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MORPHOLOGICAL AND ANATOMICAL INVESTIGATIONS IN *DESMODIUM TORTUOSUM* (SW.) DC. (FABACEAE): A NEW ADDITION TO THE EGYPTIAN FLORA

ABDEL SAMAI MOUSTAFA SHAHEEN[1]

Department of Botany, Aswan Faculty of Science, South Valley University, Aswan 81528, Egypt

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Abstract

The morphological, anatomical and micromorphological features of *Desmodium tortuosum* (Sw.) DC. were investigated to assist in the identification of the species as a new record for Egypt. Specimens collected from different places in the Egyptian Nubia (Nubian Nile Valley) confirmed the presence of *D. tortuosum* as a naturalized species in the country. In general, the results obtained from the morphological studies were consistent with the previous studies on this species. However, the present investigation into leaf, petiole and stem anatomy and the seed and the leaf patterns under light and scanning electron microscopes, respectively, is the first such study on the species.

Introduction

Desmodium tortuosum (Sw.) DC. belongs to the family Fabaceae (Leguminosae). The species is common throughout the temperate and tropical regions, with exception of Europe, New Zealand, and the United States's west of the Rocky Mountain (Schubert 1980). The native range of *D. tortuosum* includes the West Indies; other reports, however, suggest the species also may be native to the Americas (Smith 1889, Hume 1907). Of the 300 species of *Desmodium* distributed throughout the world, only 39 species occur in Africa, but none has so far been reported from Egypt (Lock 1989, Boulos 2004).

Desmodium tortuosum was once regarded as a useful warm-season crop in the USA, especially important as horse feed and as a crop improving soil structure (Smith 1889, Yaunge *et al.* 1964). Today, the species is considered among the most troublesome weeds in crop fields of the southeastern coastal plain of the USA (Webster and Cardina 2004), but still regarded as a desirable plant for wildlife. Some anatomical and morphological features of the subfamily Papilionoideae and the genus *Desmodium* were reported by Heneidak and Shaheen (2007) and Webster and Cardina (2004), respectively. However, so far, there have been no detailed anatomical and morphological studies on *D. tortuosum.*

[1]E-mail: abdushaheen@yahoo.com

In the present study, the morphological, anatomical and ultra-morphological features of fresh samples of *D. tortuosum* were studied in an attempt to provide more detailed descriptions for this species newly added to the flora of Egypt. The study may also give new characters to assess the identification and the taxonomic position of this species in the future studies.

Materials and Methods

A survey of some herbaria throughout Egypt (CAI: Cairo University Herbarium; CAIM: Agriculture Museum Herbarium; and ASW: Aswan Faculty of Science Herbarium), consultation of all published Egyptian floras and monographs and field exploration in some phyto-geographical regions revealed no report of the genus *Desmodium* from Egypt.

The author recorded the first population of *D. tortuosum* in Egypt from the Nubian Nile Valley (Al-Gahfra, latitude 24º24’51” N, longitude 32°57’17” E; 30 km north of Aswan City) in March 2001. The second one was collected from the Nubian Nile Valley (Elephantine Island, latitude 24º05’08” N, longitude 32°53’25” E; 6 km north of Aswan Dam) in November 2001 (Shaheen *et al*. 2004). Later on plant specimens were collected from different places of the Egyptian Nubian Valley through repeated visits during 2004-2007. Specimens for morphological studies were preserved according to standard herbarium techniques and stored in Aswan Faculty of Science Herbarium (ASW), Egypt.

The taxonomic description of the plant was framed using the stereomicroscope at ASW and compared with that of Webster and Cardina (2004). Anatomical investigations were performed on cross-sections of fresh samples of leaves, petioles and stems at Ain Shams University, Cairo, Egypt. Segments of petiole (distal, medial and proximal), stem and leaf were preserved in 70% alcohol. The cross- and surface-sections were covered with glycerin-gelatin (Vardar 1987) and photographs of the sections were taken using a Leitz Deplane photomicroscope.

Seed coat and leaf surface patterns were first investigated at the 7-14 × magnification using an Olympus stereomicroscope (ASW Herbarium). For more detailed study, seed and leaf were mounted on specimen stubs with conductive material paint. The specimens prepared before being examined and photographed with IVO Stero Scanning Electron Microscope (SEM) at the central laboratory at Qena Faculty of Science, Qena, Egypt.

Results and Discussion

Desmodium tortuosum (Sw.) DC., in Miller, Fl. Jamaica 4: 316 (1730). Swart, Fl. Jamaica 107 (1788); Miller and Swartz, Journal de Botanique, Appliquèe à l' Agriculture, à la Pharmcie, à la Mèdecine et aux Arts 1: 122, Pl. 5, f. 15 (1813); De Candolle, in Prodromus Systematis Naturalis Regini Vegetablis 2: 332 (1825); Schubert, Ann. Mo.

Bot. Gard. 67: 658 (1980). *D. purpureum* (Mill.) Fawc. & Rendle, Fl. Jamaica 4(2): 36 (1920). *D. stipulaceum* (Sw.) DC., Prodr. 2: 330 (1825). *Hedysarum purpureum* Mill., Gard. Dict. ed. 8, No. 6 (1768). *H. tortuosum* Sw., Prodr.: 107 (1788). *Meibomia purpurea* (Mill.) Vail & Small, Fl. S.E. U.S.: 639 (1903). *M. stipulacea* (DC.) Kuntze Rev. Gen. Pl. 1: 198 (1891). *M. tortuosa* (Sw.) Kuntze, Rev. Gen. Pl. 1: 198 (1891). (**Fig. 1**)

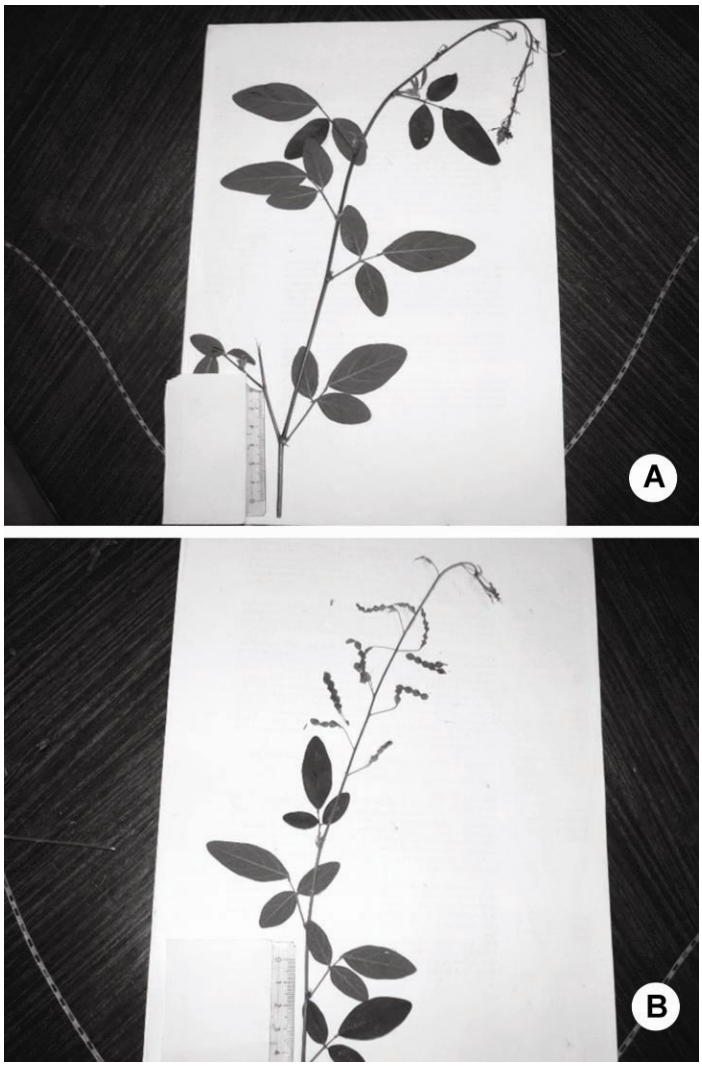

Fig. 1. *Desmodium tortuosum.* A. Vegetative part. B. Upper part of a plant with pods.

Type: Prodr. 2: 332 (1825, 13679); on Maui in 1913, s.n., BISH Hawaiian Archipelago, Kauai, Dahu, Maui, Kahoolawe and Hawaii.

English names: Beggar weed, Florida weed, Spanish clover, Dixie ticktrefoil (USDA-ARS-GRIN 2001).

Annual herb, highly branched from the base, with very dense, hooked short, stiff indumentums, unicellular trichomes covering leaves, petioles, stems, legumes, and young branchlets (glandular). Stems ascending up to 50-60 cm, often green to purple with some red markings at the nodes and typically covered with short stiff trichomes. Lower leaves alternate, unifoliate, obovate, 5.8-6.8 × 3.4-3.8 cm, petioles 2.0-2.9 cm long; upper leaves trifoliate, lanceolate 3.2-2.5 × 0.4-0.6 cm, sessile to sub-sessile, stipules 0.2-0.4 cm long. sessile to sub-sessile. Inflorescence an open panicle with occasional unifoliate leaves along the spreading branches, many flowered (16-30), pale blue pedicles loose, 1.4-1.8 cm long, erect or spreading. Legumes 3.5-4.5 × 0.3-0.5 cm, with distinct constrictions between seeds; the number of the constriction ranges from 2-8, the constrictions allow the mature fruit to separate at maturity. Seeds brownish-black in color, reniform, 1.4 × 0.9 cm, number of seeds per pod 2-8, young seeds green.

The findings of morphological studies were generally consistent with the description given by Rodford *et al*. (1968), Redhead and Polhill (1971), Lock (1989), Brown and Cardina (1992) and Webster and Cardina (2004), especially with those of pod and seed.

Distribution: Northern America (Southeastern and South Central USA) and Southern America (Mesoamerica, Caribbean, Northern South America, Brazil, Western South America and Southern South America) (Schubert 1980). In Africa, the species was collected from three sites of the regional centre of endemism (Zambezian, Sudanian and Somalia-Masai) and one regional transition zones and regional mosaics (Lake Victoria Regional Mosaic). It was also collected from Anthropic Landscape vegetation type (White 1983).

Habitat: Locally, the specimens were collected from Date Palm orchards terrace of the Nubian Nile Valley (latitude 24º8’ - 24º15’N and longitude 32º32’ - 33º30’ E) which is considered a narrow strip of Nile deposits (Shaheen 1987). The soil comprises a mixture of wadi-fill deposits and Nile alluvium. The surface layer is characterized by the coarse ingredient (67% sand) with smaller amounts of silt (15.9%) and clay (14.4%) (Shaheen 1987). The seasonal range of mean temperature of the region shows that the winter is cooler (December: 16.95°C) and the summer is hotter (July: 33.25°C). The annual mean rainfall in the region is negligible, and the relative humidity suggests the region to be dry. The plant community is basically formed of herbaceous annual and perennial species characterized by grasses in addition to prostrate weedy plants such as dominating *Oxalis corniculata* L. and *Phyla nodiflora* (L.) Greene. The main crops cultivated in this terrace are date palm, mango, clover, sorghum and maize.

Phenology: Flowering - February to April; fruiting - March to June.

Chromosome number: 2n = 22 (Webster and Cardina 2004).

Specimens examined: Nubian Nile Valley (Nn): Al-Gahfra, 30 km north of Aswan city, 25.03.2001, A.M. Shaheen, 11084 (ASW); Kubbanya Island, 18 km, northwest of

Aswan city, 25.04.2003, A.M. Shaheen, 11085 (ASW); Elephantine Island, 6 km north of Aswan Dam, 6.11.2001, F.A. Hammada, 10513 (ASW); Al-Aqaba, 25 km north of Aswan city, 15.03.2004, A.M. Shaheen, 11086 (ASW); Elephantine Island, 6 km north of Aswan Dam, 22.03.2005, A.M. Shaheen, 11087 (ASW); Kubbanya Island, 18 km north of Aswan city, 22.03.2007, A.M. Shaheen, 11088 (ASW); Elephantine Island, 6 km north of Aswan Dam, 12.05.2007, A.M. Shaheen, 11089 (ASW); Al-Gahfra, 30 km north of Aswan city, 15.05.2007, A.M. Shaheen, 11090 (ASW).

Anatomical features

Petiole anatomy: In the proximal region, the leaf trace has a less irregular shape, the adaxial and the abaxial bundles have fussed into a more or less complete vascular cylinder with a continuous layer of pericyclic fibres (Figs 2A-C). The secondary bundles and cortical sclerenchyma are completely absent. Dense solitary crystals are present in this part of the petiole. Dense unicellular and multicellular trichomes are present.

In the medial region, the petiole trace has a more irregular shape; it is already divided clearly into three adaxial and 13 small abaxial bundles. In addition to the main bundles, there is an arc of accessory bundle lie within the core of the trace under the adaxial bundles; it differentiated from the abaxial and adaxial bundles by being concentric one. Pericyclic fibres are present in separate regions outside the phloem of each of these bundles. There are no secondary bundles. The cortical sclerenchyma and crystals are absent. The unicellular trichomes are sparse.

In the distal region, the leaf trace becomes more irregular in shape; it is clearly divided into one large adaxial (weakly divided) and eight abaxial bundles forming the main trace, above which lie laterally a pair of secondary bundles. Pericyclic fibres are present as a separate layer above the phloem of each bundle of the main trace only (adaxial and abaxial bundles) while each secondary bundle has its own separate fibre cap. Cortical sclerenchyma and crystals are absent. Dense unicellular trichomes are present.

The anatomical analysis given in these studies provides the first detailed description of *D. tortuosum*. Analysis of the petiole trace structure in cross-sections (proximal-distal) shows that the petiole trace of this species has a major change in the anatomy structure throughout its petiole. The disappearing of the secondary bundles in the proximal and medial regions is also documented in this study. In addition, there is also an abnormality in the leaf trace structure of the medial region (having an accessory bundles in the core of the trace). These results are consistent with the description given by Heneidak and Shaheen (2007) in their investigation of the petioles of some papilionoid species. In this connection, Shaheen (2006, 2007) reported the usefulness of anatomy of stem-leaf transitional zone in the identification of some mimosoid and caesalpinioid species.

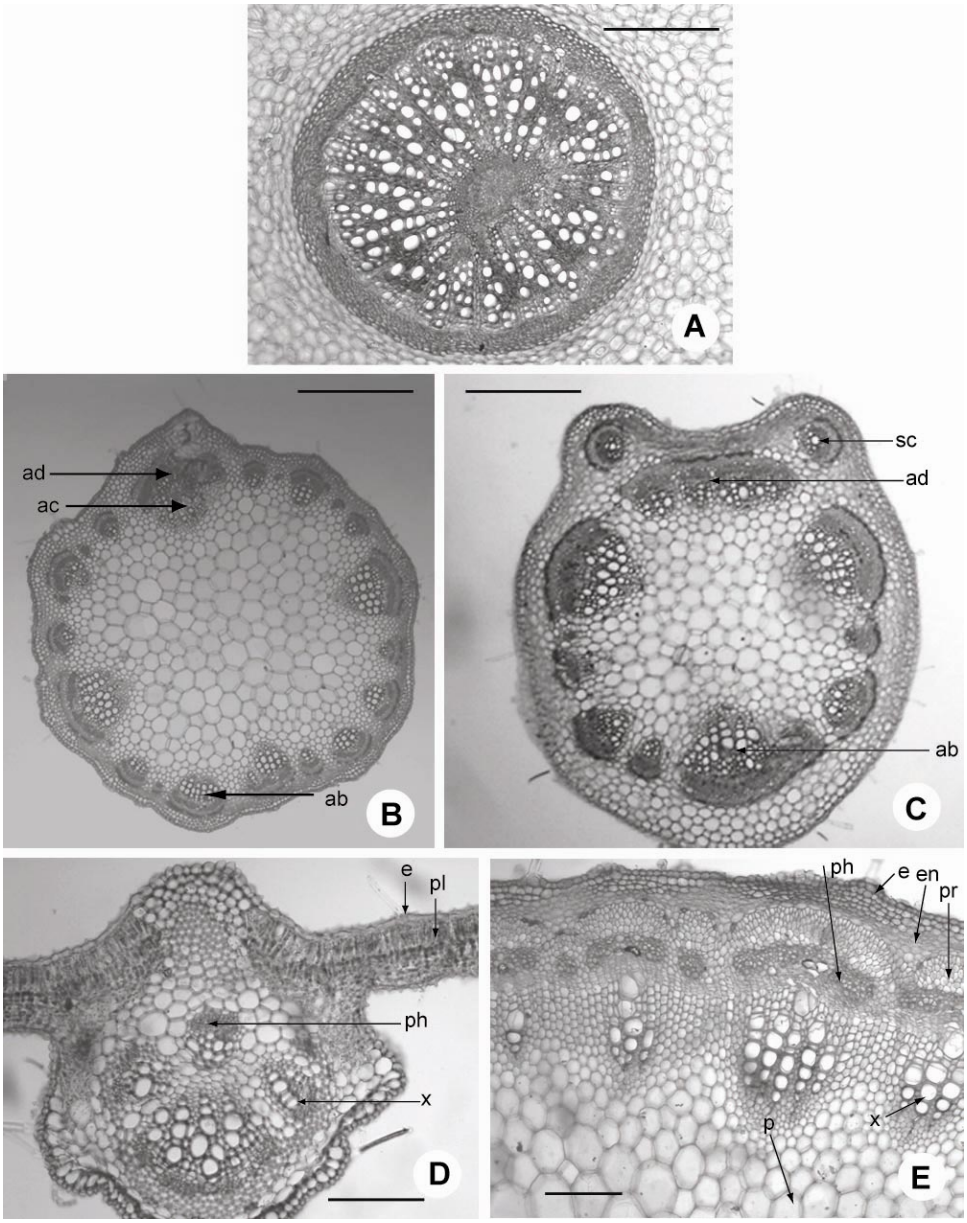

Fig. 2. *Desmodium tortuosum*. A-C. Cross-section of petiole (A. proximal region, B. Medial region, C. Distal region), D. Cross-section of the leaf, E. Cross-section of the stem. ad, adaxial bundle; ab, abaxial bundle; ac, accessory bundle; e, epidermis; en, endodermis; pl, palisade tissue; ph, phloem; pr, pericycle; p, pith; sc, secondary bundle; x, xylem. (Bars = 1 mm)

Leaf anatomy: The upper and lower leaf epidermis layers are composed of uniseriate, large elongated cells, and thick lateral walls (Fig. 2D). Both epidermal layers are covered with thick cuticle. Unicellular and multicellular hooked trichomes are very dense on both surfaces. There are some glandular trichomes as well. The stomata type is paracytic

(rubiaceous) and they occur on the surface of both sides, being more abundant on the upper surface. They are in sunken position with the epidermal cells as mentioned in the micromorphology section (Fig. 3C). The mesophyll is composed of two layers of palisade tissue. Palisade tissue has solitary crystals. The midrib is well developed. The xylem and phloem are in the normal position; the xylem (three arches) is towards the upper side, while the phloem is on the lower side.

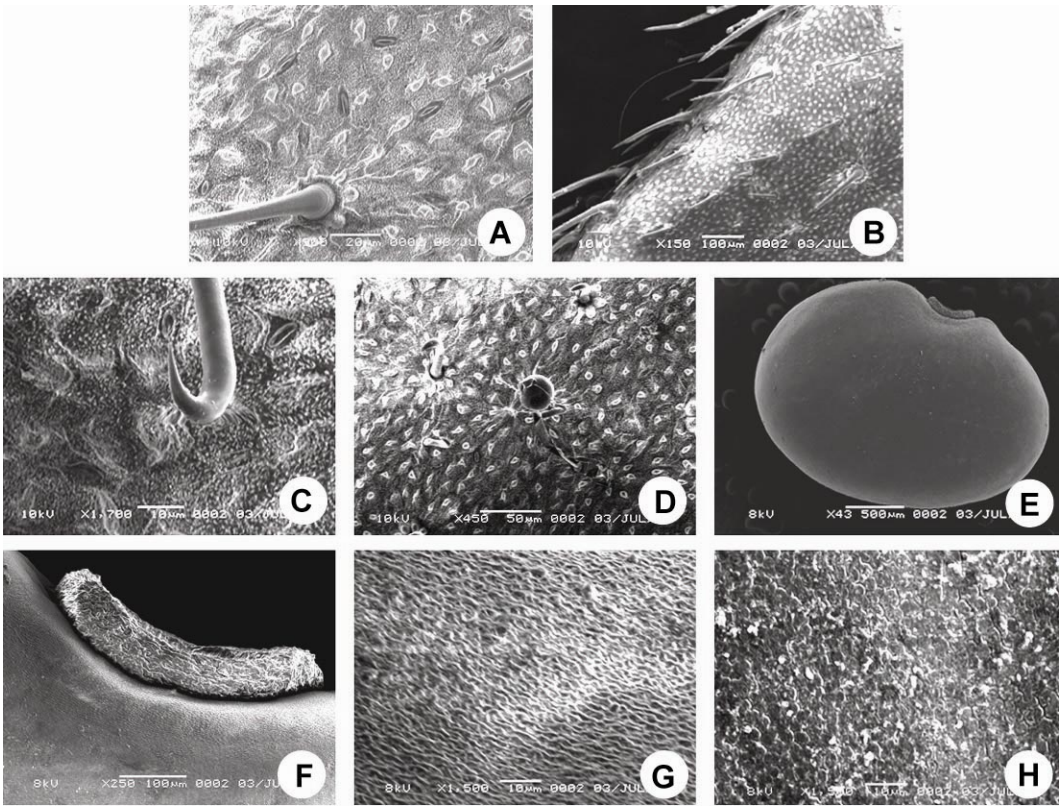

Fig. 3. *Desmodium tortuosum*. A-D. Leaf under SEM (A. Stomata pattern, B. Trichome and wax pattern, C. Hooked trichome and sunken stomata, D. Unicellular trichomes), E-H. Seed under SEM (E. Seed shape, F-H. Seed ornamentation patterns under different magnifications).

These present findings are in agreement with those of Shaheen (1995) who reported the distribution of stomata on both sides of the leaf in some species of Egyptian and Australian *Acacia*. In general, these anatomical features observed on the leaves are consistent with those of Metcalf and Chalk (1950) and Philipson (1963) for the description of leaf anatomy of Leguminosae (Fabaceae).

Stem anatomy: The epidermis is composed of almost elongated cells, with compactly arranged cells and bears no stomata (Fig. 2E). The epidermis is covered with a relatively

thick cuticle and contains dense uni- and multicellular trichomes. The cortex is 4-5-layered consisting of irregular parenchyma with chloroplasts and patches of collenchyma cells. The single-layered endodermis consists of elongated cells. The pericycle is wide consisting of 5-6-layered sclerenchyma cells. The phloem is 2-3-layered consisting of irregular cells. The fascicular and interfascicular cambium is distinguishable (6-layered cells). Xylem is composed of vessels and the phloem contains resin ducts. The pith consists of large orbicular pentahedral parenchymatous cells. These cells underlie the xylem and are thin-walled.

A sclernchymatous ring with varying width found in different genera and species of papilionoid species also characterizes the pericyclic of *D. tortuosum*. The xylem and phloem also form a continuous ring in the studied species as well as in certain species of *Desmodium* (Devadas and Brck 1972). In addition, there were no calcium oxalate crystals in their stems. These results are in agreement with Ataslar (2004) who reported the absence of calcium in the stem of *Saponaria kotschyi* Boiss.

Micromorphology

Micromorphological studies of the leaf surface pattern by Scanning Electron Microscope (SEM) show that the leaflet has clearly defined epidermal cells with fine crystals and the stomata are paracytic type and present on both top and bottom surfaces of the leaf (Figs 3A-D). Stomata are at the lower level than other epidermal cells that is in a sunken position. In addition, study of the seed surface under SEM shows an irregularly rippled pattern (Figs 3E-H).

There has been no report on micromorphology of *D. tortuosum*. Nonetheless, the results agree with those of Shaheen (1995) who reported the usefulness of sunken stomata on leaf in identification of *Acacia ehrenbergiana* Hayne. Irregularly rippled pattern on seeds has also been documented in some species of spinescent *Acacia* (Shaheen 1995). In this connection, valuable taxonomic evidence has been obtained from studying seed characteristics under SEM in some species of *Cassia* and *Senna* as well as some species of Caesalpinioideae (Hussein *et al.* 2002a, b).

The micromorphological as well as the anatomical investigations into *Desmodium tortuosum* recorded here provide the first detailed description for this species. It can be concluded that, the species has some diagnostic morphological and anatomical features with taxonomic values, especially those of the seed and pod and also the abnormality in the vascular trace structure of its petiole.

References

Ataslar, E. 2004. Morphological and anatomical investigations on the *Saponaria kotschyi* Bioss. (Caryophyllaceae). Turk. J. Bot. **28**: 193-199.

Boulos, L. 2004. Flora of Egypt. Vol. **1**. All Hadra Pub. Cairo-Egypt, pp. 1-419.

Brown, S.M. and Cardina, J. 1992. Weed Facts: Florida beggerweed. Tif-ron, GA. University Cooperative Extension Service, pp. 1-4.

Devadas, C. and Brck, C.B. 1972. Comparative morphology of the primary vascular systems in some species of Rosaceae and Leguminosae. Am. J. Bot. **59**: 557-567.

Heneidak, S.I. and Shaheen, A.M. 2007. Characteristics of the proximal to distal regions of the petioles to identify 15 tree species of Papilionoideae- Fabaceae. Bangladesh J. Plant Taxon. **14**: 101-115.

Hume, H.H. 1907. Beggerweed. In: Bailey, L.H. (ed.), Cyclopedis of American Agriculture, II Crops. Macmillan, New York, pp. 214-215.

Hussein, H.I., Khalifa, S.F., Ghareeb, A. and Fawzi, N. 2002a. Taxonomic importance of seed characteristics of some species of *Cassia* and *Senna* (subfamily: Caesalpinioideae-Leguminosae). Egypt J. Biotechnol. **12**: 248-265.

Hussein, H.I., Khalifa, S.F., Ghareeb, A. and Fawzi, N. 2002b. Taxonomic criteria of the characteristic features in seeds of some selected species of Caesalpinioideae-Leguminosae. Egypt J. Biotechnol. **12**: 280-298.

Lock, J.M. 1989. Legumes of Africa. A check-list. Royal Botanic Garden, Kew, pp. 1- 619.

Metcalf, C.R. and Chalk, L. 1950. Anatomy of the Dicotyledons (Leguminosae): Leaves, Stems and Wood in Relation to Taxonomy with Notes on Economic Uses. Vol. **1**. Oxford, Clarendon Press, pp. 153.

Philipson, W.R. 1963. Vascular patterns in dicotyledons. Bot. Rev. **29**: 382-404.

Redhead, E.M. and Polhill, R.M. 1971. Flora of Tropical East Africa, Leguminosae. Vol. **2**. Royal Botanical Garden, Kew, pp. 503-1109.

Rodford, A.E., Ahles, H.E. and Bell, C.R. 1968. Manual of the vascular flora of the Carolines Chapel Hill. The University of North Carolina Press, pp. 1- 1183.

Schubert, B.C. 1980. *Desmodium*. Ann. Mo. Bot. Gard. **67**: 658-66.

Shaheen, A.M. 1987. Studies on the weed flora of Aswan area. MSc thesis, Aswan Faculty of Science, Assuit University, Egypt, pp. 1-185.

Shaheen, A.M. 1995. Morphological and cytological variation within *Acacia* population in Egypt. PhD thesis, Aswan Faculty of Science, Assuit University, Egypt, pp. 1-163.

Shaheen, A.M. 2006. The value of vascular supply of the petiole trace characteristics in the systematics of some species of subfamily Mimosoideae: Leguminosae. Assuit Univ. J. Bot. **35**: 193-213.

Shaheen, A.M. 2007. Characteristics of stem-leaf transitional zone in some species of Caesalpinioideae (Leguminosae). Turk. J. Bot. **31**: 297-310.

Shaheen, A.M., Gaber, M., Hammed, A. and Hammada, F. 2004. Botanical Diversity in the Flora of Some Islands in the Egyptian Nubia. Proc. First Inter. Conf. on the Strategy of Egyptian Herbaria, Agriculture Museum, Dokei, Giza, Egypt, pp. 161-182.

Smith, J.G. 1889. Florida beggerweed. U.S. Dep. Agri. Circ. **13**: 1-15.

USDA-ARS-GRIN (US Department of Agriculture - Agricultural Research Service - Germplasm Resources Information Networks) 2001. National Genetic Resources Program. http://www.ars-grin.gov/cgi-bin/npgs/html/species pl3530, retrieved on 20 August 2007.

Vardar, Y. 1987. Botanikte Preparsyon Teknigi-Ismir: Ege Üniversitesi Fen Faküitesi Basmevi Press, Turkey. (in Turkish)

Webster, T.M. and Cardina, J. 2004. A review of the biology and ecology of Florida beggerweed (*Desmodium tortuosum*). Weed Sci. **52**: 186-200.

White, F. 1983. The Vegetation of Africa. UNESCO, Paris, pp. 1-356.

Yaunge, O.R., Plucknett, D.L. and Rotar, P.P. 1964. Culture and yield performance of *Desmodium inturtum* and *D. canumin* in Hawaii. No. 59 Honolulu, HI: Hawaii Agricultural Experiment Station, University of Hawaii, pp. 1-28.

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