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MALE FLOWER AND ANDROECIUM MORPHOLOGY OF *BEGONIA* SPECIES IN NEPAL

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ABSTRACT

The biodiversity in the large genus *Begonia* is partitioned between 63 sections. Characters that are currently considered important in delimiting *Begonia* sections are mostly floral, and include features of the styles, stigmas, ovaries and fruits. Stamen morphology in the Begoniaceae has been somewhat neglected. However, the present study of the stamen morphology of *Begonia* species of Nepal have shown that some characters are of diagnostic value at the section level, which has been discussed in this paper.

Key words : Anther, *Diploclinium, Platycentrum, Sphenanthera, Monopteron.*

INTRODUCTION

Begonia picta was the first Nepalese *Begonia* species described by Smith (1805) based on a specimen collected by F. Buchanan-Hamilton during 1802-1803. The genus was previously represented by 18 species in Nepal (Hara *et al*., 1978; Doorenbos *et al*., 1998; Press *et al*., 2000), now one new record (Rajbhandary and Shrestha, 2009) and three new species from Nepal (Rajbhandary *et al*., 2010) bring the total number of *Begonia* species known from the country to 22. These are placed within five different sections: *Diploclinium* (Lindl.) A.DC., *Monopteron* (A.DC.) Warb., *Platycentrum* (Klotzsch) A.DC, *Putzeysia* (Klotzsch)A.DC and *Sphenanthera* (Hassk.) Warb. (Smith *et. al*., 1986; Doorenbos *et al*., 1998). There are seven endemic species in Nepal: *Begonia tribenensis* C.R.Rao, *Begonia minicarpa* H.Hara, *Begonia flagellaris* H.Hara, *Begonia leptoptera* H.Hara, *Begonia nuwakotensis* S.Rajbhandary, *Begonia panchtharensis* S. Rajbhandary and *Begonia taligera* S. Rajbhandary.

Characters that were considered important in the early days of classification in delimiting *Begonia* sections were found mostly in the flowers, and included features of the styles, stigmas, ovaries and fruits. Klotzsch's (1855) work represents a landmark in the history of the study of *Begonia* because it marks the starting point for a modern approach to the treatment of the group. His classification of *Begonia* was based on the differences of the style shape and on stamen morphology, which he considered as taxonomic characters of primary significance.

The number of perianth segments in both the male and female flowers are also important characters for delimiting *Begonia* sections. *Begonia* perianth is considered by some as differentiated into sepals and petals (deCandolle, 1859, 1864; Lawrence, 1951; Hutchinson, 1959; Burt-Utley, 1985). Despite this, few authors have used this terminology, preferring to refer to tepals (Irmscher 1925; Doorenbos *et al.* (1998).

As with many other species-rich genera, *Begonia* suffers from a considerable amount of taxonomic confusion. Many species are still unassigned to any section and this is due in part to the lack of knowledge about some species, especially Asian ones. For example, Doorenbos *et al.* (1998) pointed out that in describing American and Asian *Begonia* species, authors often did not mention whether the anther apex was hooded or not and that correct information on this feature is lacking for 17 sections. The androecium has often been considered to be of diagnostic value for *Begonia* sections (Doorenbos *et al*., 1998) and to a lesser degree it has been used to distinguish species within sections, e.g. section *Tetraphila* (de Wilde 2002). However, anther morphology of the Begoniaceae has not been studied very extensively, so this paper tends to highlight the characteristic features of androecium, dimensions and structure of the anthers of 22 *Begonia* species in Nepal.

MATERIALS AND METHOD

Studies were carried out on flowers of 21 *Begonia* species in Nepal belonging to four sections *Diploclinium* (Lindl.) A.DC., *Monopteron* (A. DC.) Warb., *Platycentrum* (Klotzsch)A.DC, and *Sphenanthera* (Hassk.) Warb. (Smith *et. al*., 1986; Doorenbos *et al*., 1998). Due to lack of male flowers in *Begonia gemmipara* (section *Putzeysia* (Klotzsch) A.DC) during the collection and in the herbarium, the stamen morphology of this species could not be studied, so stamen morphology was carried out on 21 *Begonia* species of four sections.

Structures of the anthers were examined and measured using a Motic binocular dissecting microscope. The anthers from fresh material were mounted on the slides

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under a drop of glycerin and covered with a cover slip to observe and measure. The scale on the Motic binocular dissecting microscope was used to measure the dimensions of the anthers. Anthers from herbarium material were soaked for several hours before being observed and measured.

RESULTS AND DISCUSSION

All species of *Begonia* in Nepal have four tepals in the male flowers (Fig. 1). The outer have a broad base and larger in size and more colourful than the inner. Morphological variation in male flowers include the shape and colours of tepals, and in stamen number, androecium, anther and filament size (Table 1).

Male flowers consist of two outer tepals with valvate aestivation. The outer tepals range in colour from white to light or dark pink, depending upon the species, or sometimes white with green tinge. They may vary according to light exposure as those found growing in the shade mostly have lighter coloured flower than the ones growing in brighter light. They also vary in shape ranging from ovate through sub- orbicular to elliptic, oblong, obovate or broadly ovate.

Nepalese *Begonia* can be sorted into two groups: those with glabrous tepals and those with outer tepals hairy. Externally the outer tepals are either glabrous (*B. dioica, B. josephii, B. minicarpa, B. tribenensis, B. gemmipara, B. hatacoa, B. megaptera, B. panchtharensis, B. rubella, B. sikkimensis, B. taligera, B. nepalensis*) or sparsely pilose to pilose (*B. flagellaris, B. leptoptera, B. ovatifolia, B. picta, B.annulata, B.cathcartii, B. flaviflora, B. nuwakotensis, B.palmata, B.roxburghii*). Again depending on the species the colour of the trichomes varies from transparent white to scarlet. The tepal margin of all Nepalese *Begonia* species is entire except for *B. annulata, B. nuwakotensis* but *B. picta* have a ciliate margin.

All Nepalese *Begonia* species have two inner tepals in the male flower. They vary in shape from ovate, oblanceolate, elliptic, oblong or linear-lanceolate with cuneate base and apex ranging from obtuse to acute, sub-acute or retuse. The outer surface is glabrous and mostly white in colour. In *Begonia* section *Diploclinium* the size ranges from 5-16 × 2.5-10 mm and in section *Platycentrum* the size ranges from 4-20 × 2-13 mm.

In most of the species the androecium are symmetric, but some species posses an asymmetric androecium (*B. flagellaris, B. minicarpa, B. rubella*). Stamens in *Begonia* are fasciculate on a flat or slightly raised sub-convex torus or receptacle. They are usually yellow, or golden yellow and sometimes orange or dark yellow in colour. The filaments are short but of varying lengths within a fascicle, with the longer filaments either at the centre or at the base.

Table 1. Variation in stamen number, androecium, anther and filament size of male flowers in *Begonia* species of Nepal.

Name	Androecium (mm)	No. of stamens	Anther (mm)	Anther shape	Filament (mm)
Begonia* sect. *Diploclinium					
B. dioica	2-3	30-35	0.8-1	obovoid or obovate	1-1.5
B. flagellaris	c. 3	12-22	1-1.5	obovoid	c. 1
B. josephii	3-3.5	11-24	1-1.5	oblong to obovate-oblong	0.5-0.8
B. leptoptera	2.5-3	15-16	1-1.5	obovate	c. 1
B. minicarpa	1.5-2	10-12	0.8	obovoid or obovate	c. 0.2
B. ovatifolia	1.5-2	c. 20	0.6	obovoid	c. 0.2
B. picta	5-7	35-60	0.8-1.4	oblong	0.7-3.5
B. rubella	3-5	30-36	1-1.5	broadly obovate	0.5-1
B. tribenensis	3-4	c. 30	1-1.5	broadly obovate	0.5 - 1
Begonia* sect. *Platycentrum					
B. annulata	5-6	115-130	c. 1	obovate	1.5-2
B. cathcartii	7-9	100-110	1.0 -1.5	obovate	1.5-1.8
B. flaviflora	7-8	105-110	1.2-2	oblong	1-2.5
B. hatacoa	4-5.5	40-65	1.8-2.5	oblong elliptic or obovate	0.8-1.5
B. megaptera	6-8	60-80	c. 1	obovoid	1.2-2
B. nuwakotensis	6-10	c. 100	1.2-1.5	narrowly obovoid	1-2
B. palmata	4-8	100-200	1.0-2	narrowly obovoid	0.8-2.5
B. panchtharensis	9-12	125-141	1-1.5	oblong	0.5-2.5
B. sikkimensis	5-6	50-60	1.5-2	obovate or oblong elliptic	1.5-2
B. taligera	7-9	90-95	2-2.5	narrowly obovate	1-2
Begonia* sect. *Monopteron					
B. nepalensis	3-4	35-40	c. 1	obovoid	1-1.5
Begonia* sect. *Sphenanthera					
B. roxburghii	6-7	50-65	2-2.5	obovate-oblong or oblong elliptic	1.5-2

The filaments are either fused shortly at the base (*B. hatacoa* and *B. taligera, B. roxburghii*), free to the base on the front and slightly fused on one side or in the rear of the androecium (*B. flagellaris*), fused into a column with filaments arising all the way up the column (*B. minicarpa; B. picta; B. rubella; B. tribenensis; B. palmata; B. nuwakotensis; B. panchtharensis; B. cathcartii; B. annulata; B. flaviflora; B. nepalensis; B. sikkimensis* and *B. megaptera*), or fused at least half way into a column (*B. dioica; B. josephii; B. leptoptera* and *B. ovatifolia*) (Fig. 4).

Among the species the shape of anther varies from oblong, oblong-elliptic, obovoid to obovate. They also differ in size ranging from 1 to 2.5 mm long depending on the species (Table 1). Most of the anthers observed dehisce via stomia that are positioned longitudinally

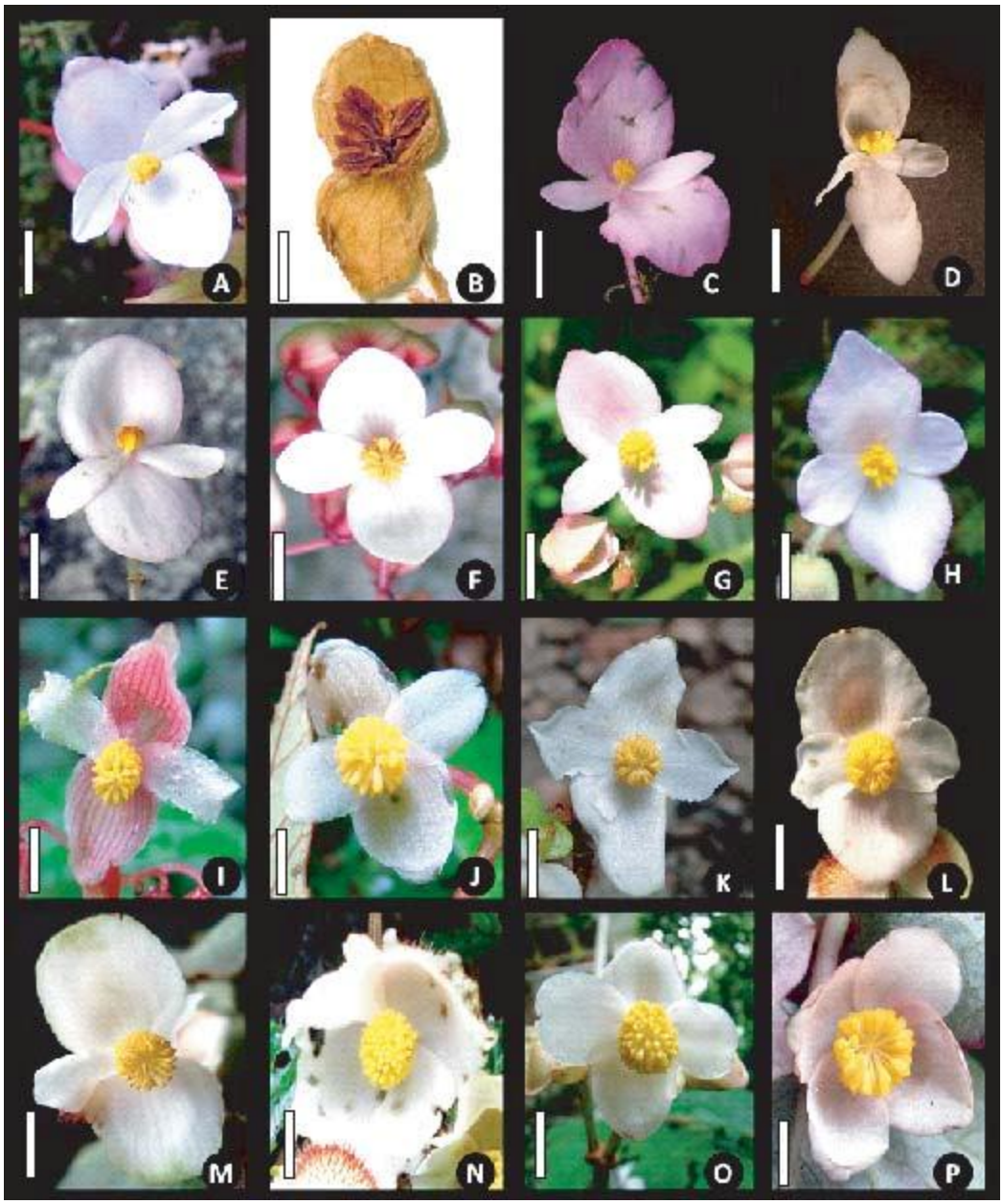

Fig. 1. Variation in male flowers (Section ***Diploclinium*** A-H): **A.** *B. dioica* (Rajbhandary & Bista 39) scale bar = 9 mm; **B.** *B. minicarpa* (Williams & Stainton 8319) scale bar = 2 mm ; **C.** *B. leptoptera* (Rajbhandary & Bista S53) scale bar = 5 mm; **D.** *B. flagellaris* (Rajbhandary & Bista 10) scale bar = 6 mm; **E.** *B. josephii* (Shrestha & Rajbhandary S77) scale bar = 10 mm; **F.** *B. tribenensis* (Rajbhandary & Poudyal S1) scale bar = 6 mm; **G.** *B. rubella* (Rajbhandary *et al.* 15) scale bar = 5 mm; **H.** *B. picta* (Rajbhandary S03) scale bar = 10 mm; (Section ***Platycentrum*** I-P): I. *B. hatacoa* (Rajbhandary & Bista 4) scale bar = 6 mm; **J.** *B. taligera* (Rajbhandary *et al. S52*) scale bar = 9 mm; **K.** *B. nuwakotensis* (Rajbhandary *et al. S31*) scale bar = 9 mm; **L.** *B. palmata* (Rajbhandary *et al. 27*) scale bar = 10 mm; **M.** *B. annulata* (Shrestha S75) scale bar = 8 mm; **N.** *B. cathcartii* (Mao M93) scale bar = 10 mm; **O.** *B. panchtharensis* (Thamsuhang S74) scale bar = 10 mm, and **P.** *B. sikkimensis* (Rajbhandary *et al. 14*) scale bar = 6mm.

along the sides of the anthers and curved at the distal end (Figs. 4 & 5) towards the front of the anther (*B. hatacoa, B. flaviflora, B. taligera, B. cathcartii, B. annulata, B. josephii, B. leptoptera, B. panchtharensis, B. roxburghii* and *B. sikkimensis*). In few taxa, the stomia are simply positioned longitudinally along the sides as in *B. rubella, B. picta, B. tribenensis, B. flagellaris, B. ovatifolia* (Fig. 4). Similarly, pollen is shed through arcuate longitudinal opening in *B. dioica, B. palmata, B. nuwakotensis, B. megaptera, B. nepalensis* (Figs. 4, 5). Poricidal dehiscence as described by Doorenbos *et al.* (1998) was observed in *B. minicarpa* (Fig. 4E).

The extension of the anther connective varies depending on the species. Connectives in most of the species of the section *Platycentrum* and section *Sphenanthera* (Fig. 5) are long and extended, while in section *Diploclinium* (Fig. 4) and section *Monopteron* (Fig. 5) there is an extension of the connectives in few species like *B. minicarpa, B. ovatifolia, B. picta, B. rubella, B. tribenensis* and *B. nepalensis* (section *Monopteron)*, but in most of the species there is complete absence of connective or they are obscure in *B. leptoptera, B. flagellaris* and *B. dioica*.

According to Doorenbos *et al.* (1998), the androecium characters are often of diagnostic value for *Begonia* sections, and to a lesser extent can be used to distinguish species within sections. This is true in the present finding as in section *Diploclinium* and section *Putzeysia* the stamens form a small fascicle which is more or less flat in structure (Fig. 2.), while in sections *Platycentrum, Monopteron* and *Sphenanthera* they form a globose cluster (Fig. 3.). Similarly, depending on the species the stamen number varies from 10 to 200 (Table 1), which can also be used to separate the sections. Not only does the number of stamens differs across the sections but there is a clear pattern in the orientation of anthers within the androecium that can be taken as diagnostic at the section level of *Begonia* species of Nepal. The number of stamens ranges from 10

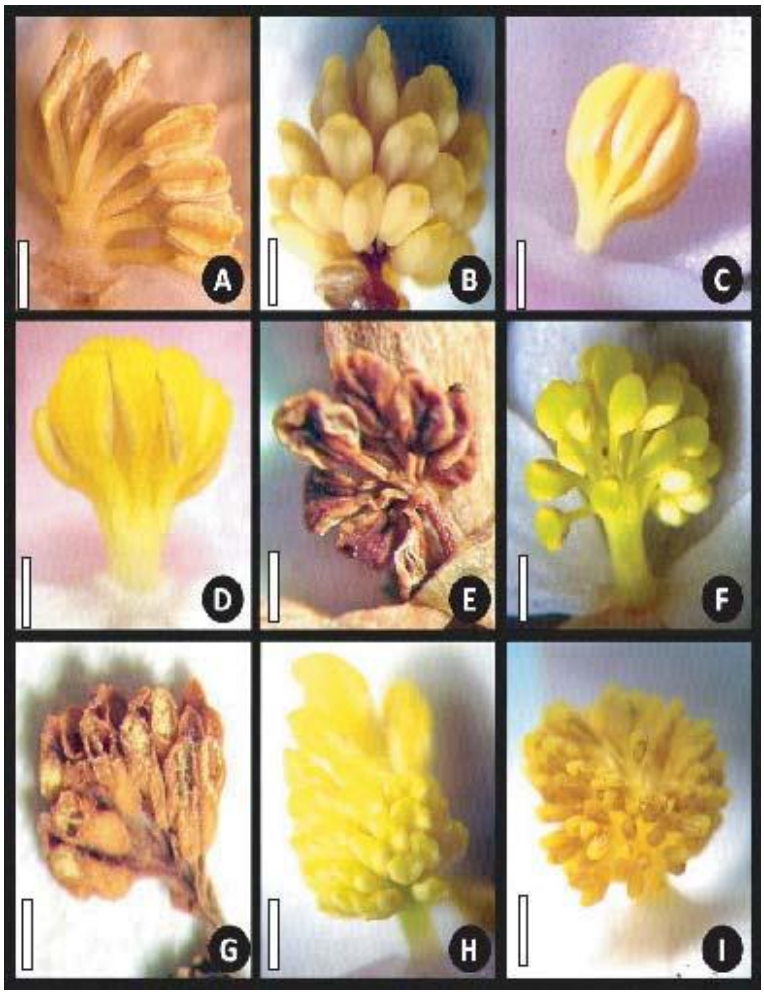

Fig. 2. Variation in androceium in section ***Diploclinium***: **A.** *B. flagellaris* (Rajbhandary & Bista 10) scale bar = 1 mm; **B.** *B. tribenensis* (Rajbhandary & Poudyal S1) scale bar = 1 mm; **C.** *B. josephii* (Rajbhandary & Bista S56) scale bar = 1 mm; **D.** *B. leptoptera* (Rajbhandary & Bista S54) scale bar = 0.9 mm; **E.** *B. ovatifolia* (Williams & Stainton 8317) scale bar = 0.6 mm; **F.** *B. dioica* (Rajbhandary 42) scale bar = 1 mm; **G.** *B. minicarpa* (Williams & Stainton 8319) scale bar = 0.5 mm; **H.** *B. rubella* (Bista S11) scale bar = 1 mm; and **I.** *B. picta* (Rajbhandary & Bista S02) scale bar = 1.5 mm.

to 36 in section *Diploclinium* (except in *Begonia picta* where the stamen number ranges from 35 to 60 and the anthers are introrse (Fig. 2)), while in section *Platycentrum* the stamen number ranges from 40 to 200 and the anthers are extrorse (Fig. 3). In section *Monopteron* the stamen number ranges from 35 to 40 and the anthers are introrse whereas in section *Sphenanthera* the stamen number ranges from 50 to 65 the anthers are extrorse (Fig. 3).

Anther shape was not found to be a good diagnostic feature at sectional level. Obovoid and oblong anthers are very common and found in most species; broadly triangular anthers are less common, found only in *Begonia rubella* and *B. tribenensis,* which is an important character of the monotypic Asian *Begonia* section *Heeringia* (Doorenbos *et al.* 1998). However, the presence and extension of the connective in the anther can be diagnostic at section level e.g. to separate section *Diploclinium* and section *Monopteron* from section *Platycentrum* and section *Sphenanthera* as the anthers in the species of the section *Platycentrum* and section *Sphenanthera* have long extended connective (Fig. 5).

CONCLUSION

From the present study it can be concluded that stamen morphology is, to some extent, useful in sectional diagnosis as discussed in the preceding paragraphs. But even in a well-circumscribed section, there are substantial differences in anther morphology among the species. In section *Diploclinium*, for example, *Begonia minicarpa, B. ovatifolia, B. picta, B. tribenensis* and *B. rubella* are with distinct extended connectives, there is not a very strong basis for placing these species within the same section based on the anther morphology data. However, when other morphological characters are taken into consideration, especially those of the fruit and the tepal, there is much support for these species to be included in section *Diploclinium*.

The study has been done with very simple equipment, but the use of Scanning Electronic Microscope (SEM) for the observations of *Begonia* anther may provide the opportunity for finding additional characters that has not been explored in the present study.

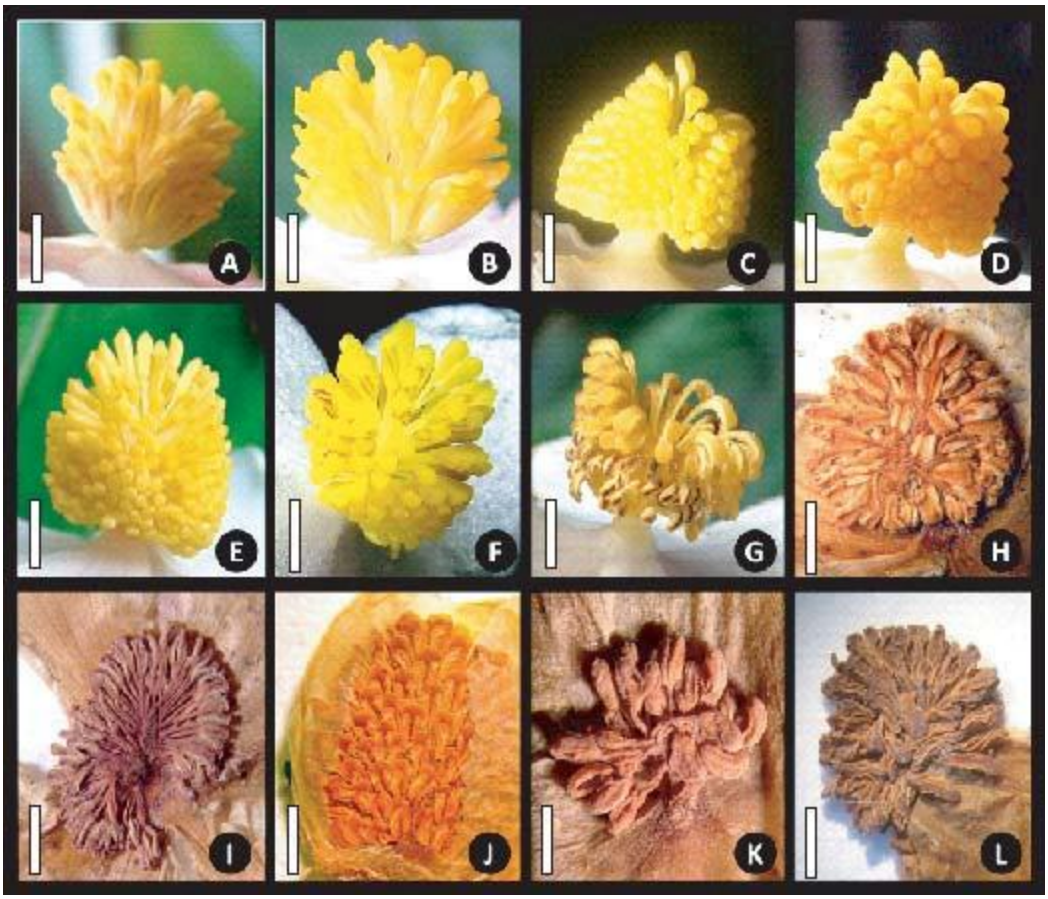

Fig. 3. Variation in androceium of section *Platycentrum, Monopteron & Sphenanthera: Section* ***Platycentrum****: A. B. hatacoa (*Rajbhandary S4*)* scale bar = 2 mm*; B. B. taligera (*Rajbhandary & Adhikari S52*)* scale bar = 3 mm*; C. B. palmata (*Rajbhandary *et al.* S27*)* scale bar = 2 mm*; D. B. nuwakotensis (*Rajbhandary *et al. S31)* scale bar = 2 mm*; E. B. panchtharensis (*Thamsuhang S74*)* scale bar = 3 mm*; F. B. sikkimensis (*Rajbhandary *et al. S14*) scale bar = 2 mm*; G. B. annulata (*Shrestha S75*)* scale bar = 3 mm*; H. B. megaptera (*Kshretri 76*)* scale bar = 2 mm; I. *B. cathcartii (*Noshiro 9241006*)* scale bar = 3 mm*; J. B. flaviflora (*Adhikari *et al. 146*) scale bar = 2 mm*; Section* ***Monopteron****: K. B. nepalensis (*Stainton 8906*)* scale bar = 2 mm*;* and Section ***Sphenanthera****: L. B. roxburghii (*Chand 5998*) scale bar = 3 mm.*

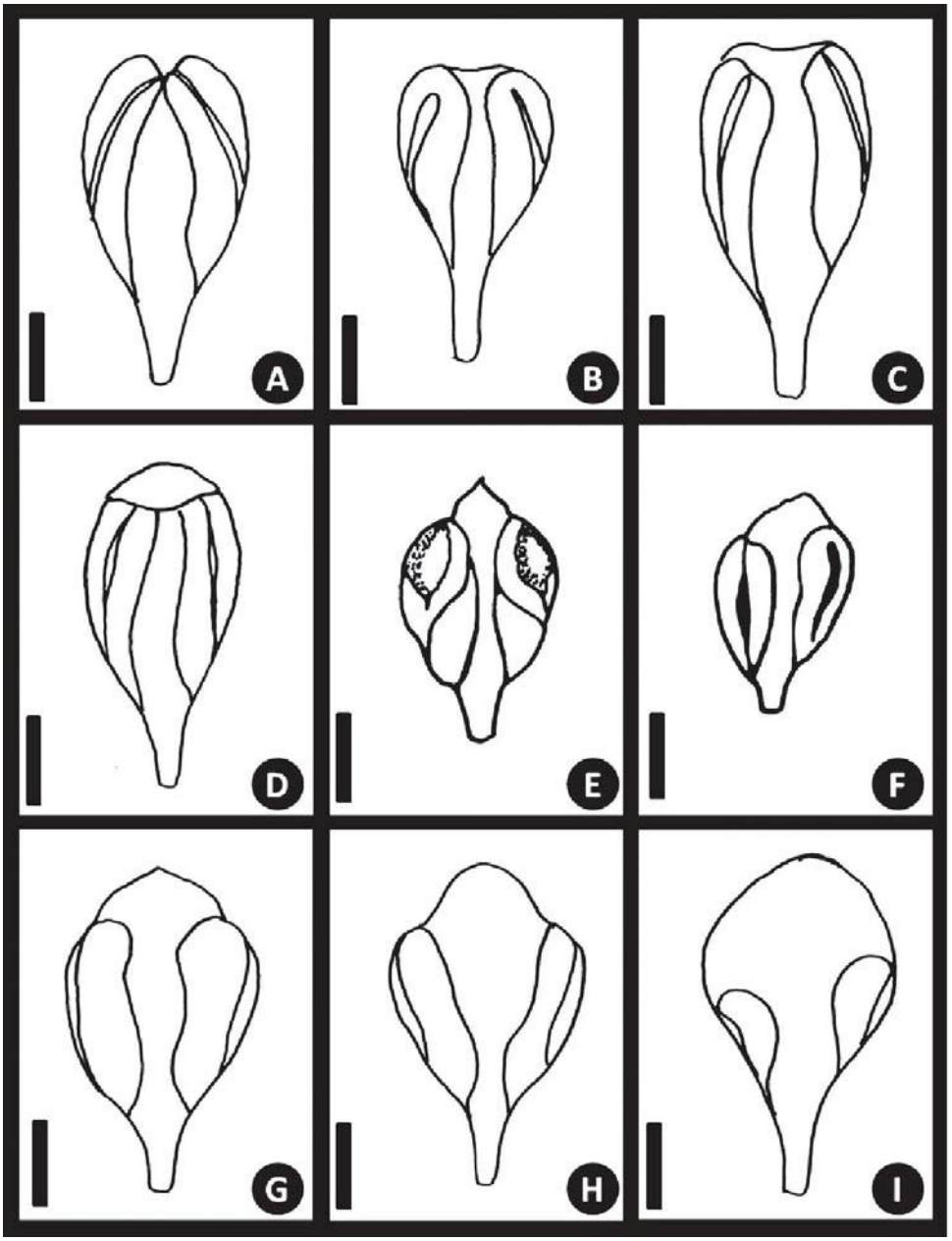

Fig. 4. Variation in stamens of section ***Diploclinium****: A. B. leptoptera (*Rajbhandary & Bista S53*)* scale bar = 0.5 mm*; B. B. dioica (*Rajbhandary & Bista S40*)* scale bar = 0.5 mm*; C. B. flagellaris (*Rajbhandary & Bista S10*)* scale bar = 0.5 mm*; D. B. josephii* (KEKE 19) scale bar = 0.5 mm*; E. B. minicarpa (*Buchanan-Hamilton 2053*)* scale bar = 0.3 mm*; F. B. ovatifolia (*William & Stainton 8317*)* scale bar = 0.3 mm*; G. B. tribenensis (*Rajbhandary & Poudel S1) scale bar = 0.5 mm*; H. B. picta (*Rajbhandary & Bista S02) scale bar = 0.5 mm*; I. B. rubella (*Bista S11*)* scale bar = 0.5 mm.

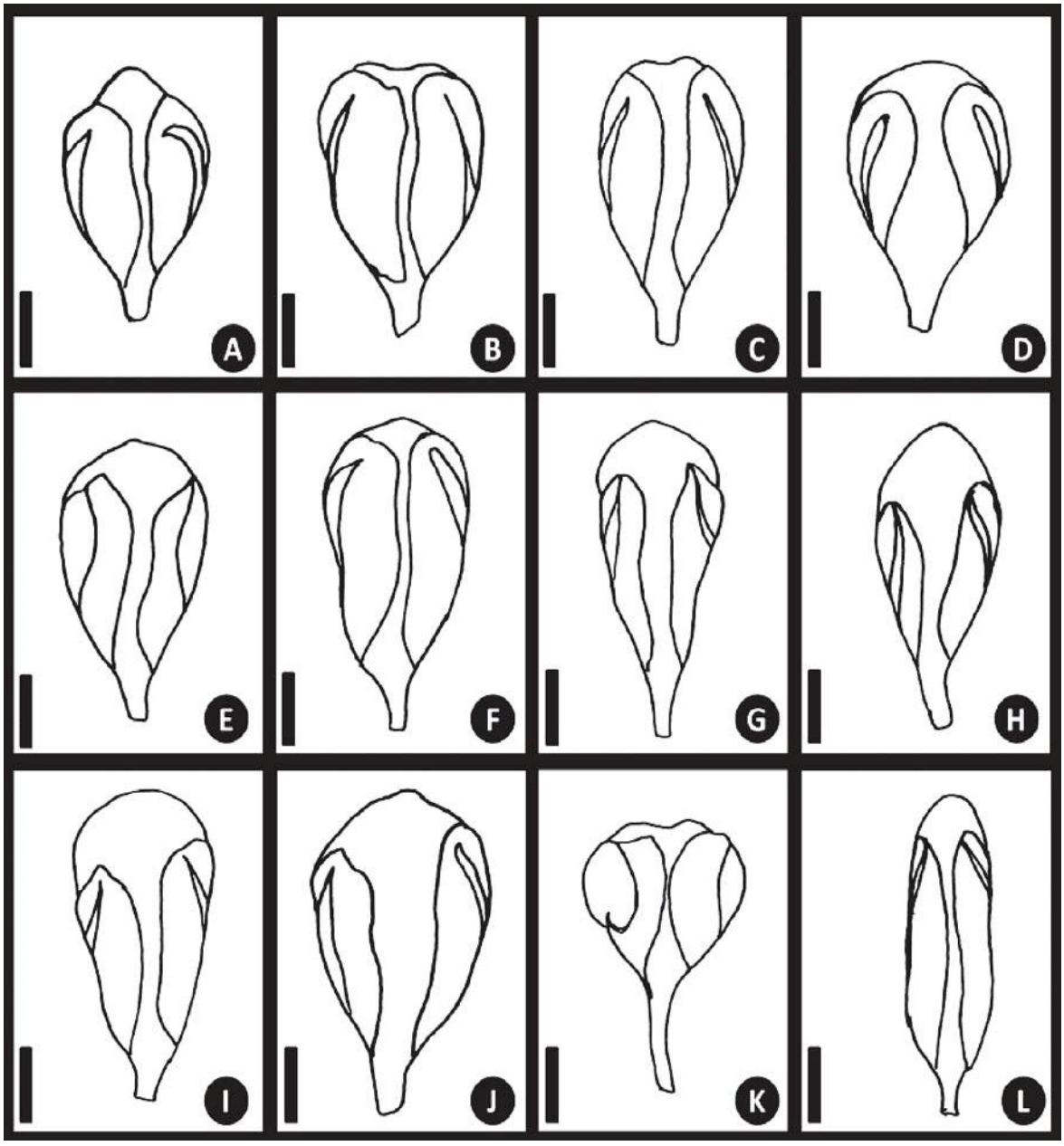

Fig. 5. Variation in stamens of section ***Platycentrum, Monopteron and Sphenanthera***. Section ***Platycentrum***: **A.** *B. annulata* (Shrestha S75), scale bar = 0.35 mm; **B.** *B. megaptera* (Kshretri 76), scale bar = 0.36 mm; **C.** *B. palmata* (Rajbhandary *et al. S27*), scale bar = 0.6 mm; **D.** *B. flaviflora* (Adhikari *et al. 146*), scale bar = 0.65 mm; **E.** *B. sikkimensis* (Rajbhandary *et al. S14*), scale bar = 0.6 mm ; **F.** *B. cathcartii* (Noshiro 9241006), scale bar = 0.4 mm; **G.** *B. taligera* (Rajbhandary & Adhikari S52), scale bar = 0.7 mm; **H.** *B. panchtharensis* (Thamsuhang S74), scale bar = 0.5 mm ; **I.** *B. hatacoa* (Rajbhandary S4), scale bar = 0.7 mm ; **J.** *B. nuwakotensis* (Rajbhandary *et al. S31*), scale bar = 0.4 mm; section ***Monopteron:*** **K.** *B. nepalensis* (Stainton 8906), scale bar = 0.5 mm; and section ***Sphenanthera*****: L.** *B. roxburghii* (Chand 5998), scale bar = 0.5 mm.

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