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Taxonomy and distribution of two newly recorded genera in Saudi Arabia

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ABSTRACT

Countries in the Arabian Peninsula have undergone strenuous plant collections during the past two decades as part of enriching various Herbaria in the region or producing and updating the flora of the region. Recent botanical explorations in the southwestern parts of Saudi Arabia have yielded interesting specimens of two distinct taxa. Critical study of these specimens revealed that they belong to two genera previously not reported for the flora of Saudi Arabia. Descriptions and photographs of the newly reported taxa, viz. *Encelia* Adanson and *Galinsoga* Ruiz & Pav., both belonging to Asteraceae, are provided for easy identification. A brief account on the taxonomy and distribution of the two genera in Saudi Arabia are also provided.

Key words: Asteraceae; *Encelia*; *Galinsoga*; flora; Saudi Arabia.

INTRODUCTION

The flora of Saudi Arabia is comparatively rich, owing to the combination of East African, Mediterranean and Irano-Turanian species (White & Leonard, 1991; Alfarhan, 1999) primarily due to the unique geographical location of the country between Africa and South Asia and a varied climate ranging from extra arid to humid. A substantial number of publications have appeared in the past few decades dealing with flora of Saudi Arabia (Chaudhary, 1989, 1999, 2000a, 2000b, 2000c, 2001; Mandaville, 1990; Miller & Cope, 1996; Collenette, 1999; Cope, 2009). A total of 2284 species including native and naturalized plants have been reported in these publications. However, during the last few years, botanists and interested plant collectors have encountered with several species of which some turned out to be new species (Abedin, 1986; Kilian, 1999; Al-Zahrani & El-Karemy, 2007; Fayed & Al-Zahrani, 2007) while others as new

records to the flora of Saudi Arabia (Nader, 1982; Abedin *et al.*, 1985; Alfarhan *et al*., 1997; Masrahi *et al*., 2010; Yahya *et al*., 2011). Despite all these previous collection efforts and research on the flora of Arabian Peninsula and Saudi Arabia in particular, new data still come to light. During such botanical explorations in the southwestern region of the country, several specimens have been collected, of which, two have been identified as belonging to genera hitherto not reported from Saudi Arabia.

MATERIALS AND METHODS

Southwestern region of Saudi Arabia is distinguished for its topographical variation and plant diversity. The region contains two thirds of the flora of Saudi Arabia including significant number of endemic, endangered and rare plants (Collenette, 1999). However, the region contains several under-explored areas, some of which are potentially rich in terms of plant diversity and one can expect more species, either new to science or taxa not previously recorded for the flora of Saudi Arabia. Apart from randomly selected regions across the country for collecting plant specimens, several field visits were also made by the authors to the southwestern region for a detailed floristic survey.

General topography, climate and the vegetation units of the collection localities

The surveyed areas are part of the southern Hijaz Mountains, parallel to the Red Sea, at an altitude that ranges between 2000 m in the southern part (Jabal Fayfa) close to the mountains in Yemen, to approximately 3050 m in the Asir Mountains (Jabal Soodah) in Abha Province. The Al-Baha region, north of Abha which includes the localities of collections of the newly recorded genera is influenced by the tropical continental air masses, resulting in an annual rainfall of <400 mm, or sometimes attaining a total of <1000 mm in certain pockets. The region experiences a maximum temperature of 38°C during summer months and a minimum of 0-3°C during winter months. Vegetation of the collection localities and adjoining areas is composed partly of open xeromorphic dwarf shrub-lands and semi-evergreen sclerophyllous woodlands and sclerophyllous scrubs. Phytogeographically, the region belongs to the Somali-Masai regional centre of endemism, dominated by a xero-mesic tropical flora of paleotropical origin.

Descriptions of the genera, *Encelia* Adanson and *Galinsoga* Ruiz & Pavon included in the paper are according to Clark (2006) and Canne-Hilliker (1977) respectively.

Encelia Adanson, Fam. Pl. 2: 128 (1763).

Type: *Encelia canescens* Lam.

Subshrubs, or shrubs (10–) 30–150 cm high. Stems erect, usually branched from base. Leaves fragrant, usually cauline, or basal, alternate, petiolate; lamina

1- or 3-nerved, mostly deltate, lanceolate, rhombic, or ovate, base broadly to narrowly cuneate, margins generally entire, sometimes toothed, face glabrous or canescent, hirtellous, scabrellous, strigose, or tomentose, often gland-dotted. Head radiate or discoid borne singly or in paniculiform arrays. Involucres more or less hemispherical. Involucral bracts persistent, 2-3-seriate, equal to unequal. Receptacle flat or convex, paleate. Ray florets 8-30, neuter, yellowish. Disc florets c. 80-150 (-200), hermaphrodite. Corolla yellow, brown or purple; 5-lobed; lobes triangular, corolla tube usually shorter than lobes. Cypselae compressed, obovate to cuneate with ciliate margins, apex more or less notched, glabrous. Pappus usually 0 or with 2 bristle-like awns.

Represented by 13 or 14 species, majority of which are in southwest United States, Mexico and South America.

Galinsoga Ruiz & Pavon, Prod. Fl. Per. 110, t. 24. (1794).

Syn.: Adventina Raf., New Fl. (Rafinesque) 1: 67 (1836); *Stemmatella* Wedd. *ex* Benth., in Benth. & Hook. f., Gen. Pl. 2(1): 359 (1873); *Vargasia* DC. In A.P. de Candolle, Prodr. 5: 676 (1836); *Wiborgia* Roth, Catal.Bot. fasc. 2: 112 (1800).

Type: *Galinsoga parviflora* Cav.

Soft, annual branched herbs, up to 60 cm high with erect stems. Leaves petiolate, opposite; lamina 3-veined, lanceolate to broadly ovate, sparsely to densely pilose, margin entire or serrulate to serrate. Heads radiate or discoid; involucres hemispheric to campanulate, 2.5-6.0 mm in diam.; involucral bracts 2-6 rows, persistent or deciduous, elliptic, ovate-lanceolate, oblong, or ovate, outer shorter, herbaceous or scarious; receptacles conical, paleae persistent or deciduous, scarious; proximal broadly elliptic to obovate, often connate at base or nearly to apice, distal persistent or deciduous, lanceolate to obovate, entire or 2- or 3-lobed. Ray florets 3-8(–15), pistillate; corolla white or dull white to pinkish, tubes pilose, laminae quadrate-obovate to oblong, lobes 0–3. Disc florets 10–50(–100), bisexual, fertile, yellow, tubes pilose, lobes 5, deltate; anthers yellow; style-branch apice acute. Cypselae obconic, glabrous or hairy; ray cypsela often shed with subtending phyllary along with 2 or 3 adjacent paleae; pappus 0 or 14-20, white or gray, persistent, fimbriate.

Represented by about 20-33 species, of which 6 species are widely distributed in North and South America; introduced in Europe, Asia, Africa, Atlantic Islands, Pacific Islands and Australia. It is closely related to *Sabazia* Cass. seen in Mexico and South America and to a few species of *Alloispermum* Willd, seen in South America

Detailed observations on vegetative and floral characters of the specimens have been made and identified using relevant literature, (Andrews, 1956; Beentje & Ghazanfar, 2005; Clark, 2006; Feinbrun-Dothan, 1978; Ghafoor, 2002) and compared

and verified with authenticated specimens deposited in the Herbarium of the Royal Botanic Gardens, Edinburgh (E) by one of the authors (Thomas, J.) in July, 2013. Voucher specimens of the newly recorded species are deposited in two different herbaria - Herbarium, Dept. of Botany & Microbiology (KSU) and Herbarium, College of Pharmacy (KSUP) - at King Saud University, Riyadh.

RESULTS

Encelia farinosa A. Gray ex Torr.in W. H. Emory, Notes Mil. Reconnois. 143: (1848). Plate 1.

Syn.: *Encelia farinosa* var. *phenicodonta* (S. F. Blake) I. M. Johnst., Proc. Calif. Acad. Sci. ser. 4, 12: 1198 (1924); *Encelia farinosa* var. *radians* Brandegee, Proc. Amer. Acad. Arts 49: 362. (1913).

Type: Northern America, Mexico/United States: 1846, *Mexican Boundary Survey under Emory 561* (Isotype: US, Catalog No. 40083, Barcode: 00125366).

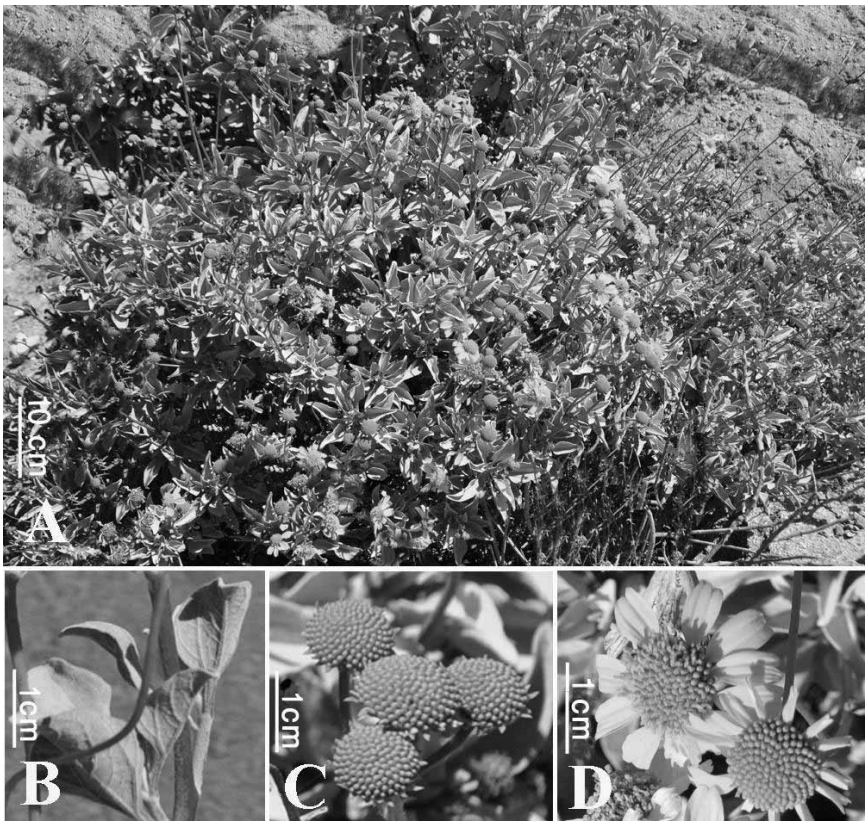
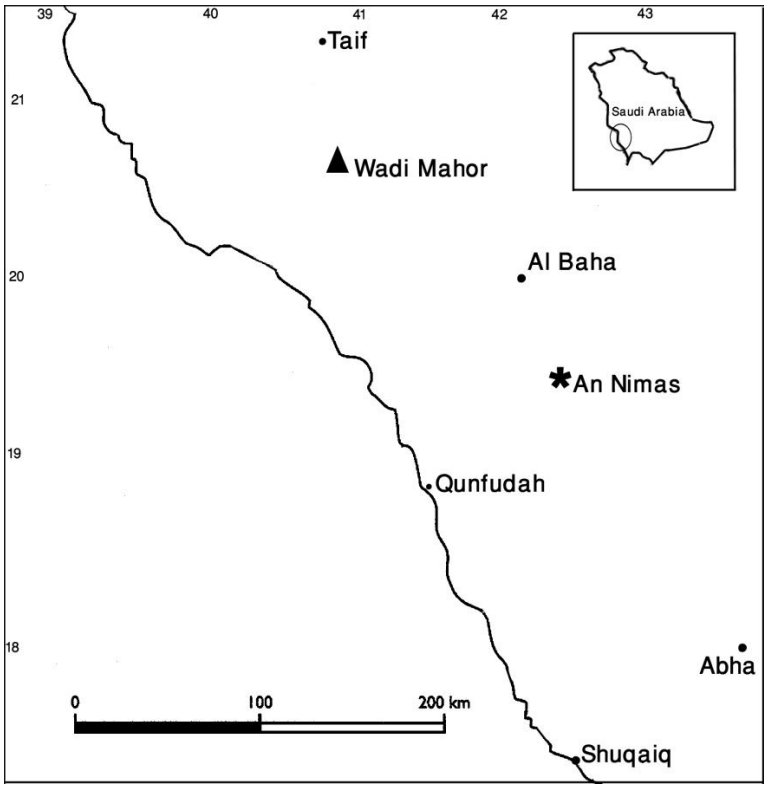


Plate 1. *Encelia farinosa* A. Gray ex Torr. A. habit; B. leaves – close-up; C. young inflorescences; D. mature inflorescences.

Shrubs or subshrubs, 30–150 cm high. Stems brittle, much branched from woody base, white-farinose, becoming glabrate. Leaves usually aggregated near stem tips; lamina ovate to lanceolate, 15-50 (-70) mm long, apex obtuse or acute, densely white-farinose. Panicle branches naked, light yellowish green, glabrous. Heads 10-15 mm diam., deep yellow. Involucral bracts 3-5-seriate, subequal, lanceolate. Ray florets 10-12, corolla 8-12 mm long, yellow. Disc florets yellow, 5-6 mm long. Cypsela 3-6 mm long, villous, pappus or awns absent.



Map 1. Collection localities of newly recorded genera. *Encelia* (▲ Wadi Mahor) and *Galinsoga* (*An Nimas)

Flowering: February–May, August–September

Habitat: Stony hillsides.

Distribution: Native to North America; introduced and naturalized in several tropical and subtropical countries including the southwestern region of Saudi Arabia. In Saudi Arabia this species was so far reported from the collection locality only and comprised of not more than 10 individual plants.

Specimens studied: An Nimas (Map 1), near Baha, 19-2-2013, *Adnan Al Rehaily & Mohammed Yusuf* (16062-KSUP).

Galinsoga parviflora Cav., Icon. 3: 41, t. 281. 1795. Plate 2.

Syn.: *Adventina parviflora* Raf., New Fl. (Rafinesque) 1: 67 (1836); *Galinsoga quinqueradiata* Ruiz & Pav., Syst. Veg. Fl. Peruv. Chil.1: 1981 (1798); *Sabazia microglossa* DC. in A. P. de Candolle, Prodr. 5: 497 (1836); *Stemmatella sodiroi* Hieron., Bot. Jahrb. Syst. 28(5): 601 (1901); *Wiborgia parviflora* (Cav.) Kunth, Nov. Gen. Sp. 4(17): 201 (1820).

Type: Peru, 1794, (Lectotype – MA - Acc. No. 475684) (Designated by Schulz, 1981)

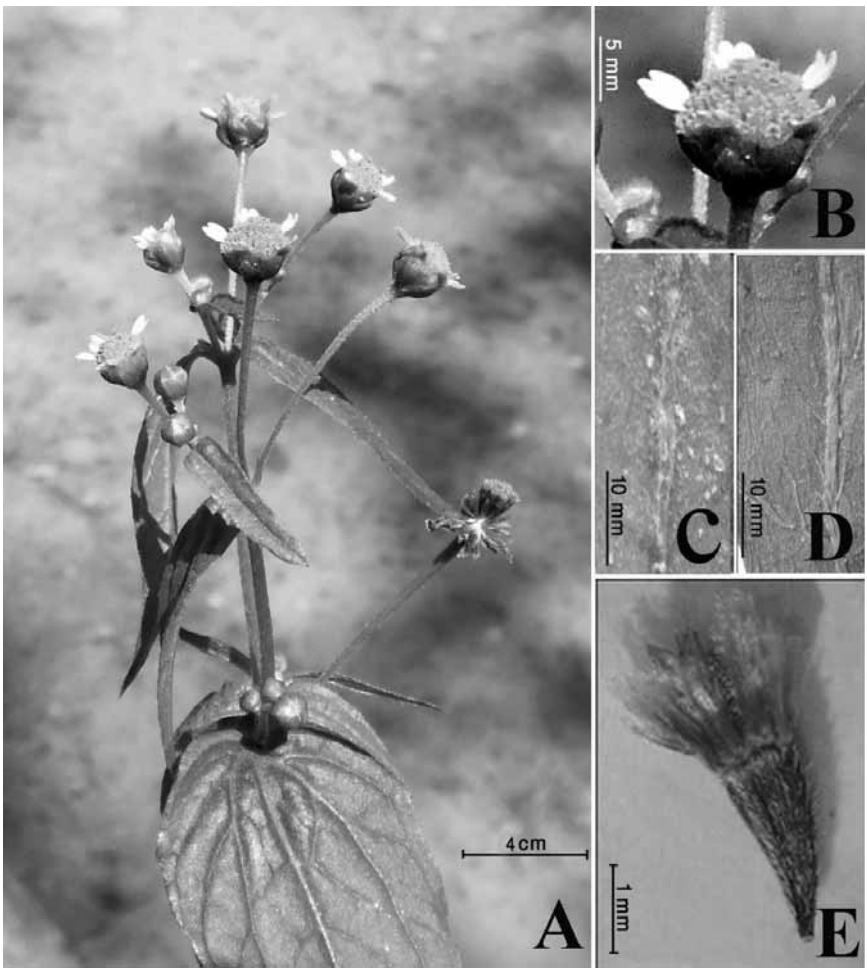


Plate 2. ***Galinsoga parviflora*** Cav. A. flowering branch; B. head; C. a small midrib portion of adaxial surface of leaf lamina; D. a small midrib portion of abaxial surface of leaf lamina showing hairs on the veins; E. Cypsela

Erect branched herbs up to 60 cm high. Stems slender, pilose. Leaves pale green; lamina 8-90 × 5-60 mm, lanceolate to ovate, margins fringed with short hairs; upper leaves usually small, sessile. Peduncles 3-40 mm long. Heads small, with 4-7mm

diam. with 2-3 rows of involucral bracts; central yellow disk florets surrounded by usually 5 small ray florets; involucres campanulate, 2.5-5.0 mm wide; involucral bracts persistent; palea, elliptic to obovate, 2.0-3.5 mm, 3-lobed, lobes acute. Ray florets 4-7(-8), white, corolla 0.5-1.8 × 0.7-1.5 mm, 3-lobed. Disc florets 15-45 (-50). Cypselae 1.5-2.5 mm long, puberulous pappus, 0.5-1.0 mm long, laciniate.

Flowering: Usually in summer, between July and October.

Habitat: Grows in sandy, loamy and clay soils and can grow in all irrigated lands and high rainfall areas, from 100 m to 2500 m.

Distribution: Common in South America; naturalized in other continents.

Specimens studied: Wadi Mahor (Map 1), between Taif and Al-Baha, Southwestern region, 15-02-2011, *A. Al-Rehaily and M. Yusuf* (21778-KSU, 15679a-KSUP).

Notes: Although two varieties, viz. *Galinsoga parviflora* var. *parviflora* and var. *semicalva* A. Gray (Smithsonian Contr. Knowl. 5(6): 98 (1853); Syn. *Galinsoga semicalva* (A. Gray) H. St. John & D. White are commonly found under this species, the latter is characterized by its less branched stems, narrow leaves and axillary short peduncles. The newly recorded specimen matches to *Galinsoga parviflora* var. *parviflora.* The population of *Galinsoga*, comprised of less than 15 individual plants, was found as a ruderal in a wadi in southwestern region.

DISCUSSION

Some of the earlier records on Asteraceae for the flora of southwestern and southern regions of Arabian Peninsula (Blatter, 1919-1936), or for parts of Saudi Arabia (De Marco & Dinelli, 1974; Migahid & Hammouda, 1974) showed that there was a gradual and steady increase in the number of genera and species. The first detailed floristic survey, exclusively for the floristic regions of Saudi Arabia reported the occurrence of 61 genera (Migahid, 1978) while some of the recent publications showed that the family contains approximately 222 species under 88 genera (Collenette, 1999) and 242 species under 87 genera (Chaudhary, 2000c), including some of the popular cultivated species, such as *Chrysanthemum coronarium* L.

With the discovery of herein described taxa, now the family in Saudi Arabia contains 90 genera and 244 species. Mountains in the Al-Baha region from where the populations of the newly recorded genera were found are renowned for abundance, density and diversity of plants. The region consists of high altitude mountains, high plateaus, valleys, alluvial plains, sandy and rocky plains, gorges, etc. Populations of *Encelia* Adanson and *Galinsoga* Ruiz & Pavon were noticed in high plateau areas. These regions were also home to a number of dominant trees and shrubs and significant number of perennial components of the understorey vegetation. These include

dicotyledonous species like *Acacia asak* (Forssk.) Willd., *Clutia myricoides* Jaub. & Spach, *Adenium arabicum* Balf. f., *Chenopodium schraderianum* Schult., *Erodium neuradifolium* Delile, etc. and grasses such as *Cenchrus ciliaris* L., *Pennisetum villosum* R. Br. *ex* Fresen., *Themeda triandra* Forssk., *Tricholaena teneriffae* (L.f.) Link, etc. Southwestern region is also home to a number of weeds, some of which were entered and established only recently (Collenette, 1999; Wood, 1997). These regions in Saudi Arabia are also the most affected areas in terms of infestation by invasive species, primarily because of the topographical and edaphic differences prevailing in the region and also due to the presence of significant number of ancient agriculture farms practicing traditional farming methods. The propagules of the new genera are apparently entered through either anthropogenic activities or through contaminated grains imported for cultivation.

Encelia farinosa, commonly called Brittle Bush, is a drought adapted shrub with weak, brittle branches and fragrant sap. Susceptibility and adaptation to drought are often found synonymous with favorable genetic characters associated with this plant. As the name implies (specific epithet - '*farinosa*'), leaves of this species are densely pubescent. The degree of hairiness varies from region to region, depending on the amount of rainfall (Sandquist & Ehleringer, 2003). Populations growing in extra arid area usually have densely pubescent stems and leaves in order to have greater control over leaf temperature and rate of transpiration. However, their photosynthetic activity will be much lower than plants growing in less arid regions because of higher reflectance of light (Ehleringer, 1993). In Saudi Arabia populations of *Encelia* grow on rocky slopes and open plateau at altitude of about 1800 m. It shows variation among populations in water-use competence. Individual plants with a high delta have a higher growth response if water stress is decreased, but perform poorly in response to drought stress, while those with a low delta show lower growth response under low water stress and a greater capacity to survive drought conditions (Ehleringer, 1993).

Encelia farinosa is a native of North America, where it is a common desert shrub, particularly in the arid parts, such as Mexico and California (Clark, 2006). Earlier collection records and literature pertaining to flora of Saudi Arabia do not carry the name of this plant and therefore the new collections of this species indicate that it is either a new introduction in Saudi Arabia or an overlooked species. Populations of this species, at present, are very sparse. However, germination rate of *E. farinosa* seeds will increase, if seeds were lying in an area where temperature is over 25°C. Success rate of this species will dramatically increase in areas, where sunshine and rainfall are moderate (Martin, 1984). Padgett *et al.* (1999) reported that successive leaching of seeds with rain water increases the germination rate at least by 50% and therefore this species may become a problematic one, if not controlled. Two types of rainfall patterns occur in the southwestern region, one in winter and another in summer. Rainfall of the

latter is ideal for the germination and establishment of new growths. Plants shed their leaves during extreme weather conditions, particularly during summer and produce new branches with the onset of rain (Martin, 1984).

In South America, Brittle Bush was used for medicinal purposes. Heated resinous gum was applied on chest to relive pain and for removing mucous from lungs. Gargling the decoction made from boiled flowering branches will relieve tooth ache, gum pain (Moore, 1989). The tea made from resinous gum was used to relieve arthritis as it has a numbness effect on body. The gum is also used as a component in making varnish and sometimes used as incense.

Galinsoga parviflora (Gallant Soldier) can tolerate acidic, but prefers a moist (irrigated) non acidic soil of farming areas, waste lands close to drainage canals, and pavements. It is a successful species in terms of propagation and establishment due to a number of significant features of this species such as lack of seed dormancy, rapid growth and development, early flowering and the ability to reproduce vegetatively under favorable conditions. *G. parviflora* competes with small herbaceous crops and often hinders crop harvest. It can be eradicated by manual weeding, repeated soil cultivation, crop rotation, mulching, and herbicide application (Kempen, 1989). The plant is reported to be edible and is also used for medicinal purposes (Damalas, 2008). Buried seeds do not germinate because seeds require medium temperature (10-35°C) and sufficient light for germination (Kempen, 1989) and hence not been observed in densely vegetated areas or in farms, where tall crops such as fig, banana, papaya, etc. are cultivated. It grows well on open plains and in a variety of soils but prefers drained soil with sufficient nutrients. It is generally considered as a cosmopolitan weed, primarily due to the activity of humans. Holm *et al.* (1979) reported the presence of this species in more than 32 crop fields distributed in 38 countries. This species has not been reported, so far from any of the farms in the area from where the present collection was made. However, *G. parviflora* was reported from Yemen as a weed and a ruderal plant between altitudes of 1100-2900m on escarpments and high plateau and areas where high rainfall is reported, particularly in the Ibb Province (Wood, 1997).

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التوزيع الجغرافي و تصنيف اثنين من الأجناس النباتية التي سجلت حديثا في المملكة العربية السعودية

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خلاصة

مرت بلدان شبه الجزيرة العربية خلال العقدين الماضيين بعمليات جمع مكثفة للمجموعات النباتية كجزء من نشاط تحديث بيانات الفلورا وإثراء المعشبات في المنطقة. وقد أسفرت الاستكشافات النباتية الأخيرة في المنطقة الجنوبية الغربية من المملكة العربية السعودية عن اكتشاف عينات نباتية متميزة ومثيرة للاهتمام. كشفت الدراسة الصارمة لهذه العينات انتمائهم إلى اثنين من الأجناس وهما (*Encelia* Adans. and *Galinsoga* Ruiz & Pav.) التى لم يسبق تسجيلهما بالفلورا السابقة للمملكة العربية السعودية. وتم توفيرالوصف التفصيلي والصور لهذين الجنسين من الفصيلة النجمية Asteraceae، لتسهيل التعرف عليهما. أيضا تم توفير معلومات موجزة عن وضعهما التصنيفي و توزيعهما الجغرافي في المملكة العربية السعودية.