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Communication

Identification of *Cassia javanica* subspecies using morphological features

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Abstract

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The morphological characters of three *Cassia javanica* L. (Fabaceae Lindl.) subspecies (*Cassia javanica* subsp. *javanica*, *Cassia javanica* subsp. *agnes* and *Cassia javanica* subsp. *renigera*) were analysed to determine their diagnostic value. These three subspecies have pink flowers and, thus, can be easily confused. Leaf, stem and flower characters were analysed to identify reliable differences between subspecies. The main focus was on the structure of stipules, variations in the appearance of sepals (red in *Cassia javanica* subsp. *javanica*), petals (white in *Cassia javanica* subsp. *renigera*) and ovary features. It was found that the subspecies of *Cassia javanica* can best be distinguished by characters of leaflets, shoot hairiness, type of stipules, characters of peduncles, colour of bracts, sepals and petals. As the variation in the diagnostic characters is rather difficult to assess from the description, the characters of the three subspecies were illustrated by photographs.

Keywords: classification, Fabaceae, flowers, phenotypes, phytodiversity, trees.

INTRODUCTION

Plant species are an integral component of civilisation and support different life forms on planet Earth, including humans. People rely on plant species to meet their diverse and basic requirements, including medicines (Pandey et al., 2013). The information on plant diversity in any area is essential for the sustainable utilisation and conservation of occurring species (Puri et al., 2022). It also provides an opportunity to understand the distribution, taxonomic structure and precise identification of the native species. It may include certain species quite close in their morphology, thus likely to be misidentified (Sidhu et al., 2023).

Morphological characters such as leaf shape, size, arrangement, presence or absence of stipules, structure of flower parts (sepal, petal, androecium and gynoecium), shape and type of fruits and seeds are essential to differentiate species and genera. These characters are also employed in resolving the phylogenetic issues of plant species (Soladoye et al., 2010; Deshmukh et al., 2014; Kabila et al., 2017).

The genus *Cassia* L. is a member of the Fabaceae Lindl. family and the Caesalpinioideae DC. subfamily (LPWG, 2017). The Fabaceae family is among the largest families of flowering plants and includes many species that are difficult to identify. Species are difficult to identify because of their high similarity, especially certain species and subspecies of the genus *Cassia* (Kabila et al., 2020).

The pink flowering plants of the genus *Cassia*, such as *Cassia javanica* L. subsp. *javanica*, *Cassia javanica* subsp. *agnes* (de Wit) K.Larsen and *Cassia javanica* subsp. *renigera* (Wall. ex Benth.) K.Larsen, are well known for their beautiful foliage and are cultivated as ornamental plants in parks, gardens and along roads. This study aimed to reveal additional morphological features that can be used to

distinguish *Cassia javanica* subsp. *javanica*, *Cassia javanica* subsp. *agnes* and *Cassia javanica* subsp. *renigera*.

MATERIALS AND METHODS

Specimens of *Cassia javanica* subspecies for the investigation were collected in habitats along the roads or wastelands of Chandigarh and Punjab (Ropar, Jalandhar, Patiala, Hoshiarpur) in 2018–2021.

Morphological features of the stem, leaves, flowers and fruits were considered for the identification. The characteristics of the collected specimens were compared with the available information in the literature (Bamber, 1916; Nair, 1978; Singh, 2001; Vattakaven et al., 2016; Sharma, 2021). Online floras and the Herbarium of the Department of Botany of Panjab University (Chandigarh) were also consulted for detailed comparison. Images of the analysed subspecies were captured in their natural habitats and at the laboratory. The flowers and their different parts were analysed in the laboratory using dissecting microscope. The collected plants were thoroughly cleaned, dried at room temperature and used to prepare herbarium samples. The voucher specimens were deposited at the Herbarium of Panjab University (PAN 22174, PAN 22175 and PAN 22551).

RESULTS AND DISCUSSION

The species under present investigation (*Cassia javanica* subsp. *javanica*, *Cassia javanica* subsp. *agnes* and *Cassia javanica* subsp. *renigera*) are similar in their macromorphology, thus, often get confused during surveys and identification. An attempt was made to resolve this issue by employing distinguishable characters.

Cassia javanica subsp. *javanica*

The trunk of this deciduous tree is armed with pointed branch remnants. The twigs are puberulous to glabrous, thin and grey with drooping slender branchlets. Leaves are long, with 10–16 pairs of leaflets. Leaflets are broadly elliptic to ovate-oblong, more or less equal-sided, top round to blunt emarginate (midrib minutely excurrent), petioleterete outlined, glandless and caducous. Yellow-green stipules are membranous to foliaceous and falcate to broadly elliptic, pointed or rounded at both ends. The inflorescence is long and wide raceme. Pinkish flowers are borne in lateral racemes on short side branches. Bracts are ovate, acute, sometimes auriculate at the base, and brown-red. Sepals are five: pink and chartaceous, narrowly ovate and acute. Petals are five, bright pinkish, broadly spathulate, obtuse to obovate, minutely thin pubescent. The blade of the petals is contracted into a narrow, long claw. Stamens are 10; three longest recurved, their filaments in the middle suddenly thickened, glabrous. Anthers are broadly ovate; their base is deeply split and opened by two pores. Filaments of four stamens are short, and anthers are slightly longer, opening by two oval pores. Filaments of another three stamens are equally long, but their anthers are largely reduced. The recurved stigma is pinkish-white, subapical and punctiform. Pods are terete, glabrous, glossy, black, thin-valved, and non-dehiscent, containing 50–60 seeds. Seeds are glossy, pale brown, smooth, flat, broadly ovate or nearly spherical (Table 1; Fig. 1).

Table 1. Distinguishing features of pink flowered *Cassia javanica* subspecies

Accepted name	*Cassia javanica* subsp. *javanica*	*Cassia javanica* subsp. *agnes*	*Cassia javanica* subsp. *renigera*
Synonyms	*Cassia bacillus, Cassia megalantha*, *Cathartocarpus javanicus*	*Cassia javanica* subsp. *indochinensis*, *Cassia agnes*	*Cassia renigera*
Trunk	Armed	Unarmed	Obscurely ribbed or smooth
Leaflets	Dull and a little silky below, the tips of leaflets are round and blunt	Leaflets are smooth; their tips are mostly pointed	Both surfaces are velvety; tips are rounded with the presence of tiny point
Stipules	Large and leafy	Crescent-shaped	Reniform
Inflorescence	Raceme	Raceme	Raceme (solitary or paired)
Sepal colour	Red or reddish brown	Mostly greenish	Greenish and lightly greenish-pink
Petal colour	Pink turning to dark red, fading to white	Pink and fading to yellow, pink or white	Pink or deep pink fading to almost white
Ovary	Hairy	Hairy	Glabrous

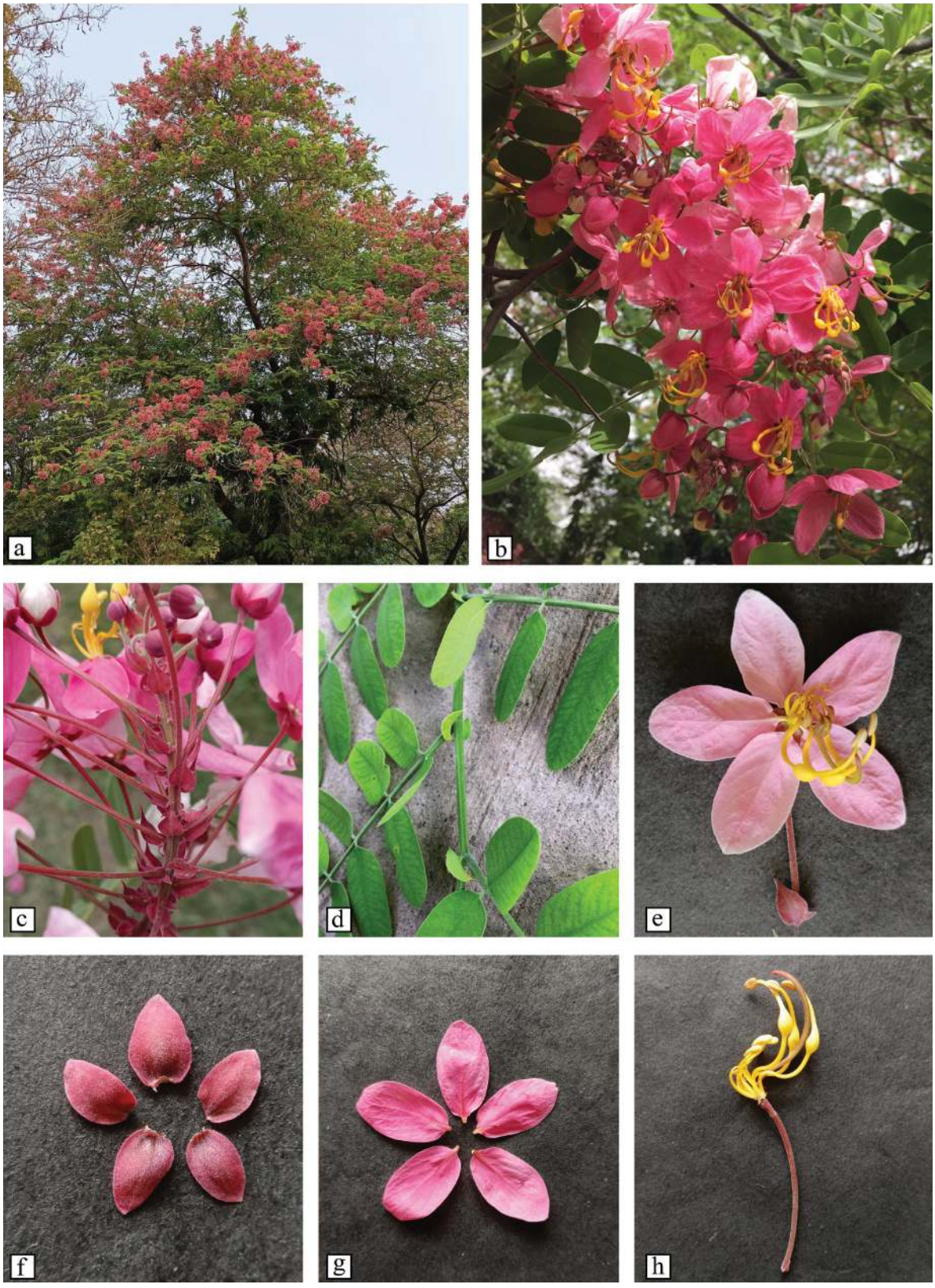


Fig. 1. Morphological characters of *Cassia javanica* subsp. *javanica*: (a) whole plant, (b) floral branch, (c) flower with peduncle and bracts, (d) stipule, (e) flower, (f) sepals, (g) petals, (h) stamens and ovary

Cassia javanica* subsp. *agnes

The trunk is unarmed, and branches are drooping. Leaves are long, pinnately compound, with 5–12 pairs of leaflets. Leaflets are elliptic ovate to oblong, their upper surface smooth, finely pubescent to glabrous, abaxial surface is dull and hairy, top blunt to acute and slightly emarginate. The petiole and rachis are long, angulate and glandless. Stipules are falcate, puberculous, long pointed at both ends and attached at their middle. The inflorescence is medium to large raceme, flowers with thin, straight, pubescent pedicles. Bracts are acute to lanceolate, broadening towards the base and accompanied by small ovate pseudobracteoles. Sepals are green, narrowly ovate and acute. Petals are pinkish to yellowish, almost fading to white, spathulate, obtuse to oblong. Stamens are 10. The three longest stamens are recurved, their filaments in the middle thickened, glabrous, anthers long, broadly elliptic ovate with deep slit at the base and opening by the pores. Four stamens are shorter, and the other three are equally long, but their anthers are significantly reduced. The ovary is linear, slender and whitish-hairy. Pods are blackish brown, cylindrical, 30–70 cm long, terete, glabrous, thin valved but not dehiscent, with prominent annular nodes. Seeds are pale brown, smooth, orbicular and flattened (Table 1; Fig. 2).

Cassia javanica* subsp. *renigera

A small tree with numerous slender, pubescent drooping branchlets. Leaves are large, pinnately compound, with 10–20 pairs of leaflets. Leaflets are subcoriaceous, oblong, elliptic or broadly round; their marginal nerve is stout, and their lower surface is dull. Gland tissue is arranged between petiolules. Stipules are leafy, kidney-shaped, mucronate, and finely pubescent on both sides. The inflorescence is solitary or paired raceme, lateral along the branches. Flowers are stiff, spreading on a 10–12 cm long pedicel. At the base of each flower stalk is a small leaf-like ovate, mucronate, pubescent bract and pseudobracteoles. Sepals are five, pinkish green, ovate, acute, long and reflexed. Petals five, pinkish to white, oblong acute to ovate, spathulate, short clawed and externally pubescent. There are 10 stamens arranged in groups of three, four, and three. Their anthers green. Three glabrous stamens with doubly curved filaments and globular swelling in the middle. Four stamens are less than half as compared to the remaining three stamens. Style is stout, with punctiform stigma. Pods are 20–60 cm long, smooth, cylindrical and contain many seeds. The primary identification features of this subspecies are almost white-mature flowers, leafy bracts below the flowers and long leafy kidney-shaped stipules (Table 1; Fig. 3).

Narayanaswami (1940) has described the differences in stem, leaves, stipules and inflorescence of *Cassia javanica* and *Cassia nodosa* Buch.-Ham. ex Roxb. (*Cassia javanica* subsp. nodosa (Buch.-Ham. ex Roxb.) K.Larsen & S.S.Larsen). The stem of *Cassia javanica* is armed, with leaves composed of 8–14 pairs of oval and oblong, emarginate leaflets. Its stipules are crescent, racemes terminal, arranged on lateral branchlets. The stem of *Cassia nodosa* (*Cassia javanica* subsp. *nodosa*) is unarmed and leaves with 8–12 pairs of ovate to ovate-lanceolate leaflets. Racemes are arranged on old lateral branchlets, and petals are lanceolate.

McCann (1959) discussed the morphology and distribution of *Cassia siamea* Lam. (*Senna siamea* (Lam.) H.S.Irwin & Barneby), *Cassia fistula* L., *Cassia renigera* Wall. ex Benth. (*Cassia javanica* subsp. *renigera*) and *Cassia grandis* L.f. The phenotypic description of *Cassia javanica* subsp. *renigera* is in accordance with the findings of this study. Singh (2001) has also studied the differences among various *Cassia* species, including the three subspecies that are currently being investigated. Similarly, while exploring the flora of China, Shu (2010) has examined morphological similarities and differences between *Cassia fistula*, *Cassia javanica*, *Cassia javanica* subsp. *nodosa*, *Cassia javanica* subsp. *agnes*. The differences, such as lateral racemes on side branches, green sepals, and yellowish ovate petals, were also recorded in *Cassia javanica* subsp. *agnes* during this study. Rocas (2012) has explained the morphology, topography (height, leaves, stem, flower, fruit) and habitat of *Cassia javanica*, *Cassia javanica* var. *indochinensis*, *Cassia javanica* var. *javanica*, *Cassia javanica* var. *pubifolia* and *Cassia javanica* var. *microcalyx*. The floral characteristics (stamen, sepal and petal) and pods were used to establish the morphological differences of these species, which supports the observations of the species under present investigation.

Sanyal (2015) has investigated the external characteristics of taxonomically complex species of *Cassia,* including *Cassia javanica*. Recently, Sharma (2021)

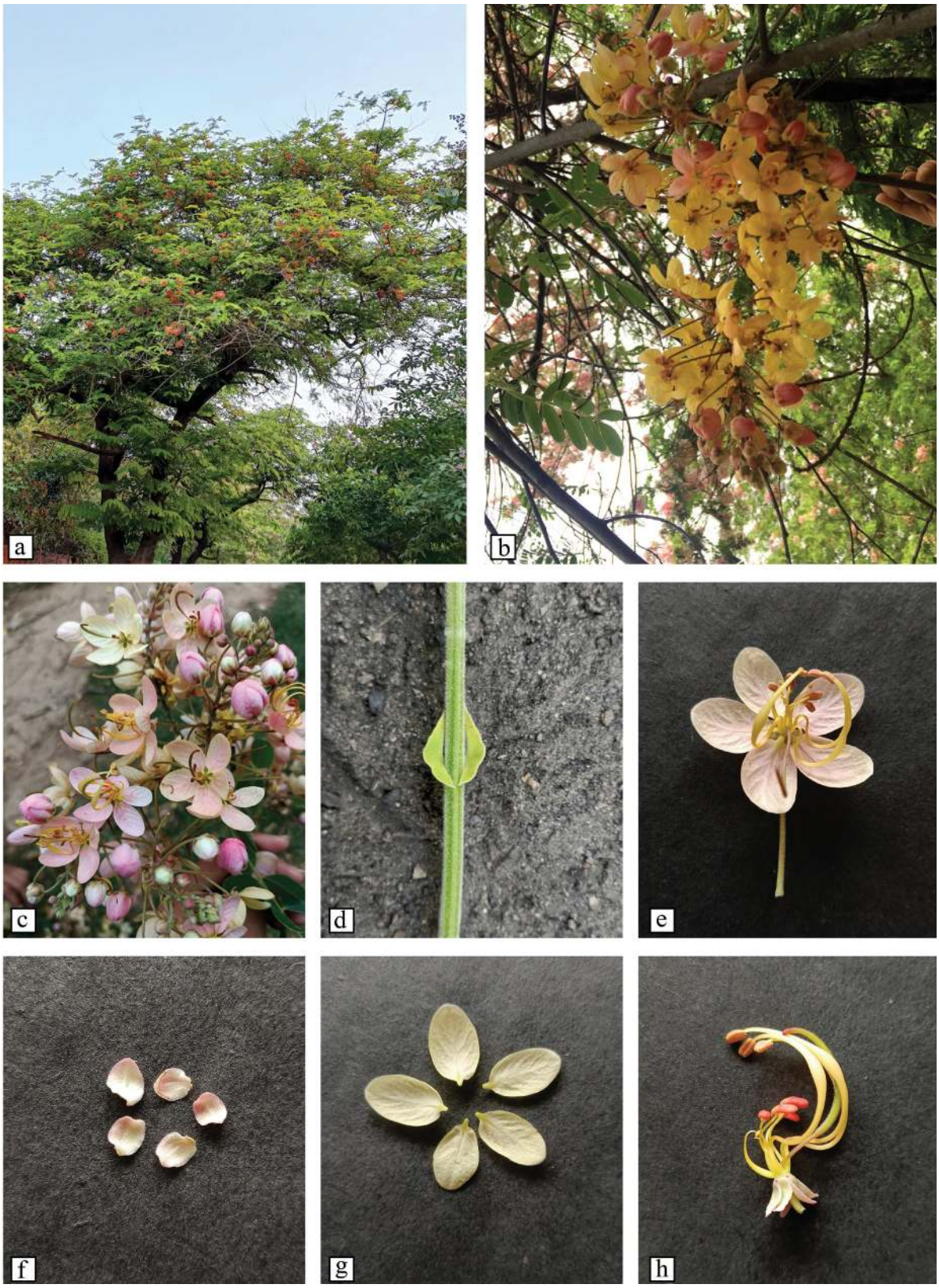


Fig. 2. Morphological characters of *Cassia javanica* subsp. *agnes*: (a) whole plant, (b) floral branch, (c) flower with peduncle and bracts, (d) stipule, (e) flower, (f) sepals, (g) petals, (h) stamens and ovary

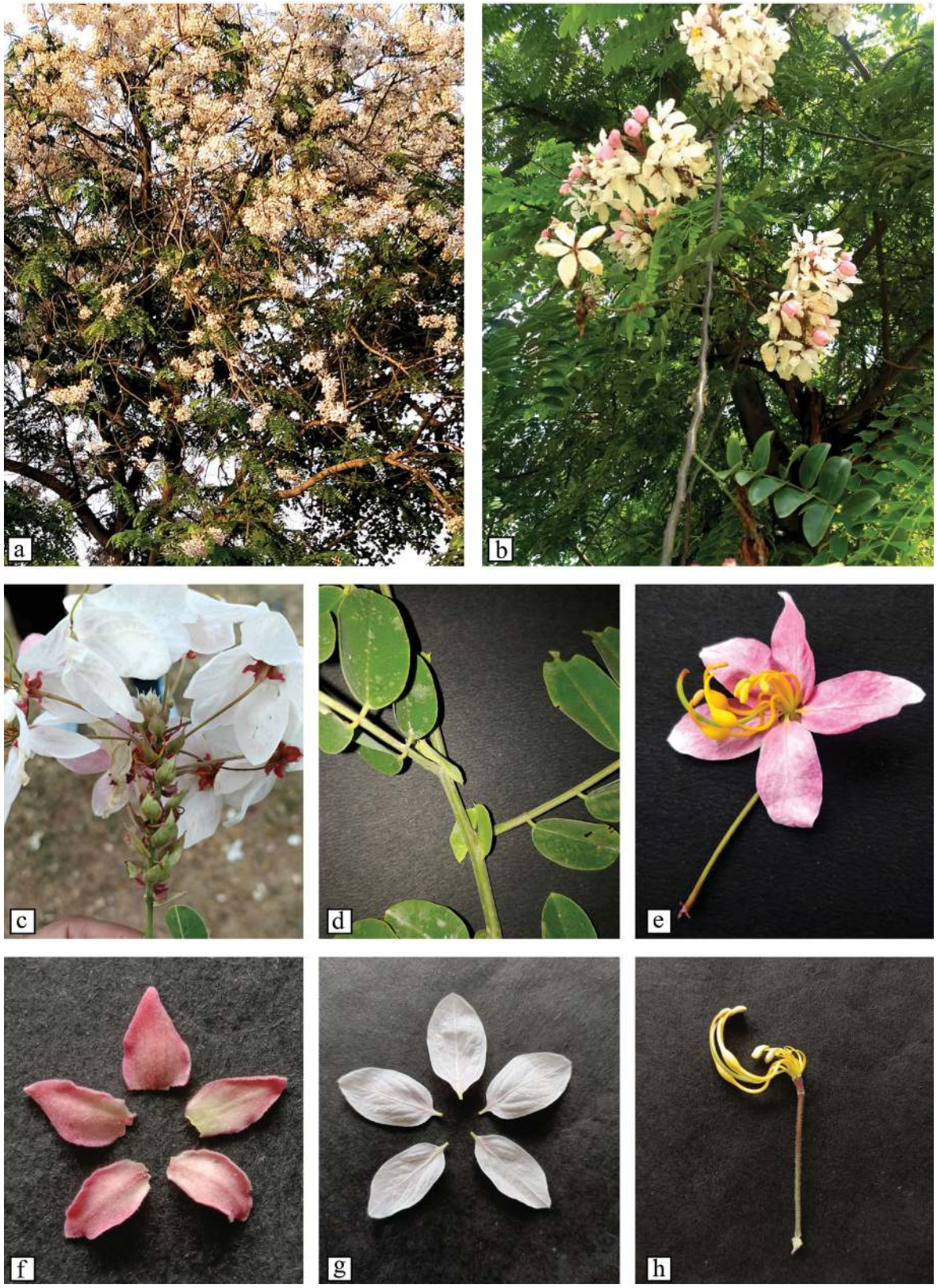


Fig. 3. Morphological characters of *Cassia javanica* subsp. *renigera*: (a) whole plant, (b) floral branch, (c) flower with peduncle and bracts, (d) stipule, (e) flower, (f) sepals, (g) petals, (h) stamens and ovary

has recorded the morphological variations among *Cassia* species, including pink flowering plants with round swelling in three stamens. The height of the subspecies under investigation was variable in different studies, possibly due to the availability of the nutrients and local environmental conditions. This study revealed that the characteristics of leaves, stems and flowers, mainly microscopic variations in the flower architect, are reliable for identifying *Cassia javanica* subspecies.

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