

Morphological screening of endangered medicinal plants of milkweed family from Thar desert, Rajasthan, India

Sunita Arora and Sonam Meena

Department of Botany, Jai Narain Vyas University, Jodhpur Rajasthan, India

ABSTRACT

The indigenous systems of medicine in India are Ayurvedic, Siddha and Unani. These traditional systems of medicine together with homeopathy and folkcare medicine play an important role in the health care system of the population. *Sarcostemma viminale* (L.) R.Br. and *Ceropegia bulbosa* Roxb. belongs to the milkweed family i.e. Asclepiadaceae, distributed in various habitats in semi-arid region of Thar desert of Rajasthan. This work was carried out to explore morphological peculiarities of whole plant of both the representatives of the family. *Sarcostemma viminale* (L.) R.Br. is used to cure diarrhoea, oedema, stomach problems and tuberculosis. *Ceropegia bulbosa* is used to cure deafness, tubers are used in the treatment of kidney stone, urinary tracts diseases and they are eaten by ladies to enhance fertility and viability. Pollinial apparatus is a significant feature of Asclepiadaceae to characterize species and genera. Morphological study revealed principle characteristic differences and similarities in both the representative plants. True xerophytic features of *Sarcostemma viminale* (L.) R.Br. are, presence of milky latex, highly reduced leaves, green globarous stem, and strong tap root affixed firmly in stony and rocky substratum in association with other xerophytic plants of stressed conditions. *Ceropegia bulbosa* Roxb. var. *bulbosa* and var. *lushii* (Grah.) Hook.f. is perennial, twining, herb of sandy substratum, bearing tubers, needs support of other xerophytic bushes/ shrubs. Both the representative genera under study are almost endangered. Since no report on systematic and comparative morphological analysis of whole plant of both the representatives is available, an effort has been made to prepare a protocol to provide the keys for taxonomy and better understanding of flora.

KEY WORDS: ASCLEPIADACEAE, *CEROPEGIA BULBOSA* ROXB., ENDANGERED, LATEX, MORPHOLOGY, POLLINIA, *SARCOSTEMMA VIMINALE* (L.) R.BR., TUBER.

ARTICLE INFORMATION:

*Corresponding Author: jnvusunitorora@gmail.com

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INTRODUCTION

Medicinal plant products have a long history of indigenous use in India as well as other countries (Hinmath *et al.*, 2000). The research on medicinal plants are important leading area in the world (Boombalagan *et al.*, 2014). Several medicinal plants remain associated with antifertility properties (Madhumita and Saral, 2009). The plants of family Asclepiadaceae remains distributed from south East Asia, India, Madagascar, Tropical Arabia, Canary Island, Africa except Mediterranean region, New Guinea and north Australia (Bruyns, 2003; Dyer, 1983). The family Asclepiadaceae was previously ranked as family and now it is treated as a subfamily of Apocynaceae. This view was also upheld by the Angiosperm Phylogeny Group (APG 2003, 2009). It is comprised of approximate 130 genera and 2000 species tropical as well as subtropical, mostly shrubs, often twining or perennial herbs (Indhumathi and Kalvimoorthi, 2010).

Both of the plant representatives under study were reported from semi arid and stressed regions of Rajasthan, the biggest state of India is situated in the north western part. A striking geological feature of the state is the Aravalli range which divides the state into two physiographic regions, the 2/3 sandy arid plain is unproductive, Thar Desert and 1/3 eastern fertile region is comparatively rich in vegetation. The Thar Desert encompasses about 70% of total landmass of Rajasthan and hence it is identified as the "Desert state of India". The average temperature in winter ranges from 8° to 28°C (46° to 82° F) and in summer the average temperature range from 25° to 46°C (77° to 115° F).

Sarcostemma is a genus of at least 35 species of flowering plants. The plants are well adapted to xeric conditions of Thar Desert. It inhabits dry and rocky areas on hills. The soft stem is filled with milky white latex that is poisonous and caustic in some species, so often named as caustic vine. The flowers have a ring of thick tissue at the base which extends into hollow spherical appendages within the flower corolla (GRIN, 2011). It is more branched, leaves are either absent or highly reduced, grows always in association with *Euphorbia caducifolia* (Shetty and Singh, 1993).

Ceropegia is old world tropical genus of climbers and it contains about 200 species, of which 49 species are found in India. It grows sporadically in red lateritic soil. Flowering occurs during July-September. This genus has always been a lure to the researchers because of structural and adaptive strategies (Percival, 1969). Flower design, corolla size, shape and coloring pattern etc. are some special characters of this genus. Among different species *Ceropegia bulbosa* is one of the widely distributed species but still threatened (Yadav and Kamble, 2008). Two varieties of *Ceropegia bulbosa* were ana-

lyzed morphologically i.e. *Ceropegia bulbosa* Roxb. var. *bulbosa* and *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f. The former one is characterized by broad leaves while the later is a narrow leaved variety (Cooke, 1958). Several species of *Ceropegia* are facing different threats and almost 16 species have been recorded under different categories in Red Data Book (Nayar and Sastry, 1987-89).

The main objective of this paper was to investigate the morphological parameters of *Sarcostemma viminale* (L.) R.Br. and *Ceropegia bulbosa* Roxb. to understand the strategies, these plants develop to survive in stressed desert conditions of Thar Desert.

MATERIAL AND METHODS

Sarcostemma viminale (L.) R.Br. was collected from Jodhpur district, that is centrally situated in the western region of the state, and covers a total geographical area of 22850 Sq. Kilometers. It lies between 26°0' and 27°37' north latitude and 72°55' and 73°52' east longitude. The district lies at a height of 250-300 meters above sea level. *Ceropegia bulbosa* was collected from Jaipur, Ajmer, Bhilwara, Chittorgarh, Udaipur and Karoli district of Rajasthan. All the plant specimens were collected during month of July-September 2015. "The Flora of Indian Desert" (Bhandari, 1978) was also consulted for identification, and then the specimens were finally authenticated by BSI (Botanical Survey of India), Jodhpur (Rajasthan). Photomicrographs of the plant in its original habitat were taken in the field to display the surface feature of the leaf, stem, root and flower. These organs were photographed in closer views. The specimens of both plant species were packed in air-tight poly bags. The specimens were sprayed with fungicide & pesticides for preparing herbarium sheets.

For morphological studies flowering twigs & herbarium samples were examined through the conventional taxonomical procedure adopted by Bentham and Hooker (1873) and Prain (1903). Morphological parameters of taxonomic value were determined.

RESULTS AND DISCUSSION

The study revealed valuable differences and similarities in morphology of two representatives genera of same family. Remarkable differences were observed in their habit, habitat, height, leaf appearance (size, shape and color) and in floral appendages.

(1) Botanical Name: *Ceropegia bulbosa* Roxb. *Ceropegia bulbosa* Roxb. var. *bulbosa*

Local name: Art khadula, Barbatta, Khaparkundis

Global Distribution: India and Pakistan

Indian Distribution: Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Rajasthan, Gujarat, Punjab, Orissa and West Bengal.

Ceropegia bulbosa Roxb. var. *lushii* (Grah.) Hook.f. :
Local name: Hedulo, Solari,

Global distribution: India and Pakistan

Indian distribution: Karnataka, Kerala, Tamil Nadu and Rajasthan.

Habit

Ceropegia bulbosa Roxb. var. *bulbosa* and var. *lushii* (Grah.) Hook.f. both are small, perennial herbs grows amongst thorny and spiny bushes of *Capparis deciduas* and *Prosopis julifera* on which they climbs and also gets protected against grazing animals. It requires sandy soil mixed with some stony fraction. It was observed that both varieties were growing together at same place (Fig. 1)

Root

10 specimen from different location were used for recording texture, type and measured by calculating mean value. Roots of *Ceropegia bulbosa* Roxb. var. *bulbosa* emerged out from turnip like tuber (4x2.5 cm) that

is glabrous, creamish brown, globose to elliptical, broad at top and narrows down, edible. Maximum 11 roots of variable length were observed emerging from the tuber, root hairs are very small. The tubers and roots grow approximately 6-8' beneath the substratum.

Roots of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f. shows similar morphological characters except its size that varies between 3x2.4-3x2.8cm (Fig. 2)

Stem

Morphological feature and measurements were recorded using 10 specimens from different location and data were analysed; stem of *Ceropegia bulbosa* Roxb. var. *bulbosa* is herbaceous, dark green climber, cylindrical, smooth, branched with nodes and internodes of variable distances, highest intermodal distance measured is 10 cm.

Stem of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f. shows similar morphological characters except the color that is less green and the maximum internodal distance is 6.7 cm (Fig. 3).

Leaf

Leaf measurement (length and width) were recorded using 10 leaves of plant, mean value was recorded and

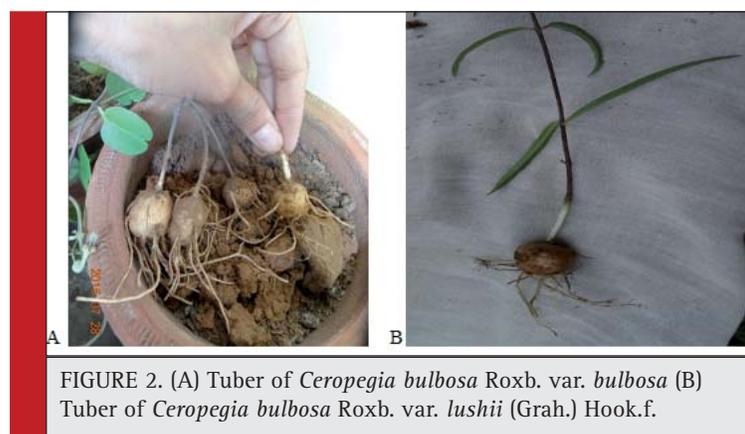
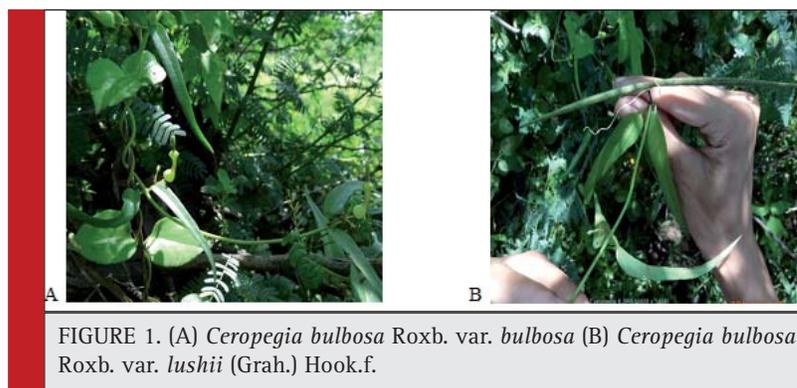




FIGURE 3. (A) Stem of *Ceropegia bulbosa* Roxb. var. *bulbosa* (B) Stem of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f.

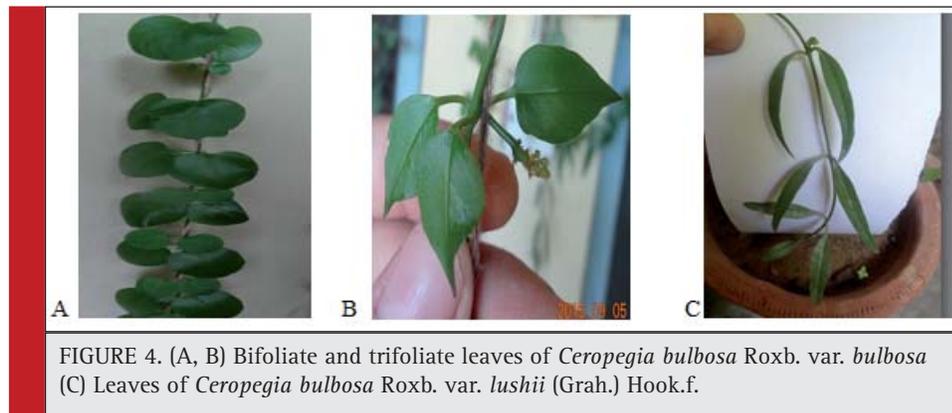


FIGURE 4. (A, B) Bifoliate and trifoliate leaves of *Ceropegia bulbosa* Roxb. var. *bulbosa* (C) Leaves of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f.

detailed morphological parameters are as follows; leaf of *Ceropegia bulbosa* Roxb. var. *bulbosa* develop on nodal region of the stem, abaxial surface dark green, adaxial surface light green, petiolate (1.8-2.3 cm), base rounded, simple, glabrous, fleshy, stipulate, 2-3 leaves arises at each node, opposite, superposed, margin slightly undulate, diameter varies between 3-3.8x2.5-3.3cm, elliptic-oblong, lowest almost orbicular, largest leaves are present almost at the middle of the stem, apex acute-mucronate, pinnate venation.

Leaf of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f. shows almost similar morphological characters except the color that is less green and shape that is linear, diameter varies between 12-15x0.8-1 cm, elliptic or elliptic lanceolate, petioles 4-8mm (Fig. 4).

Flower

10 specimens were analyzed for recording floral measurement; flower of *Ceropegia bulbosa* Roxb. var. *bulbosa* are pendunculate (1-2.5cm), pedicillate (0.5-2 cm), simple

umbel or cymose type, arises from axil of leaf, pentamerous, hermaphrodite, actinomorphic, regular, white at base and purple at top, sepals; 5, free at top, 2-3mm long, lanceolate, smooth, valvate, petals; 5, broad and fused at base, narrower and free at top, ends enrolls and make a tube like structure to make a cage (corona) that is a nectar producing region, showing conservative pollination system that may employ only small insects, hairy at top, maximum length reaches to 3.3cm, valvate, stamens; 5, adnate at base of 5 styles, pollinarium is present at base of each style making gynostegium, ovary; bicarpilary, bilocular, apocarpous, placentation marginal with many ovules.

Flower of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f. is almost morphologically similar except its color that is whiter and less purple at top (Fig. 5).

Fruit

Fruit of *Ceropegia bulbosa* Roxb. var. *bulbosa* is a pair of follicles originate oppositely, 8-10x0.5 cm long, glabrous, tapering at ends, dehisces longitudinally, many seeded.

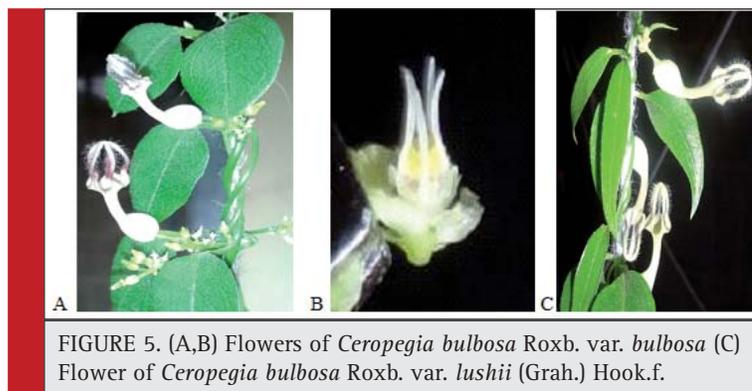


FIGURE 5. (A,B) Flowers of *Ceropegia bulbosa* Roxb. var. *bulbosa* (C) Flower of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f.

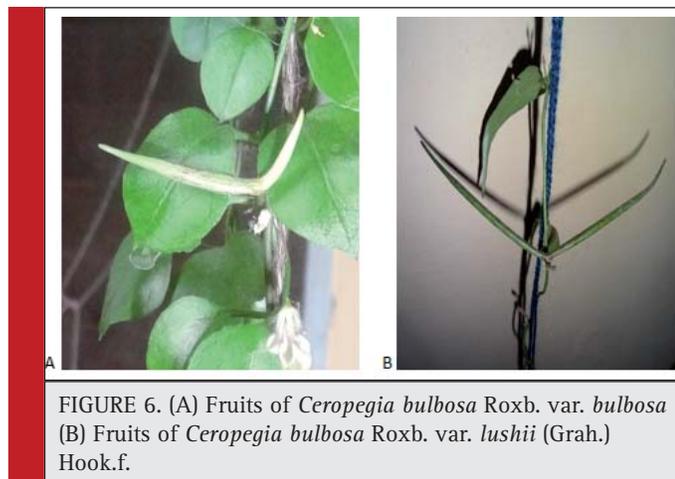


FIGURE 6. (A) Fruits of *Ceropegia bulbosa* Roxb. var. *bulbosa* (B) Fruits of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f.

Fruit of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f. is morphologically similar with var. *bulbosa*, except its diameter that is 11-13x0.4 cm (Fig. 6).

Seed

Seeds of both species are morphologically similar, except diameter, usually the seeds are flat, ovate-oblong and are crowned by a membranous margin, hairy, these hairs facilitate the dispersal of the seeds by wind, the embryo is large. Seeds of *Ceropegia bulbosa* Roxb. var. *bulbosa* are 6-7 x 2-3 mm, while seeds of *Ceropegia bulbosa* Roxb. var. *lushii* (Grah.) Hook.f. is 7-8x2-3 mm (Fig.7). (2) Botanical name- *Sarcostemma viminalis* (L.) R.Br. Syn. *Euphorbia viminalis* L.

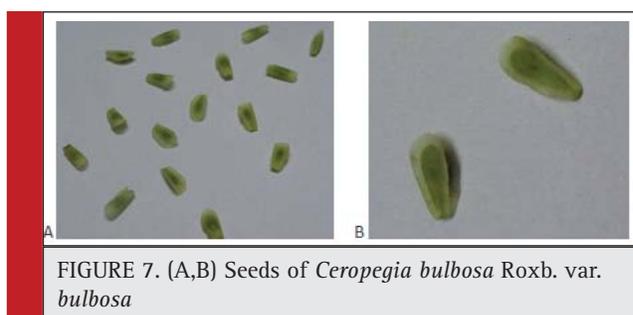


FIGURE 7. (A,B) Seeds of *Ceropegia bulbosa* Roxb. var. *bulbosa*

Accepted Scientific Name is *Cynanchum viminalis* (L.) L.

Local name- Caustic vine, khir-khimp, somlata, Melktou, Rapunzel

“Sarco” is Greek word meaning fleshy while “Stemma” refers to the fleshy inner corona. The ‘caustic’ in the common name referring to the burning power of the released latex.

Global Distribution: Myanmar, South Africa, Botswana, Namibia and all inland parts of southern Africa, Kenya, India, Burma, in coastal regions of Australia, China, Philippines, Thailand and New Caledonia,

Indian Distribution: Keralas, Bengal and Rajasthan

Habit

Vigorous shrub, rarely tree-like, erect trailing or twining, perennial, grows more luxuriantly during rainfall, requires rocky habitat with soil as a component, grows in association with *Euphorbia caducifolia*, it may be a type of indirect interaction that allows facilitation of congeneric species. When traits have diverged within genus, the competition is relaxed, that allows the coexistence of species. All parts of the plant exude milky latex when damaged (Fig.1).



FIGURE 1. (A) *Sarcostemma viminale* (L.) R.Br. growing in association with *Euphorbia caducifolia* (B) *Sarcostemma viminale* (L.) R.Br. when *Euphorbia caducifolia* was removed

Root

10 specimens from different location were used for recording texture, type and measured by calculating mean value. Primary as well as secondary (adventitious) root is present, as branches whenever comes in contact with substratum, they forms stolons. Primary root profusely branched, as compared to adventitious root, root hairs are present all along the length of branches. Primary roots pale-brown goes 15-20 cm down, the substratum (Fig.2).

Leaf

Leaves are highly reduced they develops on nodal region of stem, sessile, simple, opposite, exstipulate, apex acute, margin slightly crenate, caducous or turns scaly, 2-3 mm long (Fig.3).

Stem

Cylindrical, rigid at base, radius 3.5 cm, erect, trailing, sprawling, scrambling or lianescent, with or without a main stem, green, succulent, pubescent when young,

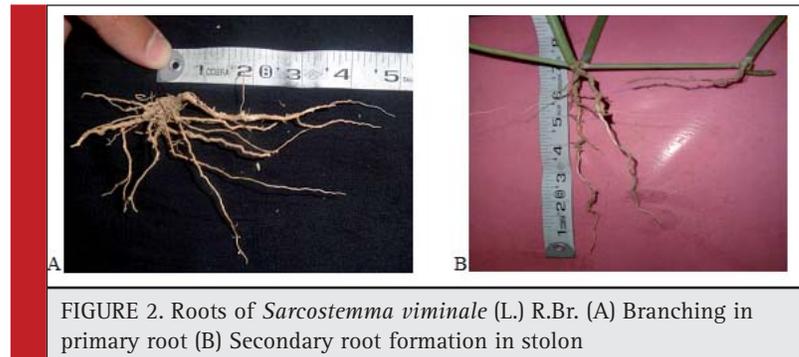


FIGURE 2. Roots of *Sarcostemma viminale* (L.) R.Br. (A) Branching in primary root (B) Secondary root formation in stolon

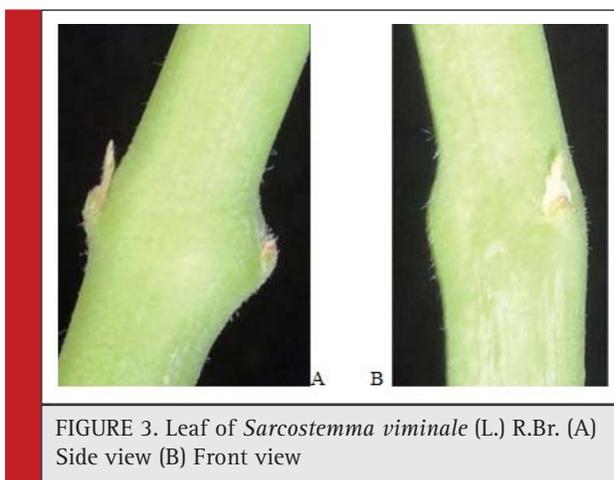


FIGURE 3. Leaf of *Sarcostemma viminale* (L.) R.Br. (A) Side view (B) Front view

glabrous when mature, internodes 9-14cm long, sometimes 2 opposite branches arises from node rather than origin of leaf, base woody and with a very thick corrugated corky bark when old(Fig. 4).

Flower

Floral diameter was recorded with 10 specimens from same plant. The details of measurement and floral features is as follows; shape when closed is like an embossed star, aroma of jasmine, many flowers originate from a common point on pedicel (30-40 in a bunch), simple umbel, the main axis ends at a summit of peduncle; maximum length of pedicel reaches upto 1.2cm, hermaphrodite, regular, tetra-pentamerous, actinomorphic,

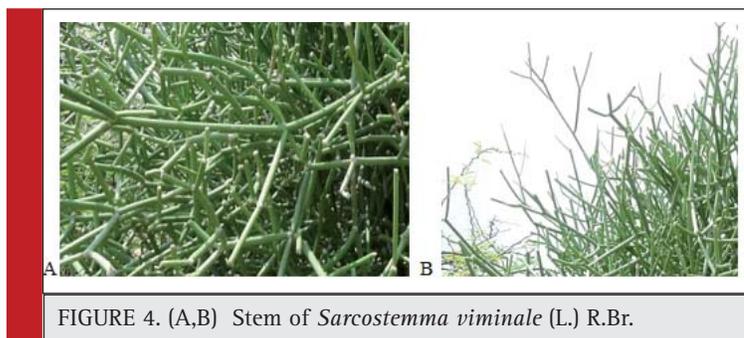


FIGURE 4. (A,B) Stem of *Sarcostemma viminale* (L.) R.Br.

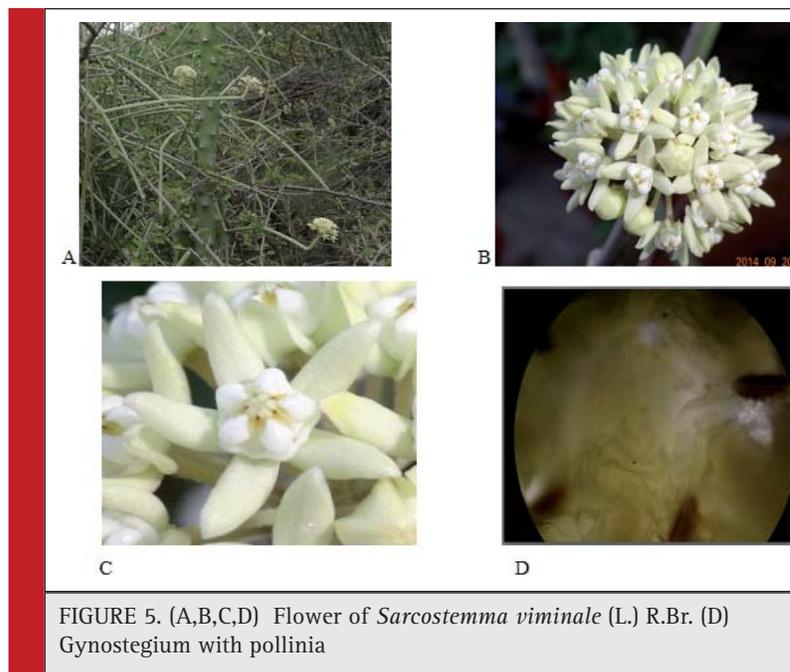


FIGURE 5. (A,B,C,D) Flower of *Sarcostemma viminale* (L.) R.Br. (D) Gynostegium with pollinia

hypogynous, glandular, bracteates; (1mm in length), fused at lower ends, glabrous, acute; sepals; 5 (maximum length 5mm), creamish yellow, facing inwards, obtuse, imbricate, membranous, alternating with bracts, petals; fused to make 2 membranous rings (outer and inner) like structures bearing stigma and staminal column; staminal column fused with stigma to form gynostegium and the gynostegium is in direct contact with inner coronary flap, that in turn is attached with outer coronary flap, staminal column bears translator, nectarines present at angle of pollinia and stigmatic disc, pollinia; sessile, flattened and lanceolate, creamish yellow; ovary; bicarpellary, apocarpus, style free, stigma makes a pentangular disc to support translator, marginal placentation, many ovules/locules (Fig.5).

Fruit

A follicle, maximum length reaches up to 10.5cm, width vary between 0.6-0.8cm, many seeded, tapering at distal end, broad at proximal end, turns brown when ripe, it

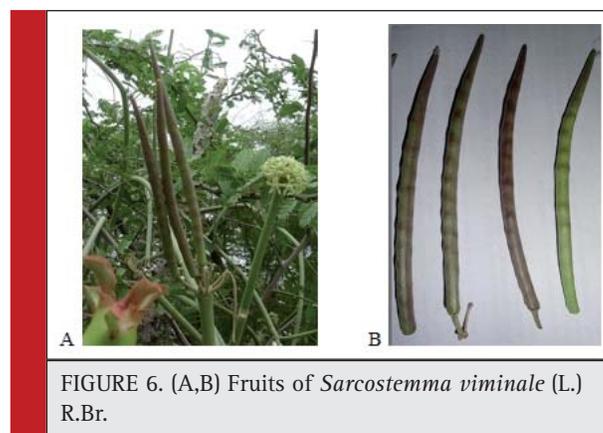


FIGURE 6. (A,B) Fruits of *Sarcostemma viminale* (L.) R.Br.

splits along one suture, it is produced from bicarpillary superior ovary (Fig.6).

Seed

0.8-0.9mm x 0.2-0.3mm, aril absent, oblong, conical at one end and broader at another end, one surface flat-

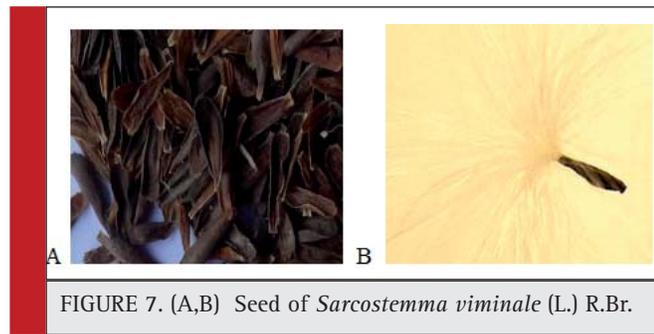


FIGURE 7. (A,B) Seed of *Sarcostemma viminalis* (L.) R.Br.

tened another convex, endospermic, uneven surface, edges sharp, with pappus (coma) at conical end, blackish brown, membranous (Fig. 7).

Plant morphology may help to understand basic conceptual aspects as new approaches need to correct a past draw back. Morphological description may serve as a conceptual framework to link with other approaches, thus this approach may be seen as an integrated and continuous process that goes through reference points.

The precise morphological description of *Sarcostemma viminalis* (L.) R.Br. is still lacking and we have tried to describe it at our best.

The family Asclepiadaceae is unique due to the presence of pollinia and milky latex. Present investigation reveals several interesting morphological similarities and differences in both plants belonging to same family, even some differences have been observed in two varieties of same genus i.e. *Ceropegia bulbosa*. The author has reported differences right from habitat that occurs till seed formation. All the plants under study have successfully adapted to harsh and stressed climate by showing remarkable adaptation like leaf less condition, lanceolate-linear leaves reducing transpiring zone, green stem substituting the absence of leaves. Twinning habit also protects them against strong winds of Thar. Thick texture of leaves of *Ceropegia* supports them against high wind currents.

Ceropegia is therefore example of a large genus that has diversified despite an apparently functionally specialized (Fenster et al., 2004; Ollerton et al., 2007).

Sarcostemma is a genus that shows peculiar morphological features to adapt in Thar desert. We always have reported it growing in association with *Euphorbia caducifolia*, most probably it facilitates *Sarcostemma* for its survival and shows commensalistic relationship. Rationale of this 'proxy' is Darwins idea that congeneric species are similar in many habits and constitution, have high overlapping niches and therefore compete more strongly than species of distant genera (Violle et al., 2011).

Burns and Strauss (2011) demonstrated that most species germinate well at conspecific and congeneric sites and less well at confamilial and distant relative sites.

Leaf less habit, photosynthetic substitution, presence of more amount of latex, strong tap root and rocky - stony habit preference are some of the strategies that the plant adapt to stay in stressed climatic conditions.

Both the plants under study are typically endangered so they need most care and conservation. Recently *Ceropegia* species have attracted attention of several workers due to its rare occurrence, it is difficult to propagate, cultivate and maintain in gardens and hence its conservation is a major challenge to biologists (Sagar et al., 2014).

Once the description of plant forms is available then the role played by genes and proteins in the maintenance or stability of shapes will be better understood, it strongly needs an elaborative and theoretical approach towards morphology rather than sophisticated experimentation that may be required later on to unveil molecular status.

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