



RESEARCH ARTICLE

Morphological characteristics of *Calamus* species of Arunachal Pradesh, India

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Abstract

The present study was conducted on eleven species of *Calamus* viz., *C. acanthospathus* Griff., *C. erectus* Roxb., *C. flagellum* Griff ex Walp, *C. floribundus* Griff., *C. gracilis* Roxb., *C. inermis* T. Anderson, *C. khasianus* Becc., *C. latifolius* Roxb., *C. leptospadix* Griff., *C. nambariensis* Becc. and *C. nambariensis* ssp. *arunachalensis* Deka, Borthakur and Tanti collected from natural forest of Arunachal Pradesh. The aim of the present investigation was to study the detailed morphological characteristics of selected species. Clustered stems were observed in all the *Calamus* species except *C. acanthospathus*. The arrangement of leaflets was regular in *C. acanthospathus*, *C. erectus*, *C. flagellum* and *C. gracilis*, alternate in *C. floribundus*, *C. leptospadix* and *C. nambariensis* ssp. *arunachalensis* and clustered in *C. inermis*, *C. khasianus*, *C. latifolius* and *C. nambariensis*. Spines were densely arranged in *C. acanthospathus*, *C. flagellum*, *C. khasianus*, *C. nambariensis* and *C. nambariensis* ssp. *arunachalensis*; scattered in *C. floribundus*, *C. gracilis*, *C. inermis*, *C. latifolius* and *C. leptospadix*; whorls in *C. erectus*. The colour of leaf sheath was dark green in *C. erectus* and *C. gracilis*, greenish brown in *C. acanthospathus*, *C. floribundus*, *C. inermis*, *C. khasianus* and *C. leptospadix* and greenish yellow in *C. flagellum*, *C. latifolius*, *C. nambariensis*, *C. nambariensis* ssp. *arunachalensis*. Flagella were present in all the selected species except *C. erectus*, *C. khasianus* and *C. nambariensis*. Whereas, cirri were absent in the selected *Calamus* species except *C. inermis*, *C. khasianus* and *C. nambariensis*.

Keywords: *Calamus*; Stem; Spine's arrangement; Leaf sheath; Leaflet; Cirri; Flagella.

1. Introduction

Calamus belongs to the subfamily Calamoideae under family Areaceae of palms (Dransfield et al., 2008) and are mostly distributed in India, South China, the Malay Archipelago, Northern Australia, Fiji, and Africa (Vorontsova et al., 2016; Henderson et al., 2020). They vary in size from tiny rosette non-climbing plants in the understorey to huge climbing trees towering over the forest canopy. They are distributed from sea level to 2000 m and appear in a variety of ecological and altitudinal zones. The majority of the species are found below an elevation of 1000 meters. In India, *C. acanthospathus* is the only species which is seen above 1700 m (Fischer et al., 2011). *Calamus* are complex species because they are mostly climbers with spiky, scaly fruits. A perusal of literature reveals that Beccari and Hooker (1894) were the first who reported distribution of *Calamus* from undivided British India. They reported 72 species of *Calamus*. Many researchers have also reported the distribution of *Calamus* species from India and north eastern region (Renuka et al., 1996; Bora et al., 2012; Henderson et al., 2020; Mondal et al., 2020). Whereas the distribution of *Calamus* species from Arunachal Pradesh was reported by Haridasan et al (2002). *Calamus* is the largest rattan genus represented by 375 species and mostly found in Asia (Dransfield, 1992; Monohara, 2007). There are 37 species and three variants of *Calamus* reported from varied habitats in the Himalaya, Western Ghats, and Andaman & Nicobar Islands of India (Renuka et al., 1987; Basu, 1992; Mondal et al., 2019). North-East India comprises of 18 species of *Calamus* and Arunachal Pradesh alone harbours 12 species of *Calamus*. Furthermore, two subspecies of *Calamus nambariensis* namely *Calamus nambariensis* subsp. *nambariensis* and *Calamus nambariensis* subsp. *arunachalensis* from Northeast India are reported by Deka et al (2020). Arunachal Pradesh has the highest rattan species followed by Assam and Meghalaya. Although the composition of *Calamus* species is highest in Arunachal Pradesh but it has become relatively

rare due to extensive habitat degradation and exploitation. Haridasan et al (2002) described detailed on propagation and plantation of canes in Arunachal Pradesh. Renuka et al (1987) identified rattan species based on floral characters as most of the species are extracted before flowering and fruiting. Whereas, some researchers identified rattan species based on their morphological characters like stem diameter, types of spines and their arrangement on stems and leaves, presence of knee, ocrea and their shapes (Renuka et al., 1987; Dransfield and Baker, 2003; Merklinger et al., 2014). Since there is no information available on morphological characteristics of *Calamus* species of Arunachal Pradesh, therefore, the present study was taken to study the detailed morphological characteristics of selected species.

2. Material and method

Extensive field surveys were carried out in three districts of Arunachal Pradesh, and eleven species were collected for the present study (Table 1). GPS coordinates and photographs of morphological characteristics like clumps, stem, leaf sheath, spines etc. were taken for each species at study site. The colour of leaf sheath, shape and arrangement of leaflets presence and absence of cirrus, flagellum, knee and spines arrangement were noted. The species were identified by consulting the relevant literature available (Renuka, 1996; Mondal et al., 2018; Haridasan et al., 2002; POWO, 2024).

3. Result

Comparative morphological features of the selected *Calamus* species were presented in Table 2. Clustered stems were observed in all the *Calamus* species except *C. acanthospathus*. *C. erectus*



Figure 1. Stem: *Calamus acanthospathus* (A), *Calamus erectus* (B), *Calamus flagellum* (C), *Calamus floribundus* (D), *Calamus gracilis* (E), *Calamus inermis* (F), *Calamus khasianus* (G), *Calamus latifolius* (H), *Calamus leptospadix* (I), *Calamus nambariensis* (J), *Calamus nambariensis* ssp. *arunachalensis* (K).

possessed a non-climbing stem, while the other had a climbing

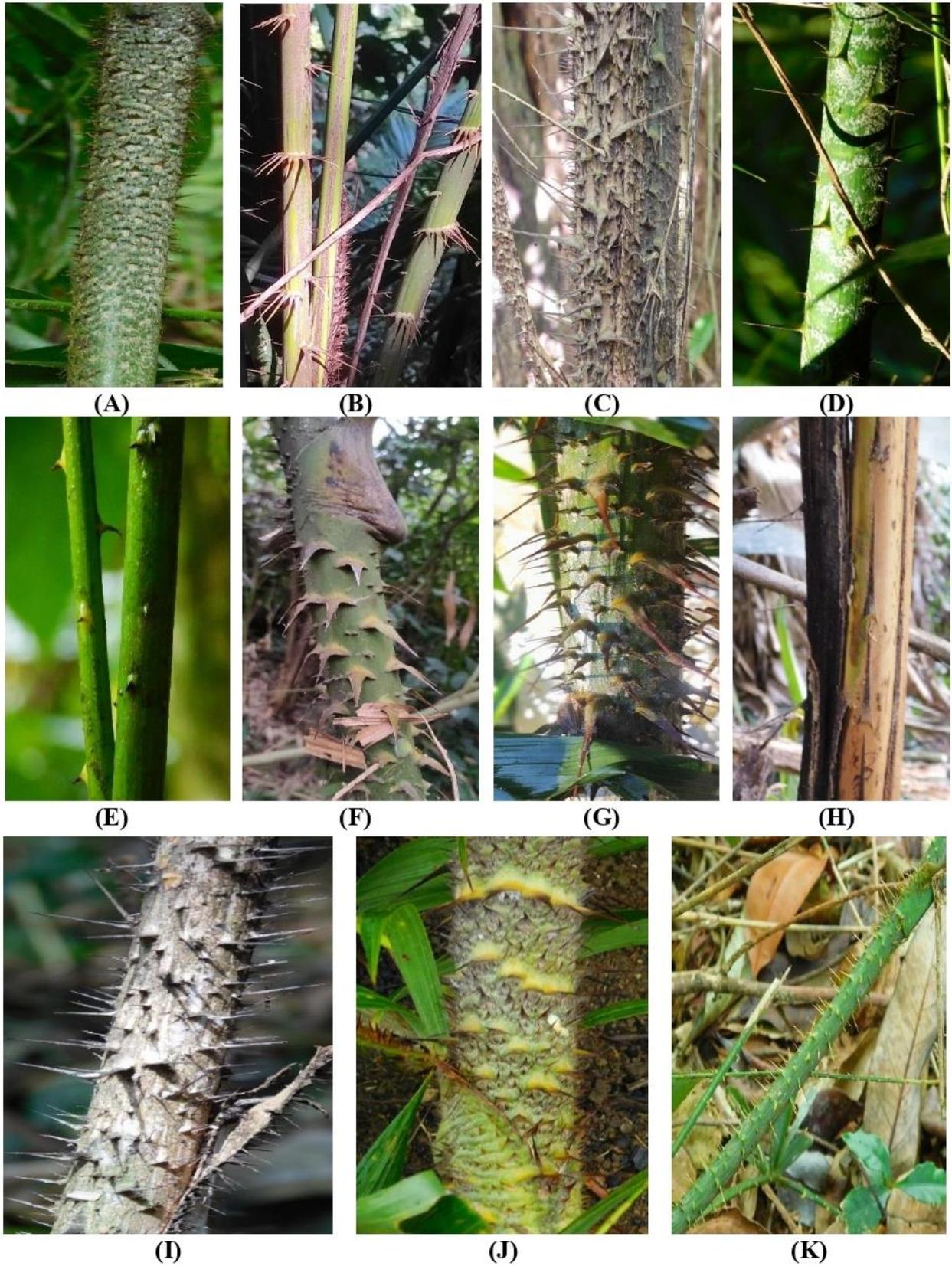


Figure 2. Spine arrangement: *Calamus acanthospathus* (A), *Calamus erectus* (B), *Calamus flagellum* (C), *Calamus floribundus* (D), *Calamus gracilis* (E), *Calamus inermis* (F), *Calamus khasianus* (G), *Calamus latifolius* (H), *Calamus leptospathix* (I), *Calamus nambariensis* (J), *Calamus nambariensis* ssp. *arunachalensis* (K).



Figure 3. Leaflets arrangement: *Calamus acanthospathus* (A), *Calamus erectus* (B), *Calamus flagellum* (C), *Calamus floribundus* (D), *Calamus gracilis* (E), *Calamus inermis* (F), *Calamus khasianus* (G), *Calamus latifolius* (H), *Calamus leptospathix* (I), *Calamus nambariensis* (J), *Calamus nambariensis* ssp. *arunachalensis* (K).

Table 1. List of selected *Calamus* species collected from different localities of Arunachal Pradesh.

Species name	Geographical co-ordinates	Locality
<i>Calamus acanthospathus</i>	28°28' 18.7"N 94°80' 26.9"E	Jomo village, Siang district
<i>Calamus erectus</i>	28°00' 57.5"N 95°14' 25.7"E	Takilalung village, East Siang district
<i>Calamus flagellum</i>	27°97' 31.8"N 95°03' 25.3"E	Sido village, East Siang district
<i>Calamus floribundus</i>	27°97' 04.7"N 95°03' 08.8"E	Sido village, East Siang district
<i>Calamus gracilis</i>	28°26' 24.7"N 94°82' 67.4"E	Jomo village, Siang district
<i>Calamus inermis</i>	27°09' 42.5"N 93°08' 05.3"E	Rilloh village, Pakke Kesang district
<i>Calamus khasianus</i>	27°12' 52.3"N 93°06' 14.3"E	Rilloh village, Pakke Kesang district
<i>Calamus latifolius</i>	27°97' 33.3"N 95°02' 92.2"E	Sido village, East Siang district
<i>Calamus leptospadix</i>	27°90' 28.5"N 95°30' 00.8"E	Sille village, East Siang district
<i>Calamus nambariensis</i>	27°94' 37.6"N 95°16' 87.8"E	Bilat village, East Siang district
<i>Calamus nambariensis ssp. arunachalensis</i>	28°28' 35.0"N 94°81' 31.1"E	Jomo village, Siang district

namely scattered in *C. floribundus*, *C. gracilis*, *C. inermis*, *C. latifolius* and *C. leptospadix* (Figures 2 D, E, F, G, H, I). Dense in *C. acanthospathus*, *C. flagellum*, *C. khasianus*, *C. nambariensis* and *C. nambariensis ssp. arunachalensis* (Figures 2 A, C, J, K). In *C. erectus*, however, the spines were arranged in a whorl (Figure 2B). The colour of leaf sheath varied from dark green (*C. erectus* and *C. gracilis*) to greenish brown (*C. acanthospathus*, *C. floribundus*, *C. inermis*, *C. khasianus* and *C. leptospadix*) to greenish yellow (*C. flagellum*, *C. latifolius*, *C. nambariensis*, and *C. nambariensis ssp. arunachalensis*). The shape of leaflets was lanceolate in *C. acanthospathus*, *C. inermis*, *C. khasianus*, *C. latifolius* and *C. nambariensis*, linear to lanceolate in *C. erectus*, *C. flagellum* and *C. leptospadix* and linear in *C. floribundus*, *C. gracilis* and *C. nambariensis ssp. arunachalensis*. The arrangement of leaflets was regular (*C. acanthospathus*, *C. erectus*, *C. flagellum* and *C. gracilis*), alternate (*C. floribundus*, *C. leptospadix* and *C. nambariensis ssp. arunachalensis*) and clustered (*C. inermis*, *C. khasianus*, *C. latifolius* and *C. nambariensis* (Figure 3). All selected *Calamus* species showed the presence of ocreas. Apart from it, all selected *Calamus* species had knees except *C. erectus* and *C. leptospadix*. Flagella were observed in selected *Calamus* species except *C. erectus*, *C. inermis*, *C. khasianus* and *C. nambariensis*. Cirri were observed in *C. inermis*, *C. khasianus* and *C. nambariensis*.

Identification key prepared based on morphological features was given below:

- 1. Spines scattered-----2
- 1a. Spines densely arranged-----6
- 2. Stem solitary-----*C. acanthospathus*
- 2a. Stem clustered-----3
- 3. Stem climbers-----4
- 3a. Stem non-climbers----- *C. erectus*
- 4. Leaf sheaths dark green-----*C. gracilis*
- 4a. Leaf sheaths other than dark green-----5
- 5. Leaflets linear and alternate-----*C. floribundus*
- 5a. Leaflets linear and alternate with gaps-----*C. nambariensis ssp. arunachalensis*

- 6. Knee absent-----*C. leptospadix*
- 6a. Knee present-----7
- 7. Flagella absent-----8
- 7a. Flagella present-----*C. latifolius*
- 8. Cirri absent----- *C. flagellum*
- 8a. Cirri present----- 9
- 9. Leaf sheaths greenish yellow-----*C. nambariensis*
- 9a. Leaf sheaths greenish brown-----10
- 10. Spines scattered-----*C. inermis*
- 10a. Spines densely arranged-----*C. khasianus*

4. Discussion

In the present study, the morphological characteristics of 11 *Calamus* species namely- *Calamus acanthospathus*, *Calamus erectus*, *Calamus flagellum*, *Calamus floribundus*, *Calamus gracilis*, *Calamus inermis*, *Calamus khasianus*, *Calamus latifolius*, *Calamus leptospadix*, *Calamus nambariensis* and *Calamus nambariensis ssp. arunachalensis* were investigated and it was reported that all the *Calamus* species were climbers except *C. erectus* and confirms the finding of Mathew and Bhat (1997). The presence of clustered stems in all the *Calamus* species except *C. acanthospathus* is in agreement with the findings of Mondal et al., (2018). The arrangement of leaflets was regular (*C. acanthospathus*, *C. erectus*, *C. flagellum* and *C. gracilis*), alternate (*C. floribundus*, *C. leptospadix* and *C. nambariensis ssp. arunachalensis*) and clustered (*C. inermis*, *C. khasianus*, *C. latifolius* and *C. nambariensis*). Similar results are reported in other rattan species by other workers (Renuka et al., 1996; Peter and Henderson, 2014; Deka et al., 2020). Spines were densely arranged in *C. acanthospathus*, *C. flagellum*, *C. khasianus*, *C. nambariensis* and *C. nambariensis ssp. arunachalensis*; scattered in *C. floribundus*, *C. gracilis*, *C. inermis*, *C. latifolius* and *C. leptospadix*. However, the whorl arrangement of spines was observed in *C. erectus*. Similar arrangements of spine on stems of *C. inermis*, *C. erectus* and *C. nambariensis* was reported by Basu (1992) and Singh et al. (2012). The colour of leaf sheath was dark green (*C. erectus* and *C. gracilis*), greenish brown (*C. acanthospathus*, *C. floribundus*, *C. inermis*, *C. khasianus* and *C. leptospadix*) and greenish yellow (*C. flagellum*, *C. latifolius*, *C.*

Table 2. Comparative morphological features of selected *Calamus* species.

Parameter	<i>C. acanthospathus</i>	<i>C. erectus</i>	<i>C. flagellum</i>	<i>C. floribundus</i>	<i>C. gracilis</i>	<i>C. inermis</i>	<i>C. khasianus</i>	<i>C. latifolius</i>	<i>C. leptospadix</i>	<i>C. nambariensis</i>	<i>C. nambariensis ssp. arunachalensis</i>
Stem	Solitary, climbers	Clustered, non-climbers	Clustered, climbers	Clustered, climbers	Clustered, climbers	Clustered, climbers	Clustered, climbers	Clustered, climbers	Clustered, climbers	Clustered, climbers	Clustered, climbers
Spines	Sparsely to densely brown flattened spines	Whorls of yellow spines	Densely arranged black flattened spines	Horizontal to deflexed spines, mostly scattered or seriate	Scattered black tip conical base	Large spines pointing downward conical base with brownish tip	Large reddish tip conical base sparingly arranged, interspersed with small spines	Very large blackish tip pointing straight flat	Scattered yellowish flattened	Densely triangular flattened downward pointing	Densely large and small deflexed and triangular base flat
Leaf sheaths	Greenish brown	Dark green	Greenish yellow	Greenish brown	Dark green	Greenish brown	Greenish brown	Greenish yellow	Greenish brown	Greenish yellow	Greenish yellow
Leaflet	Lanceolate, regularly arranged	Linear lanceolate, regularly arranged	Linear lanceolate, regularly arranged	Linear, alternately arranged	Linear, regularly arranged with gaps	Lanceolate, clustered	Lanceolate, clustered	Lanceolate, clustered	Linear lanceolate, alternately arranged	Lanceolate, clustered	Linear, alternately arranged with gaps
Ocreas	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present	Present
Knees	Present	Absent	Present	Present	Present	Present	Present	Present	Absent	Present	Present
Flagella	Present	Absent	Present	Present	Present	Absent	Absent	Present	Present	Absent	Present
Cirri	Absent	Absent	Absent	Absent	Absent	Present	Present	Absent	Absent	Present	Absent

nambariensis, *C. nambariensis ssp. arunachalensis*). Similar result of leaf sheath colour of *C. erectus*, *C. flagellum*, *C. gracilis* and *C. nambariensis* was also reported by Peter and Henderson (2014). However, there is no report on the colour of leaf sheath of other *Calamus* species. Ocreas were present in all the selected *Calamus* species. Absence of knee, flagella and cirri in *C. erectus* confirms the finding of Peter and Henderson (2014). Most of the selected *Calamus* species did not have cirri except *C. inermis*, *C. khasianus* and *C. nambariensis* and confirms the finding of Haridasan et al (2002).

5. Conclusion

The present investigation revealed that the arrangement of spines on stem, colour of leaf sheath, shape of leaflet and their arrangement and presence of ocrea, knee, cirrus and flagella were species specific. *C. acanthospathus* distinguished from other *Calamus* species by presence of solitary stem. Whorls of yellow spine and non-climber stem differentiated *C. erectus* from other *Calamus* species. Whereas, presence of greenish yellow leaf sheath, densely arranged spines and linear lanceolate regularly arranged leaflet differentiated *C. flagellum* from other *Calamus* species. Dark green leaf sheath and linear alternately arranged leaflet with gaps distinguished *C. gracilis* from other *Calamus* species. However, species which look similar like *C. nambariensis* and *C. nambariensis ssp. arunachalensis*; *C. leptospadix* and *C. floribundus*; *C. inermis*, *C. khasianus* and *C. latifolius* can be differentiated based on their distinct morphological features. *C. nambariensis ssp. arunachalensis* are differentiated from *C. nambariensis* by presence of linear alternately arranged with gaps leaflet. Spine arrangement and presence of knee distinguished *C. floribundus* from *C. leptospadix*. Greenish yellow leaf sheath and presence of flagella distinguished *C. latifolius* from *C. inermis* and *C. khasianus*. Furthermore, densely spine arrangement on *C. khasianus* differentiated it from *C. inermis*. The morphological features are species specific and can be used for the identification of the *Calamus* species.

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Conflict of Interest

Authors have no conflict of interest.

Author's contribution

First author contributed to field work, identification of species and drafted manuscript. Second and third authors supervised

throughout the study, edited and finalised the manuscript. Fourth author assisted in identification of species.

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