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INTRODUCTION

According to estimates made by Gatti et al. (2022) and Pimm & Joppa (2015), 400,000 of the estimated 15 million species on the planet are vascular plants. Discovering new species aids in their conservation. Furthermore, new plant species enrich a country's flora and its economy if these plants are economically significant. The inventory of Saudi's flora is far from complete, and more work is needed to document the country's missing floristic knowledge, particularly in less explored areas like southwestern highland regions, and thereby improve the conservation of its floristic wealth and reap the economic benefits.

Several new species or records, published in various papers and books, have been added in the past to the flora of Saudi Arabia (e.g., Mandaville 1990; Alfarhan et al. 1997; Chaudhary 1999; Collenette 1999; Chaudhary 2000, 2001; Al-Turki 2004; AlFarhan et al. 2005; Fayed & Alzahrani 2007; Al-Surour 2018; El-Shaboury et al. 2018; Al-Gifri et al. 2019; Alzahrani et al. 2022).

In previous trips, authors discovered several plants that recorded for the first time for the flora of Saudi Arabia, such as *Celtis toka* (Forssk.) Hepper & J.R.I.Wood (Al-Surour 2020), *Aspilia kotschy* (Sch.Bip. ex Hochst.) Oliv. (Al-Khulaidi et al. 2021), *Alysicarpus vaginalis* (L.) DC., *Commiphora schimperi* (O.Berg) Engl., *Maerua angolensis* DC. ssp. *angolensis*, *Peperomia leptostachya* Hook. & Arn. (Piperaceae), and *Vigna vexillata* (L.) A.Rich. (Al-Khulaidi et al. 2023).

In this study, a botanical exploration was carried out in this framework between January 2021 and May 2022 in some parts of Saudi Arabia, specifically in the Faifa region and surrounding areas, and resulted in the discovery of eight new vascular plant species and one liverwort (Bryophyta) belonging to eight families that had not previously been recorded for the flora of the Kingdom of Saudi Arabia.

MATERIALS AND METHODS

Floral studies and atlas of the Arabian Peninsula and other countries (e.g., Post 1932; Miller 1996; Wood 1997; Collenette 1999; Chaudhary 1999, 2000, 2001; Kürschner 2000; Miller & Morris 2004; Al-Khulaidi 2013) were used to identify and search for the newly recorded plants along with the researchers' own experiences. ArcMap version 10.8 software was utilized to prepare the distribution maps of the plants.

Study Area

The investigated areas are located in southwestern Saudi Arabia in Asir region particular in Raidah Sanctuary and around Jabal Al-Balace, and in Faifa mountains in region of Jazan, and in the north of Saudi Arabia, Jabal Al-Lawz, in Tabuk Region (Figure 1, Table 1).

Field Surveys

Field trips for plant survey and collections have been done between January 2021 and May 2022 in different parts of Saudi Arabia. All the collected specimens are deposited in the herbarium (MUZ) of King Abdulaziz City for Science and Technology (KACST).

RESULTS

This study adds eight new vascular plant species and one liverwort (bryophyte) belonging to eight families, of which five species are angiosperms and three are pteridophytes to the Saudi Arabian flora, namely: *Asplenium dalhousiae* Hook., *Bolanthus hirsutus* (Labill.) Barkoudah, *Hemionitis viridis* (Forssk.) Christenh., *Grewia flavescens* Juss. var. *flavescens*, *Nicandra physalodes* (L.) Gaertn., *Oxymitra incrassata* (Brot.) Sérgio & Sim-Sim, *Hemionitis calomelanos* (Sw.) Christenh., *Pentodon pentandrus* (Schum. & Thonn.) Vatke. var. *pentandrus*, and *Zornia glochidiata* Rchb. ex DC.

1. *Asplenium dalhousiae* Hook., Icon. Pl. 2: t. 105. 1837 (Aspleniaceae) (Figure 2 & Image 1)

A perennial tufted fern. Frond simple, pinnatifid, up to 15 cm high, glabrous above, scaly below; sori linear; petiole brown. Pinnae alternate, triangular-ovate to oblong, up to 17 mm long.

Specimen examined: Faifa Region, on moist shady crevices, 17.264667° N, 43.110083° E, 1,695 m, March 2021. M. AlFaifi, MUZ-20235 (KACST),

2. *Bolanthus hirsutus* (Labill.) Barkoudah Wentia 9: 168 (1962) (Caryophyllaceae) (Figure 3 & Image 2).

Perennial herb, up to 20 cm high, glandular-pubescent, cushion-forming; leaves 1–1.5 x 0.2–0.5 cm, elliptic to linear, apex acute, base obtuse, margin entire; calyx tubular, 3–4 mm long, 5-toothed; flowers white with purple veins, short-pedicellate.

Specimen examined: Jabal Al-Lawz, Tabuk Region, in crevices of granite, 28.735095° N, 35.338322° E, 1,900 m, 17.vii.2021, A. Alzahrani 301, MUZ-20230 (KACST),

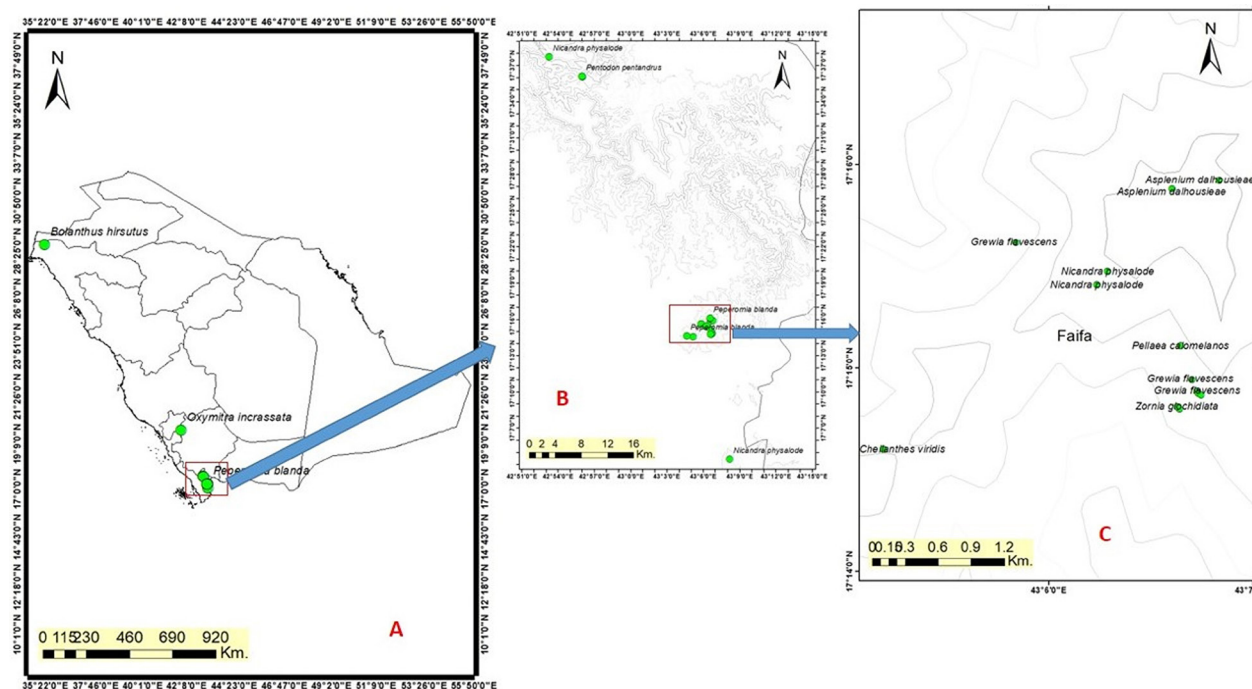


Figure 1. A—areas investigated during the present study (Tabuk, Asir and Jazan) | B—distribution of the plants within Jazan region | C—distribution of the plants within Faifa district.

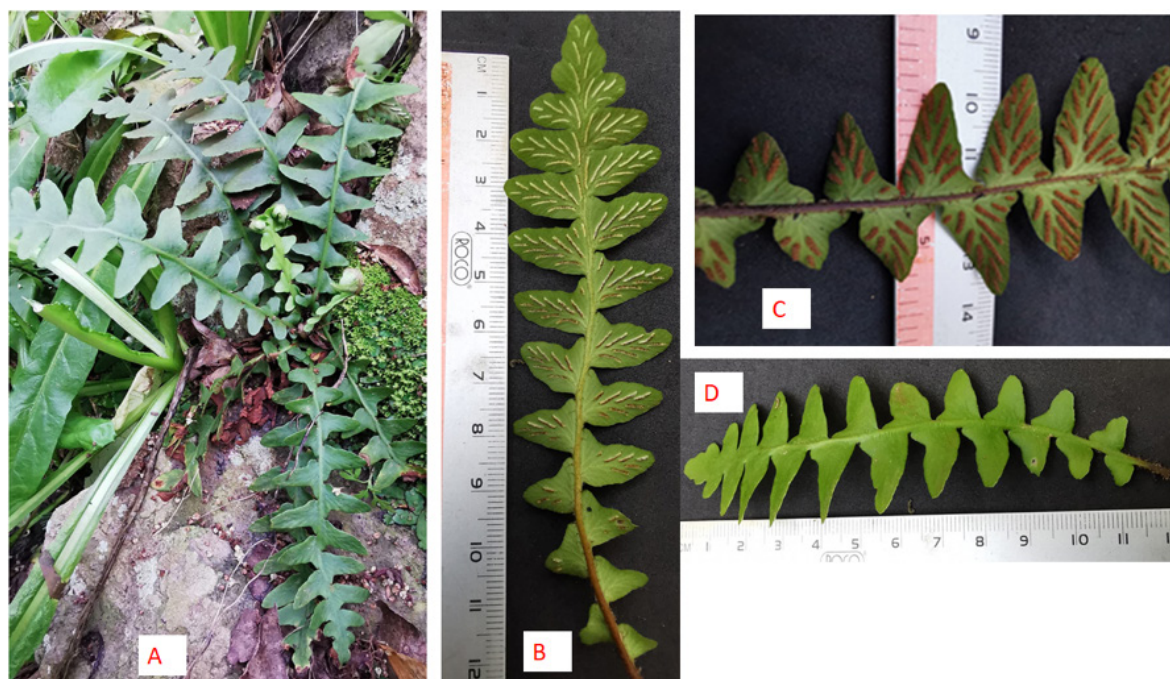


Image 1. *Asplenium dalhousieae*: A—Life form | B—Leaf shape | C—Close-up of under surface of frond, showing linear sori | D—The upper surface of frond. © Eisa Ali Al-Faifi.

3. *Hemionitis viridis* (Forssk.) Christenh., Global Fl. 4: 22. 2018 (Pteridaceae) (Figure 4 & Image 3)

Rhizomes short, creeping. Fronds tufted, erect to arching, up to 60 cm high; stipe dark brown to blackish,

glabrous or with hair-like scales, up to 20 cm long; lamina herbaceous, 2-pinnate, lanceolate to ovate; pinnules green to dark green, variable, glabrous, ovate to triangular, apex obtuse, base rounded to hastate,

Table 1. The plant species with their number of individuals, habitat information and world distribution.

Latitude	Longitude	Plant name	Individuals	Altitude (m)	World distribution	Habitat
17.26467	43.11008	<i>Asplenium dalhousieae</i> Hook.	17	1,695	Afghanistan, Arizona, East Himalaya, Eritrea, India, Mexico, Nepal, Pakistan, western Himalaya, Yemen	wall terraces
17.26538	43.11392	<i>Asplenium dalhousieae</i> Hook.	13	1,663		
28.73514	35.33832	<i>Bolanthus hirsutus</i> (Labill.) Barkoudah	2	2,009	Syria, Palestine, and Egypt	in crevices of granite
17.24330	43.08645	<i>Hemionitis viridis</i> (Forssk.) Christenh.	50	1,300	Yemen, South Africa, eastern tropical Africa, Cape Verde, the Comoro Islands	shady crevices
17.24810	43.11210	<i>Grewia flavescens</i> var. <i>flavescens</i>	2	1,330	Yemen, tropical Africa, South Africa to India	slope
17.26030	43.09730	<i>Grewia flavescens</i> var. <i>flavescens</i>	2	1,250		slope
17.24900	43.11170	<i>Grewia flavescens</i> var. <i>flavescens</i>	2	1,340		slope
17.24790	43.11220	<i>Grewia flavescens</i> var. <i>flavescens</i>	2	1,327		road side
17.24776	43.11244	<i>Grewia flavescens</i> var. <i>flavescens</i>	2	1,327		road side
17.25680	43.10390	<i>Nicandra physalodes</i> (L.) Gaertn.	3	1,530	Yemen, South America (Peru to northwestern Argentina), widespread in the world	terraces
17.25790	43.10480	<i>Nicandra physalode</i> (L.) Gaertn.	2	1,553		terraces
17.07410	43.13640	<i>Nicandra physalode</i> (L.) Gaertn.	1	1,116		rocky slope
17.62932	42.88751	<i>Nicandra physalode</i> (L.) Gaertn.	3	1,689		rocky slope
19.82817	41.86146	<i>Oxymitra incrassata</i> (Brot.) Sérgio & Sim-Sim	10	1,996	Texas, Mexico, Europe and northern Africa	beneath rocks
17.25179	43.11077	<i>Hemionitis calomelanos</i> (Sw.) Christenh.	1	1,400	Eastern and southern Africa	shady crevices
17.60190	42.93360	<i>Pentodon pentandrus</i> (Schum. & Thonn.) Vatke, var. <i>pentandrus</i>	2	1,257	Yemen, Oman, tropical Africa, South Africa, and Madagascar	wadi
17.60220	42.93350	<i>Pentodon pentandrus</i> (Schum. & Thonn.) Vatke, var. <i>pentandrus</i>	4	1,252		wadi
17.24660	43.11070	<i>Zornia glochidiata</i> Rchb. ex DC.	5	1,276	Yemen, tropical Africa, South Africa, and Madagascar.	road side
17.24680	43.11050	<i>Zornia glochidiata</i> Rchb. ex DC.	2	1,270		road side

Table 2. A comparison of *Grewia* species found in Saudi Arabia with the new ones (Wood 1997; <https://powo.science.kew.org> 2021). *Grewia flavescens* Juss". Plants of the World Online. Board of Trustees of the Royal Botanic Gardens, Kew. Retrieved 27 May 2021.).

Plant name	Leaves	Flowers	Fruits
<i>Grewia villosa</i> Willd.	Orbicular cordate up to 120 mm	Reddish-brown	Unlobed
<i>Grewia tembensis</i> Fresen.	Ovate to elliptic, up to 140 mm	White with pink filament	3-4 lobed
<i>Grewia tenax</i> (Forssk.) Fiori	Orbicular, up to 15 mm	White with white filament	2-4 lobed
<i>Grewia erythraea</i> Schweinf.	Obovate to elliptic, up to 30 mm	White with white filament	2-4 lobed
<i>Grewia flavescens</i> Juss.	Oblong to lanceolate, up to 80 mm	White with yellow to golden filament	Single, or 2-4 lobed
<i>Grewia gillettii</i> Sebsebe & B.Mathew	Obovate to oblanceolate, up to 40 mm	Yellow with yellow filament	2 lobed or unlobed
<i>Grewia velutina</i> (Forssk.) Lam.	Obovate, up to 60 mm	Yellow	Unlobed
<i>Grewia trichocarpa</i> Hochst. ex A.Rich.	Ovate, up to 70 mm	Yellow	Unlobed

margins minutely crenate; sori marginal.

H. viridis is reported for the first time from two locations in southwest Saudi Arabia, where it is growing under dense shade along terraces of Jabal Faifa and in shady crevices of Raidah Sanctuary, near Abha city.

Specimen examined: Jabal Faifa, Jazan Region, in deep shade on terraces, 17.243302° N, 43.086448° E, 1,300 m, 25.vii.2021, A. Alzahrani 302, MUZ-20232; Raidah Sanctuary, Asir Region, in shady crevices, 18.197737° N, 42.408689° E, 1,200 m, 23.ii.2021, A.

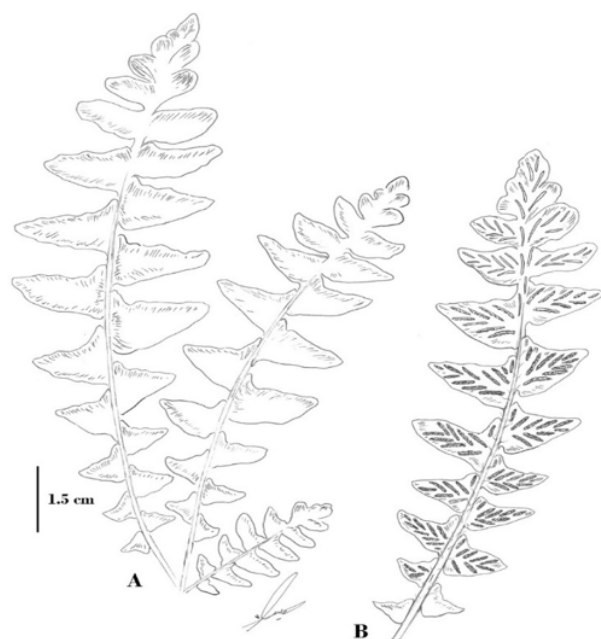


Figure 2. *Asplenium dalhousieae*: A—habitat | B—under surface of frond showing linear sori.



Image 2. *Bolanthus hirsutus*: A—Habitat | B—calyx | C—Flowers. © Ali M. Alzahrani.

Alzahrani 303, MUZ-20233 (KACST).

4. *Grewia flavescens* Juss. Ann. Mus. Natl. Hist. Nat. 4: 91. 1804, **var. *flavescens*** (Malvaceae; Grewioideae) (Figure 5 & Image 4).

A small bushy tree with deeply grooved four-angled stems. Leaves alternate oblanceolate, up to 80 mm long. Inflorescence solitary with two or three bright yellow flowers in axillary cyme, with yellow to golden colour filament. Fruits single, or 2–4-lobed, covered with rough white hairs.

Widespread throughout tropical Africa. The species has been recorded in Yemen in the Arabian Peninsula



Image 3. *Hemionitis viridis* (Forssk.) Christenh.: A—frond (white arrow indicates rachis) | B—sori marginal (white arrow) | C—pinna. © Ali M. Alzahrani

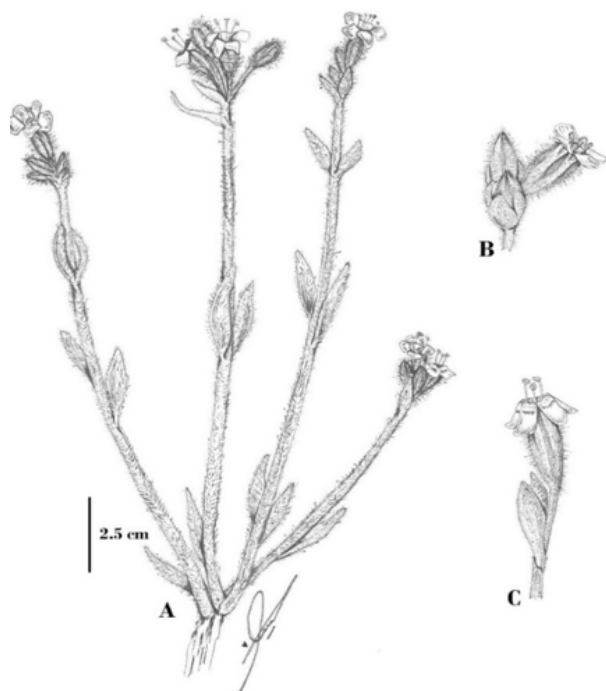


Figure 3. *Bolanthus hirsutus*: A—Habit | B—Calyx | C—Flower.

only. We did not find a published paper mentioning the occurrence of this plant species in Saudi Arabia, except on the KEW site Plants of the World Online (POWO 2023), which is likely to be based on a study of the plant specimen collected from Sudan

Specimen examined: Faifa Region, on rocky slope, 17.2481° N, 43.1121° E, 1,330 m, 25.v.2021, E. AlFaifi MUZ-20220 (KACST),

5. *Nicandra physalodes* (L.) Gaertn., Fruct. Sem. Pl. 2: 237, t. 131, f. 2. 1791 (Solanaceae) (Figure 6 & Image 5).

Annual herb, up to 20 cm high. Leaves alternate,



Image 4. *Grewia flavescens* var. *flavescens*: A—inflorescence | B—close-up of a flower showing stamens | C—leaves | D—deeply grooved four-angled stems | E—fruits | F—fruits with two–four lobes. © Mohammed Musa Alfaifi.



Figure 4. *Hemionitis viridis*: A—habit showing a general view of frond | B—sori marginal (black arrow).

ovate to elliptic, margins toothed and undulated or almost lobed. Flowers solitary, axillary, bell-shaped, c. 4 cm in diam., blue-purple. Fruit spherical, with swollen and winged calyx.

Introduced species, found on terraces and rocky slopes, probably has also long been cultivated as an ornamental plant, besides Faifa region, the plant found in Jabal Al-Qahar at an elevation of 1,689 m, between latitude 17.6293 and longitude 42.8875.

135 Km. SE Abha, Saudi Arabia The plant is recorded in some countries as a weed in many types of crops as well as in disturbed sites, roadsides, rangelands (Holm et al. 1997; CABI 2011), and may become invasive with time.

Specimen examined: Faifa Region, on terraces, 17.2568° N, 43.1039° E, 1,530 m, 28.ix.2021, E. AlFaifi MUZ 20215 (KACST),

6. *Oxymitra incrassata* (Brot.) Sérgio & Sim-Sim, J. Bryol. 15: 662. 1989 (Oxymitraceae) (Figure 7 & Image 6)

Thalli 5–10 mm long, dark green to greyish, simple or in branching rosettes; epidermal pores prominent, with a deep midline; with hyaline, narrowly acuminate ventral scales extending beyond thallus edges.

Specimen examined: Near Jabal Al-Balace, Asir Region, in shallow soil beneath rocks, 19.828173° N, 41.861464° E, 1,996 m, 27.ii.2022, A. Alzahrani 304, MUZ-20234 (KACST),



Figure 5. *Grewia flavescens* var. *flavescens*: A—flowering-twig | B—a leaf | C—flower | D—fruit.



Image 6. *Oxymitra incrassata*: A—habitat and habit, showing a general view of thalli | B— thalli branching | C—silvery ventral scales (white arrow). © Ali M. Alzahrani.

7. *Hemionitis calomelanos* (Sw.) Christenh. Global Fl. 4: 11. 2018. (Pteridaceae) (Figure 8 & Image 7).

Rhizomes erect or shortly creeping, c. 6 mm in diam. Frond pinnate; Lamina ovate-lanceolate to narrowly triangular, blue-green to light green, glaucous, with pale-

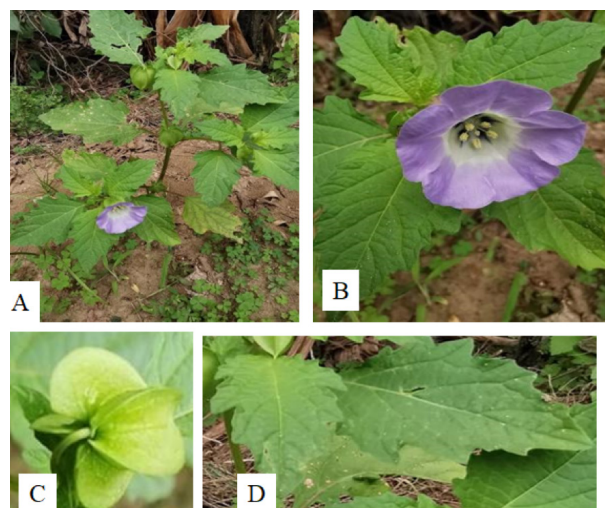


Image 5. *Nicandra physalodes*: A—habit | B—flower with five stamens | C—fruits with winged calyx | D—leaves with coarsely sinuate-dentate margins. © Mohammed Musa Alfaifi.

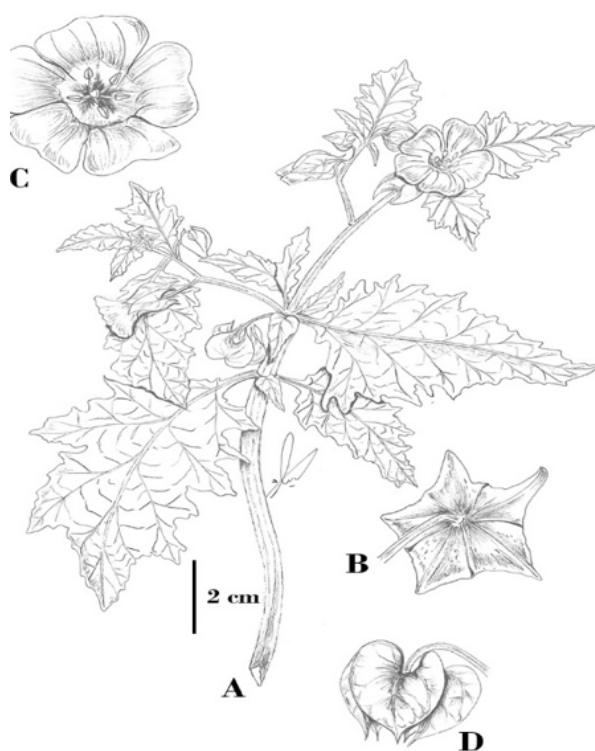


Figure 6. *Nicandra physalodes*: A—habit | B—calyx | C—flowers | D—fruits with winged calyx.

brown margins and shiny black rachis; the upper with (1–)2-pinnate, often the lower pinnae 2- or 3-pinnate; pinnae opposite to slightly alternate; sori borne on a continuous ridge along the margins.

Specimen examined: Faifa, in crevices of granite, 17.251785° N, long. 43.110767° E, 1,400 m, 18.xii.2021,

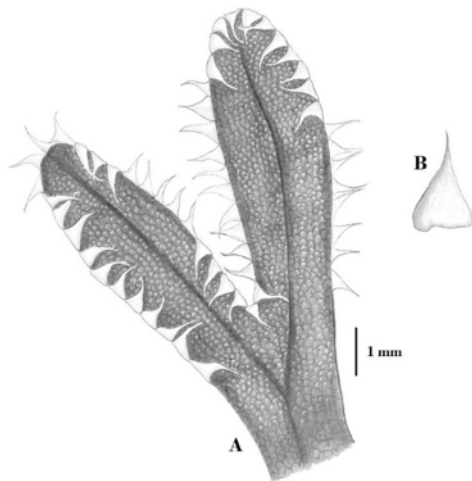


Figure 7. *Oxymitra incrassata*: A—thallus | B—silvery ventral scale.

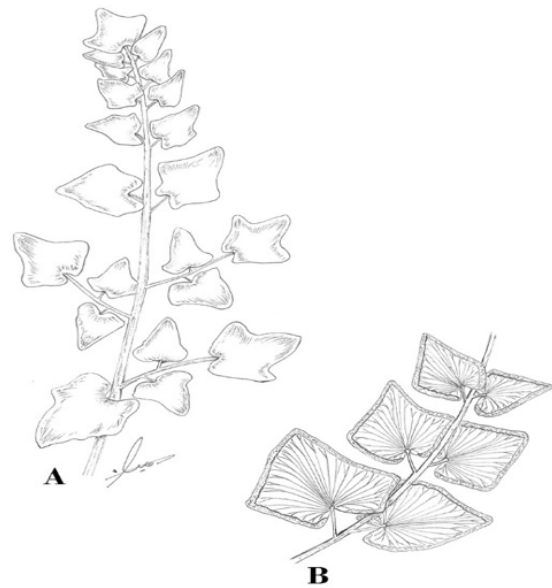


Figure 8. *Hemionitis calomelanos*: A—the habit | B—fronds with marginal sporangia.



Image 7. *Hemionitis calomelanos* (Sw.) Christenh.: A—the fronds with sporangia | B— habit. © Ali M. Alzahrani.

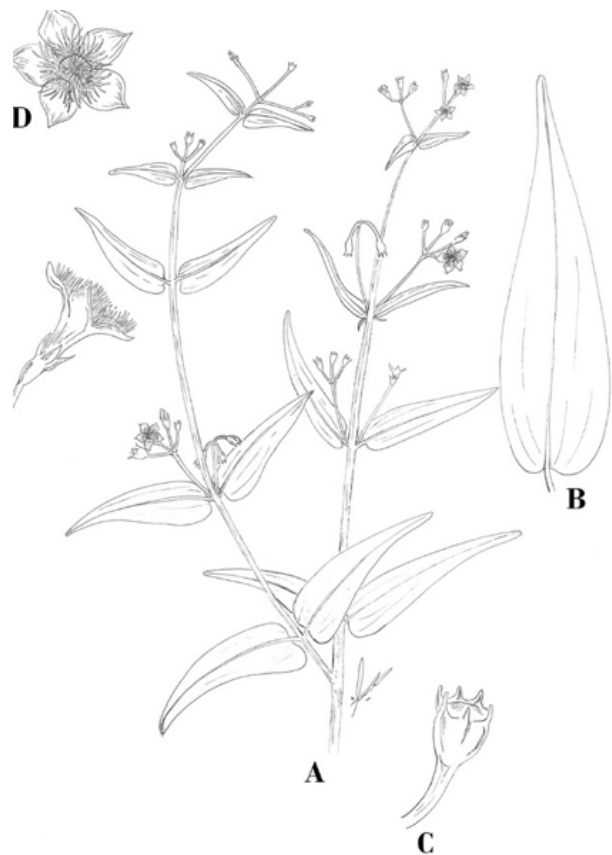


Figure 9. *Pentodon pentandrus* var. *pentandrus*: A—a flowering-twig | B—leaf | C—calyx with five triangular teeth | D—flower.

Mohamed Alfaifi MUZ-20219 (KACST).

8. *Pentodon pentandrus* (Schumach. & Thonn.) Vatke Oesterr. Bot. Z. 25: 231. 1875, var. *pentandrus* (Rubiaceae) (Figure 9 & Image 8).

Annual herb. Stem soft, succulent, shiny, glabrous. Leaves simple, opposite-decussate, sessile, linear-lanceolate, margins entire. Flowers on long peduncle in axillary panicle, 6–13-flowered. Flowers pedicelled, pale blue or mauve. Calyx with lobed sepals, narrowly extended with five triangular teeth. Corolla usually small, up to 3 mm long, cylindrical, with five stamens.

Specimen examined: Faifa Region, on wadi, 17.6019° N, 42.9336° E, 1,257 m, 26.iii.2021, M. Alfaifi MUZ-20211.



Image 8. *Pentodon pentandrus* var. *pentandrus*: A—habit | B—opposite, sessile leaves | C—flowers on long peduncles in axillary panicle | D—pale blue flowers | E—calyx with five triangular teeth. © Eisa Ali Al-Faifi.

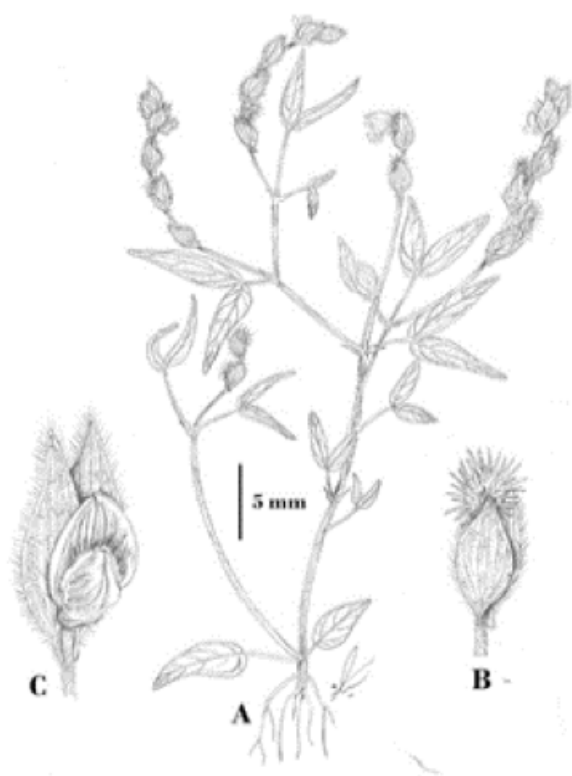


Figure 10. *Zornia glochidiata*: A—habit | B—a Loment enclosed between hairy leaf-like bracts | C—flower.

9. *Zornia glochidiata* Rchb. ex DC., Prodr. 2: 316. 1825 (Fabaceae) (Figure 10 & Image 9)

Annual, erect herb. Leaves 2-foliate, with two asymmetrical leaflets at the end of a long petiole;

upper leaflets lanceolate, up to 40 mm long, acute, sparsely and obscurely glandular beneath, especially near margins. Flowers enclosed between two hairy leaf-like bracts, shorter than the bracts. Petals yellow, with red markings. Pods of constricted segments, covered in spiny bristles.

Specimen examined: Faifa Region, on roadsides, 17.2466° N, 43.1107° E, 1,276 m, 20.viii.2021, M. AlFaifi MUZ-20217.

DISCUSSION

Recently, new plant records have been documented in the Saudi flora, and the number of these plants is estimated to be 17 new records and five new taxa (Fayed & Alzahrani 2007; Thomas et al. 2014; El-Shaboury et al. 2018; Basahi & Masrahi 2019; Alzahrani et al. 2022; Al-Khulaidi et al. 2021; Al-Robai et al. 2022; Al-Khulaidi et al. 2023). The number of new records is relatively low compared to the number of new taxa discovered in Africa. The low number discovered in Saudi Arabia may be related to the lack of studies and surveys in the field of plants, and perhaps the lack of specialists in botany. Some of the plants listed in this paper are widely recognized as weeds, so we advise treating them with caution and making an effort to stop their spread so they do not establish themselves as invasive weeds in the area, and pose a challenge to control or eradicate them in the future.



Image 9. *Zornia glochidiata* floral and vegetative parts: A—habit | B—flowers enclosed between hairy leaf-like bracts | C—loment enclosed between hairy leaf-like bracts, showing two segments | D—loment of the plant, with curved bristles | E—two asymmetrical leaflets | F—flower. © Mohammed Musa Alfai.

In Arabian Peninsula, *Asplenium dalhousiae* were previously recorded from Yemen only (Wood 1997). The genus *Bolanthus* (Ser.) Rchb. belongs to the tribe Caryophyllaceae (Bittrich 1993). *Bolanthus hirsutus* is native to Syria, Palestine, and Egypt (Post 1932; Boulos 1999). For the Arabian Peninsula the plant is only known from Jabal Al-Lawz, northwestern Saudi Arabia. *Hemionitis viridis* is a native species of South Africa, tropical East Africa, Cape Verde, the Comoro Islands, Madagascar, and the Mascarene Islands (Roux 2009). In addition to Yemen in Arabian Peninsula (Miller 1996; Wood 1997). The species *Nicandra physalodes* is so far, recorded as an introduced species in Socotra Island, Yemen (Miller & Morris 2004). The genus *Oxymitra* Bisch. ex Lindenb., comprises two species: *O. cristata* Garside and *O. incrassata* (Brot.) Sérgio & Sim-Sim (Söderström et al. 2016). *Oxymitra cristata* is found in southern Africa (Perold, 1993), whereas *O. incrassata* is widely distributed (Kürschner 2003). In fact, in the Arabian Peninsula, *O. incrassata* was recorded only from Yemen by Kürschner (2000). The species is documented for the first time in Saudi Arabia, where it is found in shallow soil beneath rocks near Jabal Al-Balace, Asir Region. In

the Arabian Peninsula, the plant *Pentodon pentandrus* is recorded only from Yemen (Wood 1997) and Oman (Ghazanfar 2007; Patzelt et al. 2014). The plant occurs in Tanzania as a weed, as well as in some countries of the world (Burkill 1997). In the Arabian Peninsula, *Zornia glochidiata* is recorded only from Socotra Island, Yemen (Miller & Morris 2004). The plant is recorded as weed in some parts of the world (Ekeleme & Chikoye 2003).

CONCLUSION

The recorded plant species suggest that further botanical study is necessary in the Faifa region and other unexplored regions farther north of the country (e.g., Tabuk and Al-Ula). The study areas' proximity to Yemen, Sinai (Egypt), and Jordan might also have helped some plants spread to nearby areas, such as Tabuk and Faifa. Some of the species observed, like *Nicandra physalodes*, are aggressive and well-known weeds worldwide. Over time, they may establish themselves in Saudi Arabia as invasive species. The results of this study and the previous studies that have been mentioned have added

new plants to the Saudi Arabia's flora, and enriched it.

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