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A study of Morphological Characterization in Three Species of *Indigofera* (Linn.)

ORIGINAL ARTICLE



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Abstract

Morphological characters are features of external form or appearance. They currently provide the characters used for practical identification and some of those used for hypothesizing phylogenetic relationships. These features have been used for a longer time than anatomical or molecular evidence, and they were the only source of taxonomic evidence in the beginnings of plant systematics. Morphological characters are easily observed and find practical use in keys and descriptions; the characters used in phylogeny reconstruction may not so easily observed. Characters of both sorts are found in all parts of the plants, both vegetative and reproductive. The objective of the present study was to morphological characterization of three species of *Indigofera* viz., *Indigofera endecaphylla* Jacq., *Indigofera enneaphylla* Linn. and *Indigofera linifolia* (L.f.) Retz. through

some qualitative and quantitative morphological parameters. Characters of plant, leaf, inflorescence, flower, fruit and seed were taken into account. The most significant morphological parameters differentiate three species were: habit, stem nature, leaf type, length of leaf rachis, number of leaflets, pod shape & arrangement and seed per pod, seed shape & colour.

Key Words

Morphological Characterization, *Indigofera*, Plants Systematics, Vegetative, Reproductive.

Morphological characters are features of external form or appearance. They currently provide the characters used for practical identification and some of those used for hypothesizing phylogenetic relationships. These features have been used for a longer time than anatomical or molecular evidence, and they were the only source of taxonomic evidence in the beginnings of plant systematics.

Morphological characters are easily observed and find practical use in keys and descriptions; the characters used in phylogeny reconstruction may not so easily observed. Characters of both sorts are found in all parts of the plants, both vegetative and reproductive. *Indigofera* belongs to the family Leguminosae (fabaceae), sub family-papilionoideae and tribe *Indigoferaeae* (Sanjappa 1995 : Hanelt 2001).

Morphology has been the major criterion for classification over the last many centuries. The initial classifications were based on gross morphological characters. During the last two centuries, more and more

microscopic characters of morphology were incorporated. Although floral morphology has been the material for classifications, other morphological characters have also contributed in specific groups of plants.

Even today the fact can not be denied that morphological characters have their own importance in taxonomy and all systems of classifications suggested, are based on principles of morphology. In spite of the great importance of *Indigofera* species, only little study has been done on their identification as well as classification of the species scattered in Bihar. Available reports on the genus include: morphological and agronomic characterization of *Indigofera* species using multivariate analysis (Hassen *et al.*, 2006); leaf anatomy of eight species of *Indigofera* species (Nwachukwu and Mbagwu, 2007); Tannins, starch grains and crystals in some species of *Indigofera* (Nwachukwu and Edeoga, 2006); Novel reports of glands in Neotropical species of *Indigofera* L. (Leguminosae, Papilionoideae) (Marquiafavel *et al.*, 2008). This study thus examines the differences and similarities in macromorphological characters used in delimiting the three *Indigofera* species (*Indigofera endecaphylla* Jacq., *I. enneaphylla* Linn., and *I. linifolia* (L.f.) Retz. which are commonly available in the Gangetic part of Bihar using both herbarium and freshly collected specimens.

The present study therefore aims at evaluating morphological characters among three wild species of *Indigofera* found in Patna and its locality, as morphological features have proved to be of immense assistance in plant classification.

Materials and Methods

Extensive survey of Gangetic regions of Patna and other district of Bihar has been made for the collection of *Indigofera* species. Sites were selected and species were collected from time to time.

Three wild species selected for present study were:

Species 1: *Indigofera endecaphylla* Jacq. Collected from the campus of A. N. Sinha Institute, Patna, especially from the regions of Ganga banks.

Species 2: *Indigofera enneaphylla* Linn. Collected from the field of Patna science college campus.

Species 3: *Indigofera linifolia* (L.f.) Retz. Collected from Maner, near the tomb of Hazrat Makhdum Yahya, Maner.

Seed samples of three species were grown under uniform ecological conditions. The plants of three species raised from seeds were carefully studied by using several morphological parameters for assessing the variations, both in vegetative and reproductive characters

Observations

Morphological Details

1. *Indigofera hendecaphylla* Jacq., *Indigofera endecaphylla* Auctt., orth. Var.: Spreading or diffuse, perennial herb or sub-shrubs, with many prostrate stems up to 0.4-0.6 m with taproot; young stems flattened and ridged, deep green or yellowish, strigose with sparse, hyaline to white, appressed, equally biramous hairs. Leaves pinnate, 7-10 leaflets, 20-34 mm long; stipules triangular with scarious margins, 4-8 mm long, glabrescent, not spinescent, persistent; petiole 1.5- 5 mm long; rachis furrowed; multicellular hairs at the base of petiole absent. Leaflets alternate; stipella absent or inconspicuous, 0.1- 0.5 mm long, hair like; lamina obovate to elliptical, 8- 22 mm long, 5- 10 mm wide; upper surface dull green, glabrous; lower surface green, with sparse to moderately dense, appressed hairs; apex retuse; veins not prominent. Inflorescences 30 -80 mm long, longer than leaf- rachis; peduncle 10-20 mm long; bracts ovate to triangular, 1.2-2.5 mm long; flower light red; pedicel 0.3-0.7 mm long. Calyx 2.5-4 mm long; lobes longer than the length of the tube, subequal, 1.5-3 mm long and covered with moderately dense, white, appressed hairs. Standard light red, obovate, 3.8-4.9 mm long, 2.5-3.7 mm wide; apex obtuse. Wing oblong to spatulate, 3.7-4.5 mm long, 0.5-1.1 mm wide, keel 3.9-4.4 mm long, 1-1.3 mm deep; lateral pockets (spurs) 0.3-0.5 mm long; apex rounded; glabrous, margin ciliate. Staminal

- tube 3.5-4 mm long, colourless, ovary moderately to densely hairy. Pod deflexed, terete to slightly tetragonal, 10-27 mm long, 1-2.5 mm wide, brown, strigose, glabrescent; hairs sparse, appressed; apex shortly beaked; seeds cuboid, 6-10 per pod, brown, 1.2-1.6 mm long, 1-1.4 mm wide.
2. ***Indigofera enneaphylla* Linn., *Indigofera linnaei* Ali.:** A perennial herb, prostrate to spreading, subwoody at base, with numerous stems 0.1- 0.3 m long, to 0.7 m wide, with taproot; young stems slightly ridged, green to brown, pubescent with dense, appressed to spreading, equally biramous hairs. Leaves pinnate, 7-9 leaflets; stipules triangular with linear, drawn-out tip and thin scarious margin, 3-7 mm long, pubescent, often persistent; petiole 1-4 mm long; rachis furrowed or flattened, multicellular hairs at the base of the petiole absent. Leaflets mostly alternate; stipellae absent or very inconspicuous, 0.1-0.4 mm long; lamina obovate, 3-10 mm long, 2-4 mm wide; upper surface green to grey, with sparse to dense, appressed to spreading hairs; lower surface green to grey with moderately to dense, appressed to spreading hairs; apex obtuse and mucronate, emarginated or rarely acute; veins not prominent. Inflorescences 5-20 mm long, generally shorter than the leaf – rachis; peduncle 2.5-3.7 mm long. The flowers are small, pea-like, pinkish red and crowded onto short stalks. Calyx 2.5- 3.7 mm long; lobes unequal or subequal, longer than the length of the tube, covered with moderately dense to dense, grey, white or pale brown, appressed to shortly spreading, very unequal biramous hairs. Standard red, obovate, 3-5 mm long, 2.3-3.3 mm wide. Wings oblong to spatulate, 3.5- 5 mm long, 0.7-1.2 mm wide. Keel 3.5-4.5 mm long, 0.7-1.2 mm wide; lateral spurs 0.3-0.6 mm long; apex beaked to acute; glabrous. Staminal tube 2.5-3.2 mm long, colourless. Ovary densely hairy. Pod ascending and radiating, shortly cylindrical to oblong, 3-7.5 mm long, 1.1-2.5 mm wide, grey or yellowish and brown, strigose to pubescent; hairs moderately dense to dense, appressed to spreading; apex shortly pointed; seeds sub-globose, 2 per pod, golden yellow, 1.1- 1.8 mm long and 1-1.5 mm long wide.
3. ***Indigofera linifolia* (L.f.) Retz., *Hedysarrum linifolium* L.f.:** A much branched, prostrate to spreading, perennial herb, 0.1- 0.3 m long, with taproot; young stems ridged, silvery green, strigose with dense, appressed hairs. Leaves simple with no apparent articulation; stipules triangular, 0.9-3.1 mm long, pubescent, not spinescent, not persistent though occasionally persisting beyond leaf fall; petiole 0.5-1 mm long; multicellular hairs in the leaf axis lacking; stipellae absent. Lamina linear or narrowly obovate or elliptic, 6-20 mm long, 2-4 mm wide; both surfaces green to silvery green, with moderately dense to dense hairs; apex acute and shortly mucronate; veins not prominent. Inflorescence 10- 33 mm long, longer than leaf axis; peduncle 0.5-1 mm long; bracts ovate with scarious margin, 0.7-1.5 mm long; flowers red, pedicel 0.5 mm long. Calyx 1.5-4.5 mm long, with subequal lobes longer or much longer than the length of the tube, and dense, grey, appressed hairs. Standard red, obovate to orbicular, 2.5-3.5 mm long, 1.7- 3 mm wide. Wings narrowly obovate, 2.5-3 mm long, 0.7- 1.2 mm wide. Keel 2.5- 3.8 mm long, 0.8-1.1 mm deep; lateral pockets 0.3-0.7 mm long; apex acute or rounded; glabrous. Staminal tube 2.5- 3 mm long, free ends pigmented. Ovary densely hairy. Pod ascending, globular, 2-3 mm long, 1.5-1.8 mm wide, white or grey, stigose; hairs dense, long appressed to spreading; apex shortly beaked; seed 1 per pod, globose, brown, 1.6-1.9 mm long and 1.5- 1.8 mm wide.

Taxonomic Key for the Species *Indigofera*, Linn.

- A. Leaves simple. linear to narrowly elliptical, pods 1- seeded, globose. *Indigofera linifolia*
- AA. Leaves compound, imparipinnate, leaflets alternate, pods oblong 2 to more seeded.
- B. Flowers in long slender racemes, pods cylindrical, deflexed and more than 2 – seeded. *Indigofera endecaphylla*
- BB. Flowers in dense, shortly peduncled, spike like heads, pods oblong, radially arranged and 2- seeded. *Indigofera enneaphylla*

Results and Discussion

In the morphological analysis of three *Indigofera* species utilizing various characters, present results confirm that variations in the vegetative and floral characters among the three species of *Indigofera* are important, diagnostic and could be used taxonomically in the delimitation of these taxa. For example, the distinct variation in habit in the species constitute an important distinguishing feature. *Indigofera endecaphylla* and *Indigofera enneaphylla* are herb with prostrate and diffuse habit while *Indigofera linifolia* are shrublet with erect or prostrate habit. Hence the three species studied could therefore be separated into two groups based on their habit. This observation is in line with earlier works of Okwulehie, Edeoga and Hemtzelma (1999, 2000 & 1948), who studied comparative morphology of different species in establishing relationship among the taxa.

The variation in stem type, colour and nature of hairs clearly delineates *Indigofera linnaei* from other two species. Similarly, the pod shape and arrangement, raceme and seed shape & colour clearly make distinction between three species of *Indigofera*. This is important since Okwulehie and Okoli (1999) in Tiliaceae and Nwachukwu (1997) in Euphorbiaceae have distinguished and separated some species using variations in their morphology though not in the genus *Indigofera*. The length of leaf rachis and raceme separate *Indigofera endecaphylla* from *Indigofera enneaphylla*, on the otherhand shape and apex of the leaf clearly delineates *Indigofera linifolia* from *Indigofera endecaphylla* and *Indigofera linnaei*. This is in line with the works of Okeke and Nwachukwu (2001), who used morphological features in determining taxonomic relationships among taxa. The floral features of the taxa further confirm the interspecific variation between *Indigofera linnaei* and *Indigofera endecaphylla* in their raceme length, flower arrangement, colour, size, pod shape and seed number per fruit (pod). The keel also has what Schrire (1995) calls 'lateral prominences' which take the form of pockets or spurs and which may interlock with the wings to produce a platform level with the upper margin of the keel. Such structure was also observed in all the three species under investigation. This finding was different from Nair and Tewari (1975), who reported such structure only in *Indigofera linnaei*. *Indigofera* species examined exhibited variations based on location and localities. Such variation may be due to environmental as well as genetic factors and interaction among them (Gbile, 1976; Nwachukwu and Mbagwu, 2006). These distinguishing morphological characters studied in these investigation are of systematic value because they are reasonably constant and hence can be used in delimitation of taxa.

Conclusion

Thus morphological study of three *Indigofera* species suggests that *Indigofera endecaphylla* are more closely related to *Indigofera enneaphylla* rather than to *Indigofera linifolia*.

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