CHAPTER 6
DISCUSSION

In the present revision an attempt has been made to study the morphology of all Indian species of Murdannia. Entire morphological variation occurring within the genus has been considered. Various aspects of morphology are examined, of which the inflorescence; floral and seed morphology are found most functional in delimiting species within this genus.

Vegetative morphology

Habitat

Murdannia, principally an Asiatic genus of Commelinaceae, is distributed mainly in the tropics, sub tropics and warm temperate regions of the world. The species of Murdannia shows considerable ecological diversity. Except for most saline and most xeric conditions, they occur on extensive range of habitats. Mostly they are widespread weeds of agricultural fields. They are found along waysides, marshy and swampy areas, plantations, near streams and waterfalls, sandy soil and sea coasts, woods, secondary forests, mountain grasslands and seepage areas of rock outcrops. The altitudinal distribution ranges from sea level to ca. 2000 meters.

The members are either exposed to sun or occur in shady to partial shady conditions. M. nudiflora and M. spirata, two most common species in India occur in almost all habitats. Perennial species like M. gigantea, M. lanuginosa, M. simplex, M. esculenta are confined mostly to higher elevations, preferably in mountain grasslands. M. japonica and M. edulis are evergreen forest species. M. fadeniana a rosette perennial grows on moist, dripping rocks in stream banks. M. blumei the most aquatic Indian species is seen in marshy pools or tanks. M. crocea an amphibious species occasionally
grows in water. *M. sahyadrica*, *M. semiteres* and *M. juncoide* occur on lateritic rocks during monsoon.

**Habit**

*Murdannia* shows considerable variations in habit. Both annual and perennial species occur in *Murdannia*. The general habit types seen in the genus are discussed below.

Fibrous rooted annuals or perennials are i. decumbent- main shoot overtaken in growth by lateral branches; ii. ascending with longer branches decumbent; iii. ascending; iv. ascending to erect; v. erect; vi. procumbent; vii. long trailing and looping; viii. decumbent or ascending branches with rosette; ix. erect or ascending with dimorphic shoots, the vegetative forming rosettes.

Tuberous rooted perennials are i. ascending to erect with sessile tubers; ii. erect with long uniform thick roots; iii. erect to ascending with long uniform thick roots; iv. erect to ascending with subsessile tubers; v. decumbent or ascending branches with rosette and thick roots; vi. erect to ascending with dimorphic shoots, the vegetative forming rosettes.

*M. assamica* is ascending to decumbent. *M. crocea* and *M. versicolor* are ascending to erect while *M. dimorpha* is ascending with longer shoots decumbent. In *M. dimorpha* the basal leaves sometimes become close together forming a rosette. In *M. fadeniana* and *M. edulis* the shoots are dimorphic where the vegetative shoots forms the basal rosette. In *M. fadeniana*, roots are fibrous while in *M. edulis*, the roots are tuberous. *M. sahyadrica*, *M. semiteres* and *M. juncoide* are erect tufted species. *M. pauciflora* is a procumbent herb. Habit is highly variable in *M. spirata* where it ranges from decumbent or ascending or procumbent or trailing and looping. *M. gigantea* is an erect perennial with long thick roots. In *M. japonica* shoots are erect to ascending with long thick roots. In *M. divergens* and *M. esculenta* shoots are ascending to erect and with sessile tubers. In *M. simplex* and *M.
loriformis the main axis is reduced to a basal rosette where the lateral branches are decumbent to ascending even forming new rosettes.

Roots

In Murdannia the roots in all established plants are adventitious. They are seen at the base or develop from the lower nodes or the nodes that are in touch with the soil. Roots are either thin fibrous or tuberous. Tuberous roots may be variously thickened. All moderately thick roots are treated as tuberous in this account. Fibrous roots are also present in all tuberous rooted plants of Murdannia. In M. gigantea and M. japonica the tuberous roots are long, uniformly thickened and measuring about 5 mm in diameter. In M. japonica long stalked fusiform tubers are also present. Most species have tuberous roots that are tapering either at one end or at both ends. M. edulis have both sessile and fusiform tubers. In M. divergens and M. esculenta, tubers are sessile. In M. lanuginosa tubers are subsessile. In some populations of M. spirata from North East India an unusual thick, tuberous roots are present and such retained is under cultivation also (Plate 93).

Shoot

In Murdannia the shoot system is diffuse without a distinct main axis. The main axis is generally overtaken by the lateral shoots. In Indian plants of M. loriformis and M. simplex, the main stem is reduced to the basal rosette and further growth is continued with lateral shoots developed from the axillary buds. Lateral shoots have two toothed bladeless sheath or a prophyll at their base. Majority of Murdannia species are monomorphic with no difference between vegetative and reproductive shoots. Dimorphic shoots are present in M. edulis and M. fadeniana where the inflorescence is scapose and the vegetative shoot forming the rosettes. Strict dimorphic shoots are absent in Murdannia except in dry conditions or off seasons the vegetative shoots becomes highly thick with reduced leaves, as in M. zeylanica.
Internodes

The internodes, in general, are terete, succulent and green. In most species they are laterally compressed. The length of internodes differs with species. Usually the middle internodes on a branch are longer and gradually the length decreases towards the tip. The succulence of internodes varies according to the species and the habitat. Sometimes the internodes are striped with purple. The colour becomes much prominent during dry season. Internodes are mostly glabrous or with a line of cilia along the compressed region. In *M. lanuginosa* the internodes are covered with long hairs.

Leaves

The leaves are both radical and cauline. Radical leaves are seen in *M. edulis*, *M. fadeniana*, *M. simplex*, *M. gigantea* and *M. loriformis*. Leaves are always simple with parallel veined laminae. Leaf arrangement is commonly alternate or spiral, rarely distichous. Margins are mostly scabrous and slightly hyaline. Much broad hyaline margins are seen in *M. japonica*. In *M. japonica* and *M. fadeniana* margins are highly undulate.

The sheath remains closed in *Murdannia*. In *M. juncoïdes*, *M. semiteres* and *M. sahyadrica*, the sheath is completely fused. Length of the sheath ranges from 0.2 to 3 cm. Sheath is variously pubescent. In some species it is glabrous throughout with hairs along the fusing margins while in others are regularly pubescent. It may be pubescent or puberulous or with lanuginose hairs as in *M. lanuginosa*. Mouth of sheath is always ciliate. Sheath is either green or pale green or spotted with red. *M. blumei* and mostly in *M. triquetra* the flowers are enclosed within the sheath.

Lamina is green. The shape of lamina varies from linear to lanceolate to ovate elliptic. In *M. pauciflora* the lamina is cordate. In *M. semiteres*, *M. juncoïdes* and *M. sahyadrica* the leaves are filiform, falcate. The base of lamina is mostly amplexicaul or rounded. Apex is acute or acuminate. The
surfaces are glabrous or pubescent. There is a gradual increase in leaf size from the very first leaf at the base of the plant to the top. A gradual reduction in leaf size is also noted towards the inflorescence. Rosette leaves are always longer than cauline leaves. Rosette leaves of *M. gigantea* reaches about 25 to 55 cm in length. In *M. fadeniana* the leaves are thick and succulent.

**Reproductive morphology**

**Inflorescence**

The fundamental pattern of inflorescence in the genus *Murdannia* is a terminal thyrse. Thyrse is a mixed inflorescence, consisting of single to several cincinnus arranged in a racemose manner on an indeterminate inflorescence axis. Each cincinnus in turn is a monochasial scorpioid cyme. The thyrse is subtended by a foliaceous bract. It is mostly terminal in position, either on the main shoot or on lateral shoots. They are also axillary from the upper nodes. Occasionally secondary inflorescences are also seen arising from the bract as in *M. edulis*.

The term ‘thyrsiform’ follows the usages of Clarke (1881), Brenan (1966), Faden (1974). Most of the earlier authors, like Bentham (1849), Hutchinson (1934), Morton (1966) however, have termed the arrangement ‘a panicle’.

The thyrse is lax to moderately lax thyrse. Density of largely depends on the length of inflorescence axis, length of cincinni and the number of cincinni. Number of cincinni produced is a characteristic of each species and ranges from one to about fifteen. The cincinni have a basically alternate arrangement on the inflorescence axis. Sometimes sub opposite arrangements are seen in *M. dimorpha*. In *M. spirata* and *M. lanceolata* when having only two cincinni they are subopposite. Alternate to sub opposite to sub verticillate patterns are seen in *M. divergens*. 
The uppermost foliage leaf forming the bract is highly modified, differing in size, texture, colour and pubescence. Each cincinnus is subtended by a persistent cincinnus bract. Each flower on the cincinnus in turn is subtended by bracteoles in all species of *Murdannia*. Bracts and bracteoles are amplexicaul in most species. They are maroon dotted and perfoliate in *M. edulis*. Bracteoles are large and caducous in *M. nudiflora, M. assamica, M. loriformis, M. gigantea* and *M. simplex*.

As Brenan (1965) suggested, the genus *Murdannia* shows great modifications in the inflorescence pattern. In *Murdannia* several stages of reduction of the basic terminal thyrse are observed. In *M. zeylanica* the terminal thyrse and the lateral ones are so closely arranged forming a larger inflorescence unit, the ‘synflorescence’ (Troll, 1961) while in species like *M. pauciflora* the thyrse is highly reduced appearing as if the flowers are in axillary or terminal fascicles. In these species the inflorescence is a single flowered cincinnus. Reduction in number of cincinni from 1 to 3 per thyrse is noted in *M. nudiflora, M. loriformis, M. assamica*. In *M. vaginata* inflorescence is composed of 2 to 3 fascicles of 2 to 15 one flowered cincinni enclosed in prominently ribbed, glabrous, bladeless sheaths. All the species with single flowered cincinnus except *M. blumei* and *M. triquetra* have yellow flowers. Based on the similarity and difference in inflorescence pattern the *Murdannia* species are grouped as, species having

i. Inflorescence scapose, thyrse consisting of 3–several cincinni. In *M. edulis, M. fadeniana*.


iii. Thyrse formed of 3–5 (–7) alternate cincinni. In *M. divergens, M. japonica, M. esculenta, M. hookeri, M. zeylanica (M. dimorpha)*.
iv. Thyrse with one or two opposite/sub opposite cincinni. In *M. spirata*,
*M. striatipetala*, *M. dimorpha*, *M. lanceolata*.

v. Cincinni usually 1–flowered, ‘Pedicel’ jointed. In *M. lanuginosa*, *M.*
*blumei*, *M. crocea*, *M. versicolor*, *M. vaginata*, *M. pauciflora*, *M.*
*triquetra*.

Bracts filiform, cincinni arranged pseudoumbellately on the peduncle. In *M.*
*semiteres*, *M. juncoides*, *M. sahyadrica*.

**Flower**

Good diversity in floral morphology is exhibited by the members of
this genus. Flowers are pedicellate, trimerous, pentacyclic, actinomorphic to
slightly zygomorphic. The basic floral structure consists of outermost 3 free
sepals; 3 free petals; 3 (–2) antesepalous stamens alternating with 3 (–4)
staminodes and the innermost completely fused tri carpellary, trilocular
gynoecium. The zygomorphic symmetry is due to the 2 stamen 4 staminode
condition and the sub equal petals and sepals.

Flowers are short lived and deliquescent with only a brief period of
anthesis and without any nectar forming the possible reproductive huddle
within the genus. Faint foul smell is been noted in several populations of *M.*
*pauciflora*. Floral characters are difficult to interpret from dried specimens.

In *Murdannia* flowers are borne on two ranks along the cincinni or are
in axillary fascicles. The flowers of *Murdannia* species are either vertically or
horizontally held. Horizontal flowered species like *M. nudiflora*, *M. simplex*
are characterized by the medial sepal and paired petals. In species like *M.*
*blumei* and *M. triquetra* flowers are barely exserted from the sheath.

Bisexuality and andromonoecy are most common in *Murdannia*.
Gynomonocey is very rarely seen. Long styled and short styled flowers are
seen in *M. japonica*. In the male flowers stamens are symmetrically arranged where as in bisexual flowers stamens bend to one side and style to the other favoring out crossing. Enantiostyly or the mirror image symmetry is rather common in *Murdannia* species.

**Pedicel**

In *Murdannia* species, the pedicel varies in length, pubescence and curvature. In all species the pedicel length increases in fruit. As a result the capsules of *M. blumei* and *M. triquetra* become exserted from the sheath. In general the fruiting pedicels are ascending in orientation. In several species various degrees of curvature are noted. Pedicels are densely to sparsely puberulous or highly ciliate as in *M. lanuginosa*.

**Calyx**

Outermost whorl the calyx consists of three, free, equal to subequal, persistent sepals. Sepals are green or pale green and are distinct from inner showy corolla. Sometimes they are marked with purple at the apex. Commonly the margins are transparent, scabrous and rarely tinged with purple. Sepal shape varies from oblong to elliptic. Sepal length ranges 2–9 mm Inner surface of sepals are glabrous while the outer surface varies from glabrous to puberulous. Comparison of sepals of various species is shown in plate 96 & 97.

**Corolla**

Corolla consists of three, free, equal to subequal, showy petals. Deliquescence of flower is owing to the nature their petals. Petal shape varies from ovate to oblong to obovate. Petal length ranges from 2–12 mm. Petals colour is generally blue, where it varies from lilac to lavender to purple to
Plate 97. Sepals of *Murraya* species. 

- **a.** *M. nudiflora* (L.) Brenan; 
- **b.** *M. paniculata* (G. Brückn.) G. Brückn.; 
- **c.** *M. salguadríca* A. Ancy & Nampy; 
- **d.** *M. semiseta* (Dalzell) Santapau; 
- **e.** *M. simplex* (Vahl) Brenan; 
- **f.** *M. spirata* (L.) G. Brückn.; 
- **g.** *M. striatipetala* Faden; 
- **h.** *M. triquetra* (Wall. ex C.B. Clarke) G. Brückn.; 
- **i.** *M. versicolor* (Dalzell) G. Brückn.; 
- **j.** *M. vaginata* (L.) G. Brückn.; 
- **k.** *M. zeysanica* (C.B. Clarke) G. Brückn.
Plate 99. Petals of *Murdannia* species. 

- **a.** *M. nudiflora* (L.) Brenan;  
- **b.** *M. pauciflora* (G.Brückn.) G. Brückn.;  
- **c.** *M. sahyadrica* A. Ancy & Nampy;  
- **d.** *M. semiteres* (Dalzell) Santapau;  
- **e.** *M. simplex* (Vahl) Brenan;  
- **f.** *M. spirata* (L.) G. Brückn.;  
- **g.** *M. striatipetala* Faden;  
- **h.** *M. versicolor* (Dalzell) G. Bruckn.;  
- **i.** *M. vaeanata* (L.) G. Brückn.;  
- **j.** *M. zebyanica* (C.B. Clarke) G. Brückn.
blue. Most Indian species with single flowered cymes are have yellow to orange brown petals. Slight differences in shape and size between median petal and lateral petals are noted in *M. simplex* and *M. gigantea*. Sometimes hairs are found at the base of petals of *M. simplex* which is not a common character in *Murdannia*. In *M. semiteres* shape of apex acuminate.

**Androecium**

Androecium consists of three stamens and three staminodes alternating each other. The outer androecial whorl contains stamens which are antesepalous while the inner whorl contains staminodes that are antepetalous in position. In some species the third stamen is reduced to a stamiode thus two stamen and four staminodes are seen.

**Stamen**

In *Murdannia* species the stamens of a flower are almost equal in length. Seldom size differences are noted in the stamens of *M. esculenta*. Stamen filaments are free along their entire length in all species except *M. juncoides, M. semiteres* and *M. sahyadrica* where the three stamen and two staminode filaments are fused basally. Filament curvatures are noted especially in bisexual flowers and in species showing enantiostyly. In most species the stamen filaments are oriented closely parallel to each other. Filaments are either glabrous or variously hairy. Occasionally variation may be noted within a species. The staminal hairs are monoliform and are mostly attached towards the lower half of the filament. In *M. simplex* rarely branched hairs are found on the filaments. Filament colour varies with species from yellow, orange, blue, lilac to white. Stamen length usually varies 2–15 mm.

Anthers are elliptic, dorsifixed and four celled. They are yellow to blue to black in colour. The anther connectives may be spotted or transversely stripped with red as in *M. versicolor*. The dehiscence is longitudinal. The pollen grains in *Murdannia* are usually elliptic and creamy yellow to white in colour.
Plate 103. Staminodes of *Murdannia* species. **a.** *M. nudiflora* (L.) Brenan; **b.** *M. pauciflora* (G.Brückn.) G. Brückn.; **c.** *M. sahyadrica* A. Ancy & Nampy; **d.** *M. semiteres* (Dalzell) Santapau; **e.** *M. simplex* (Vahl) Brenan; **f.** *M. spirata* (L.) G. Brückn.; **g.** *M. striatipetala* Faden; **h.** *M. versicolor* (Dalzell) G. Brückn.; **i.** *M. vaginata* (L.) G. Brückn.; **j.** *M. zeylanica* (C.B. Clarke) G. Brueckn.
Staminode

The staminodes are either three or four in number depending on the species. In *M. simplex*, *M. nudiflora*, *M. assamica*, *M. gigantea* and *M. loriformis* three antepetalous and one antesepalous staminodes are present. In *M. gigantea* the antesepalous staminodes are densely hairy with short appressed hairs and reduced, knob like antherode. Staminode filaments are rather glabrous to few haired. Hairs are monoliform. Filament colour varies with species from yellow, orange, blue and lilac to white.

The antherodes are trilobed to hastate. Antherodes of antesepalous staminode are scarcely lobed. Antherodes are yellow to creamy to white in colour. The surface of antherode is usually smooth but in *M. sahyadrica*, *M. semiteres* and *M. juncoides*, the anterode surface is verrucose. In these species two staminode filaments are fused with stamen filaments basally while one remains free. In *M. lanuginosa*, the middle lobe is highly reduced and with reddish tinge. In *M. nudiflora*, the typical trilobed anterodes sometimes gets highly reduced. In one population of *M. blumei* staminodes were completely absent.

Staminodes completely lack pollen and their purpose seems to attract pollinators. Relative degree of development of antherode, their curvature of filaments, shape and size of antherodes seems to differ among species, but are not much reliable due to their inconsistency.

Gynoecium

The innermost whorl is the completely fused carpels. The gynoecium consists of trilocular ovary, simple style and stigma. Ovary in general is entirely green or pale green but in *M. semiteres* sometimes slightly maroon tinged. The ovary is glabrous, globose to elliptic in shape. Number of ovules varies from 1 to 22 per locule. They may be arranged uniseriately or biseriately.
Style is slender, glabrous, straight to differently curved. In *M. japonica* the style is j-shaped. It is usually white or creamy but some species basally mauve. Stigma is terminal, papillate and usually white in colour. The comparison of the capsule and seeds of Indian species are presented in Chapter 6.

**Distribution of Murdannia in India.**

The genus *Murdannia* Royle (*nom. cons.*) with about 52 species worldwide has greatest diversity in tropical Asia (Faden, 2000). The genus is well represented in India with 26 species (50%) of which 21 (81%) occur in Peninsular India. The neighbouring countries are reported to have, 13 species in Srilanka; 1species in Pakistan; 10 species in Myanmar and 7 species in Nepal. It is significant that India has more number species of *Murdannia* than in any other country in the world.

Thus, peninsular India with 21 species (81 %), has highest number of species followed by 12 species (56 %) in North Eastern India. State wise, Tamil Nadu have the maximum diversity with 20 species (80%) followed by Kerala with 18 species (76%). From the Andaman and Nicobar islands, 7 species (28%) are reported. The distribution of *Murdannia* in India and world is given in Appendix 5.

**Morphometric analysis in Indian Murdannia**

A cluster analysis is performed to classify all the species, as it is better in representing distances among similar species (Newmaster *et al.*, 2008). In the present study, morphometric analysis of genus *Murdannia* is performed with NTSYS software. Twenty six species are selected as Operational Taxonomic Units (OTU’s) and a total of 61 characters are selected for the cluster analysis. Both vegetative and reproductive characters are used for the analysis. A data matrix of 61 morphological characters of 26 species is
prepared (Table 4; Appendix VII). All the computations are done using NTSYS software (Rohlf, 2000) and a cluster analysis for the qualitative morphological data is performed using Simple matching coefficient. A dendrogram (Plate 105) is plotted from a distance matrix generated using an arithmetic average (UPGMA) clustering algorithm and standardized data based on the average taxonomic distance subjected to the unweighted pair-group clustering method using NTSYS Software version 2.02i.

The similarity studies using morphological characters indicated that there exists considerable variation among the twenty six species of *Murdannia* studied. The dendrogram obtained through the analysis clearly revealed that 26 species used in the morphometric analysis falls under 6 distinct sub-clades in 3 different homogeneous clades portraying the interrelationships among the species.

**Clade I** represents 5 species *viz.* *M. assamica*, *M. loriformis*, *M. nudiflora*, *M. simplex* and *M. gigantea*, characterized by long pedunculate cincinni, caducous bracteoles, flowers with approximate bases, 4 staminodes and high mucilage content. *M. gigantea* is represented as a separate sub-clade (Ia) with an erect habit and terminal flowering shoot while rest of the members, characterized by a decumbent to ascending habit with lateral flowering shoots forms another sub-clade (Ib). However, *M. assamica* forms a separate section under sub-clade Ib, is distinct in the absence of a basal rosette and having 1-seeded capsule locules.

**Clade II** representing a total of of 18 species, is further subdivided in to four more or less uniform sub-clades. *M. blumei*, *M. ochracea*, *M. pauciflora*, *M. versicolor*, *M. triquetra* and *M. lanuginosa*, all charcterized by axillary, usually 1-flowered cincinni with jointed pedicel, forms the sub-clade Iia. *M. lanuginosa*, having tuberous roots, orange flowers and grass like
lanuginose habit forms a separate section while *M. blumei* stands alone under separate section, while rest of them forms another section under Clade II.

All those species with a thyrse having one or two opposite cincinni *viz.* *M. dimorpha, M. lanceolata, M. spirata* and *M. striatipetala* forms another sub-clade (IIb), in which former two species with thyrsiform inflorescence with more than 1-flowered cincinni, fall in to a separate section leaving the latter two taxa in to another section which are closely related and similar in their habit and habitat requirements.

*M. vaginata* with its lone representation forms another sub-clade (IIc) owing to their persistent ribbed sheath covering the inflorescence, twice jointed pedicels, 1-seeded capsule locules and dorsi-ventrally compressed seeds.

Sub-clade IId is represented by a group of 7 species, characterized by thyrse inflorescence includes *M. divergens, M. hookeri, M. zeylanica, M. edulis, M. fadeniana, M. esculenta* and *M. japonica* which is further subdivided under 3 sections. *M. edulis* and *M. fadeniana* has scapose inflorescence with 3–several cincinni groups under section I along with *M. divergens* which forms a lone sub-section. *M. hookeri, M. zeylanica* and *M. japonica* groups under section II, among which *M. japonica* falls under a separate sub-section with lone representation. However, *M. esculenta* groups oddly from all other species to form a separate section III under sub-clade IId.

**Clade III**, represented by 3 species *viz.* *M. juncoide*, *M. semiteres* and *M. sahyadrica* is charcterised by erect habit, filiform leaves and pseudo-umbellate cincinni. *M. juncoide* is a perennial species with a tuberous base while the other two annuals lacking a tuberous base. *M. sahyadrica* is a recently described species resembling *M. semiteres* and *M. juncoide* but differs by its orbicular petals, stamens arranged symmetrically around the central erect style, ovoid capsule and uniseriately arranged seeds.
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<td>Plants glabrous /or with a line of cilia (0)</td>
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<td>18.</td>
<td>Plants with bulbous base (0)</td>
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<td>Roots thick fibrous (0)</td>
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<td>19.</td>
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<td>Antipetalous staminode with antherodes hastate or otherwise (1)</td>
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<td>Flowers zygomorphic (1)</td>
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<td></td>
<td>Roots not tuberous (1)</td>
<td></td>
<td></td>
<td>Plants without bulbous base (1)</td>
</tr>
<tr>
<td>33.</td>
<td>Flowers yellow (0)</td>
<td></td>
<td></td>
<td>Flowers not yellow (1)</td>
</tr>
<tr>
<td>48.</td>
<td>Style S or j shaped (0)</td>
<td></td>
<td></td>
<td>Style other than s or j shaped (1)</td>
</tr>
<tr>
<td>4.</td>
<td>Roots thick fibrous (0)</td>
<td></td>
<td>19.</td>
<td>Lanuginose hairs present (0)</td>
</tr>
<tr>
<td></td>
<td>Roots not thick fibrous (1)</td>
<td></td>
<td></td>
<td>Lanuginose hairs absent (1)</td>
</tr>
<tr>
<td>34.</td>
<td>Flowers white (0)</td>
<td></td>
<td></td>
<td>Flowers not white (1)</td>
</tr>
<tr>
<td>49.</td>
<td>Capsule with locules one seeded (0)</td>
<td></td>
<td></td>
<td>Capsule more than one seeded (1)</td>
</tr>
<tr>
<td>5.</td>
<td>Nodal roots present (0)</td>
<td></td>
<td>20.</td>
<td>Inflorescence scapose (0)</td>
</tr>
<tr>
<td></td>
<td>Nodal roots absent (1)</td>
<td></td>
<td></td>
<td>Inflorescence not scapose (1)</td>
</tr>
<tr>
<td>35.</td>
<td>Flowers blue/lilac (0)</td>
<td></td>
<td></td>
<td>Flowers not blue/lilac (1)</td>
</tr>
<tr>
<td>50.</td>
<td>Fruiting pedicel erect (0)</td>
<td></td>
<td></td>
<td>Fruiting pedicel recurved (1)</td>
</tr>
<tr>
<td>6. Plants with a definite base</td>
<td>21. Inflorescence thyrsiform or variously reduced (0) Inflorescence fascicles of cincinni (1)</td>
<td>36. Pedicel glabrous (0) Pedicel hairy/sparcely ciliate (1)</td>
<td>51. Seeds uniseriate (0) Seeds biseriate (1)</td>
<td></td>
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<tr>
<td>(0) Plants without a definite base (1)</td>
<td>22. Inflorescence opposite or sub opposite pseudoumbellate cincinni (0) Inflorescence not opposite or subopposite pseudoumbellate cincinni (1)</td>
<td>37. Pedicels once/twice jointed (0) Pedicels not jointed (1)</td>
<td>52. Seeds with a deep ventral pit (0) Seeds without a deep ventral pit (1)</td>
<td></td>
</tr>
<tr>
<td>7. Basal rosette present (0) Basal rosette absent (1)</td>
<td>23. Cincinni single flowered (0) Cincinni more than one flowered (1)</td>
<td>38. Petals ovate/elliptic (0) Petals oblong/orbicular (1)</td>
<td>53. Seeds smooth to variously pitted (0) Seeds verrucose (1)</td>
<td></td>
</tr>
<tr>
<td>8. Stem erect (0) Stem not erect (1)</td>
<td>24. Cincinnus alternate (0) Cincinnus not alternate (1)</td>
<td>39. Petals striate, margins crenulate (0) Petals not striate, margins not</td>
<td>54. Seeds 2 per locule (0) Seeds never 2 per locule (1)</td>
<td></td>
</tr>
<tr>
<td>9. Lateral branches forming new basal rosette (0) Lateral branches not</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>forming new basal rosette (1)</td>
<td></td>
<td>crenulate (1)</td>
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<tr>
<td>10.</td>
<td>Cauline leaves present (0) Cauline leaves absent (1)</td>
<td>25.</td>
<td>Secondary thyrse present (0) Secondary thyrse absent (1)</td>
<td>40.</td>
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<td></td>
<td></td>
<td></td>
<td>55.</td>
<td>Seeds dorsiventrally compressed (0) Seeds not dorsiventrally compressed (1)</td>
</tr>
<tr>
<td>11.</td>
<td>Leaves filiform falcate (0) Leaves never filiform falcate (1)</td>
<td>26.</td>
<td>Cincinnus bracts perfoliate (0) Cincinnus bracts amplexicaul (1)</td>
<td>41.</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>56.</td>
<td>Embryotega dorsal (0) Embryotega semi dorsal to lateral (1)</td>
</tr>
<tr>
<td>12.</td>
<td>Leaves linear lanceolate/ lanceolate/elliptic (0) Leaves not linear lanceolate (1)</td>
<td>27.</td>
<td>Bracts filiform falcate (0) Bracts not filiform falcate (1)</td>
<td>42.</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>57.</td>
<td>Hilum linear (0) Hilum elliptic or otherwise (1)</td>
</tr>
<tr>
<td>13.</td>
<td>Leaf base ovate-cordate (0) Leaf base not ovate-cordate (1)</td>
<td>28.</td>
<td>Bracteole caducous (0) Bracteole persistent (1)</td>
<td>43.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>58.</td>
<td>Testa tuberculate (0) Testa not tuberculate (1)</td>
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</tr>
<tr>
<td>14. Lamina glabrous/ rarely puberulent (0) Lamina hairy (1)</td>
<td>29. Flowers barely exserted from the sheath (0) Flowers long exserted from the sheath (1)</td>
<td>44. Staminal filaments hairy (0) Staminal filaments glabrous (1)</td>
<td>59. Testa pale yellow/white (0) Testa Reddish brown/black (1)</td>
<td>60. Raised flattish warts uniformly distributed throughout surface (0) Raised flattish warts not uniformly distributed throughout surface (1)</td>
</tr>
<tr>
<td>15. Leaf margin undulate (0) Leaf margin not undulate (1)</td>
<td>30. Flowers with distant bases on cincinnus (0) Flowers with approximate bases (1)</td>
<td>45. Stamens with short appressed hairs (0) Stamens without short appressed hairs (1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Plate 105. Dendrogram of divergence between the species of Murdannia in India