limited extent of occurrence and limited number of mature individuals (<50).

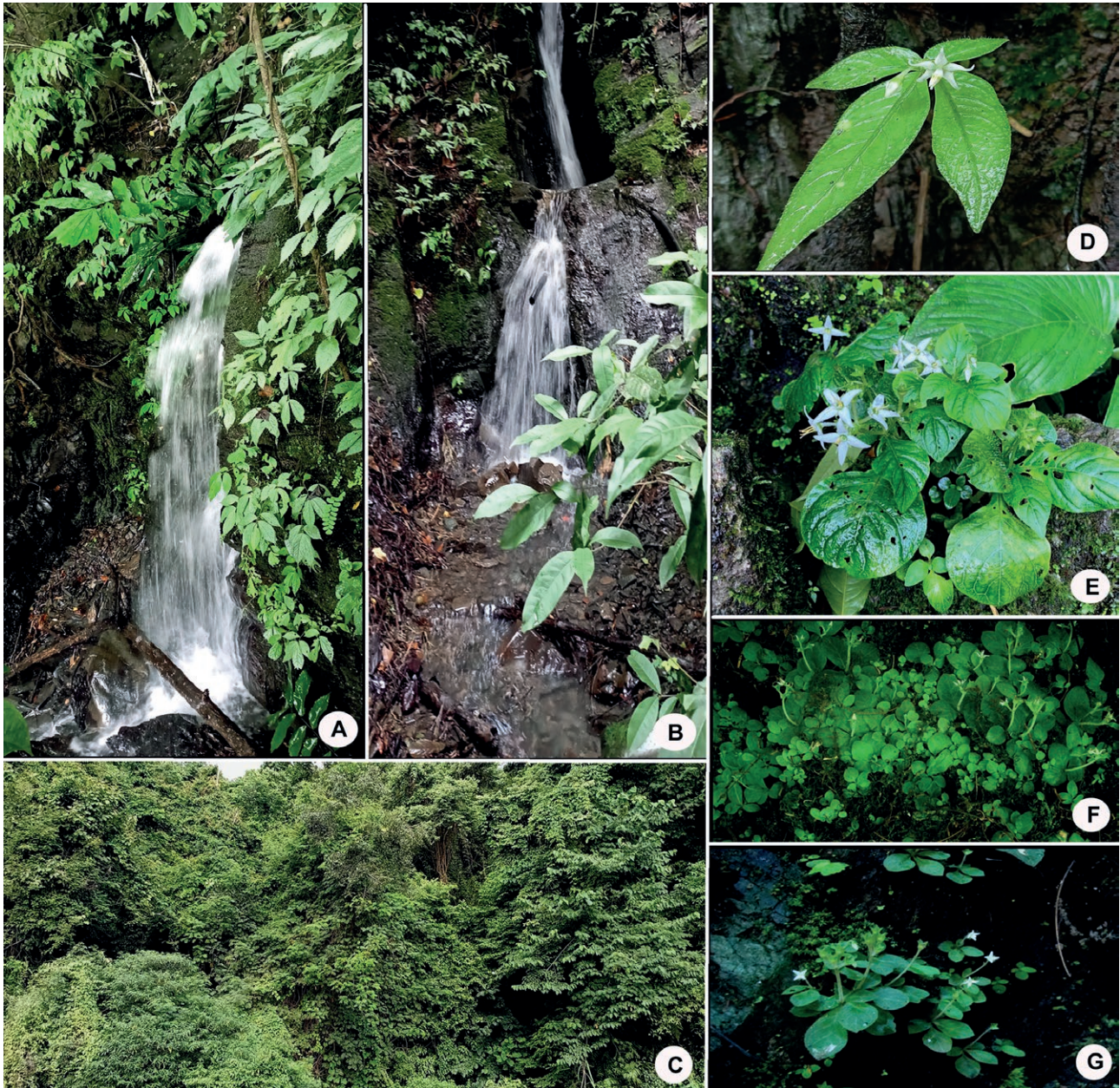
To survive in the rough hostile environment, the new species has manifested certain ecological adaptations which are highlighted below:

1. Presence of tubers which are perennial in nature. This feature boosts the survival rate of the plant which has an epilithic habit by providing nutrients during unfavorable conditions (nutrient deprivation, temporary dehydration, desiccation of photosynthetic parts etc.).
2. Anthers coherent into a cone at young stage (agglutination), becoming free and widely opening towards

**Table 1.** Morphological comparison between *A. kamjongense*, *A. verticillatum* and *A. sarmentosum*.

Characters	<i>A. kamjongense</i>	<i>A. verticillatum</i>	<i>A. sarmentosum</i>
Habit and Habitat	Epilithic, 4–6 cm tall, erect, tuberous	Epilithic, 2–7 cm tall, erect, tuberous	Epilithic, 10–20 cm tall, creeping at base with filiform runners
Leaves	Ovate to elliptic, 0.5–2.5 cm long, 3–4 lateral leaf veins on each side	Ovate, elliptic, elliptic–oblong or obovate, 2–7 cm long, 4–7 lateral leaf veins on each side	Broadly ovate, rounded or elliptic, 2–10 cm long, 5–7 lateral leaf veins on each side
Numbers of flowers per inflorescence	1–8 flowered	2–several flowered	6–10 flowered
Peduncle	1.5–3 cm, pubescent	1–3 cm, glabrous	3–6 cm, pubescent
Bracts	1–2, non–foliaceous	Groups of 4 or basally fused, non–foliaceous	More than 2, foliaceous
Flowers	4–merous	5–merous	4–merous
Calyx	4 lobes, ovate, pubescent, up to 4 mm long	5 lobes, ovate–acute, glabrous, up to 2 mm long	4 lobes, ovate–oblong, strigose, up to 10 mm long
Corolla	4 lobes, lanceolate–acute, white, yellowish at base, slightly reflexed, uncoiled tip, outer upper lobe pubescent, inner lobe glabrous	5 lobes, ovate–acuminate, white, greenish at base, strongly reflexed, coiled tip, glabrous both side	4 lobes, lanceolate–acute, white, greenish at base, rarely reflexed, outer lobe pubescent
Stamens & Nature of agglutination	4 stamens, filaments free, anthers coherent, connivent	5 stamens, filaments fused around the middle to form a short tube, anthers free but connivent	4 stamens, filaments free, curved, rarely approaching to form connivent anthers
Style	Not exerted, enclosed within anther cone	Exserted	Exserted
Geographical Distribution	Yeasom Hills (Manipur, India)	Bhutan, Myanmar, Nepal, Thailand, Laos, Vietnam, Northeast India	Himalayas, Bhutan, Pakistan, Northeast India (Sikkim, Meghalaya)





**Figure 3.** A–C. Habitat showing waterfalls and forest canopy D. *A. verticillatum* from Kamjong District, Manipur E. *A. sarmentosum* from Meghalaya F–G. A population of *A. kamjongense* growing among mosses under low light intensity.

maturity. This ensures protection of the young developing pollens. Filaments are robust, which served as a reliable platform for buzz pollination. Interestingly, dehiscence takes place from apical pores, and effectively translates the mechanism of insect pollination. Agglutinations and synandry syndrome in *Argostemma* also help in insect pollination (Puff et al. 1995).

3. As in most of the species under *Argostemma*, the fruit is protected by a persistent calyx and opens

by an apical operculum. Seeds are extremely small in size and enable them to easily lodge inside the narrow rock crevices and are protected from being washed away by the water drops hitting against the rocky walls. They will grow again when soil moisture and temperature conditions are appropriate for germination.

4. Manifestation of sciophytic adaptations like growing in top thin layer humus deposited places (forest



floor, rock crevices, mossy boulders, bogs etc.), slow growth, small sized non showy flowers, little tolerance to bright sunlight, anisophylly and thin leaves and extensive vegetative growth.

Few factors also attributed to its habitation in a small or isolated geographical area. Morphologically, *A. kamjongense* is very small in size compared to other well flourished species of the genus. As in most of the epilithic sciophytes, the vegetative growth phase is comparatively longer than the fruiting phase. Other factors like nature of seed (minute, low yield of around 15–25 seeds per locule, absence of appendages/parts related to seed dispersal), limited number of flowers (1–8) per inflorescence, reduced rudimentary leaves decreasing photosynthetic yield, thin-layered cuticle etc. also contributed to their small sized population. The species has narrow range of tolerance to sunlight and temperature above 25°C. Many streams and waterfalls in Manipur are perennial as the State receives an annual rainfall of around 1500–2000 mm. The phenological period of this plant coincide with the monsoon season. As a result, there are high chances of viable seeds being washed off/ carried away by the flowing water currents from the site. When landed in exposed alien environment, the seeds will not germinate if it does not meet the optimum conditions. The occurrence of this new species in Yeasom Hills also indicates that the forest is presently undisturbed by anthropogenic activities as *Argostemma* are ecological indicators and can only survive in undisturbed primary environment. They are very sensitive to micro-climatic changes and any disturbance in ecological balance will soon cause the population to die (Sridith and Puff 2000). Changes in the existing abiotic factors (sunlight, temperature, precipitation, minerals, soil), local land-use pattern (jhum, terrace farming, clearing of forest for firewood), landslides etc. will be a major concern for keeping the forest intact and for shaping the biodiversity.

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#### AUTHOR CONTRIBUTIONS

BSS & DW conducted repeated field surveys in various parts of the State & studied the taxonomic parameters. SDY & SDK analyzed, identify the specimen, preparation of photo plates and did extensive literature survey. All the authors finally read and approved the manuscript.

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