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Ziziphus rivularis Codd. from Faifa, SW Saudi Arabia: a new addition to the flora of Arabian Peninsula

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In addition to the continuous discoveries of new wild plant species and the increasing additions to the flora of Saudi Arabia, this study recorded *Ziziphus rivularis* for the first time in Saudi Arabia and Arabian Peninsula. Through the field work, the species was discovered with limited distributed in Faifa escarpments, Southwestern Saudi Arabia, and was not reported or collected previously from Arabian Peninsula. The accurate identification is performed and confirmed using the published literature and formal taxonomic websites. Location map, plant photographs, taxonomic notes and full morphological description are included. Simple comparison with those of *Ziziphus* taxa grow naturally in the same area is discussed for distinguishing the new species. The global diversity of the species verified that the plant could grow in Southwestern Saudi Arabia, where the environmental conditions which the plant prefers are provided, so the plant considered native to the flora of Saudi Arabia.

Keywords: Faifa, Jazan, New record, Rhamnaceae, *Ziziphus rivularis*

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INTRODUCTION

Vegetation diversity of Arabian Peninsula has been under exploration during the last two decades, that a number of floristic studies achieved numerous checklists for regional floras (Mandaville 1977, 1985, 1990; Migahid 1989, 1990; Cornes & Cornes 1989; Gabali and Al-Gifri 1990; Ghazanfar 1992; Boulos & Al Dosari 1994; Shuaib 1995; Collenette 1999; Chaudhary 1999, 2000, 2001; Al-Hawshabi & El-Naggar 2015). Saudi Arabia occupy large area of the Arabian Peninsula with the greatest plant diversity (Collenette 1998).

Several plant taxa were recently added as new records to the flora of Saudi Arabia as: *Solanum dulcamara* L., *Solanum sisymbriifolium* LAM., and *Solanum torvum* SWARTZ (El-Shaboury et al. 2018); *Phragmites australis* (Cav.) Trinius ex Steud (Remesh et al. 2019); *Celts toka* (Forssk) Hepper & J.R.I.Wood (Al-Surour 2020); *Aspilia kotchyi* (Sch. Bip. Ex Hochst.) Oliv. (Al Khulaidi et al. 2021); *Alysicarpus vaginalis* (L.) DC., *Commiphora schimperi* (O.Berg) Engl., *Maerua angolensis* DC. Subsp. *Angolensis*, *Peperomia leptostachya* Hook.& Arn. and *Vigna vexillata* (L.) A.Rich. (Al Khulaidi et al. 2023); *Asplenium dalhousiae* Hook., *Bolanthus hirsutus* (Labill.) Barkoudah, *Hemionits viridis* (Frossk.) Christenh., *Grewia favescens* Juss. var. *favescens*, *Nicandra physalodes* (L.) Gaertn., *Oxymitra incrassate* (Brot.)Sergio&Sim-Sim, *Hemionits calomelanos* (sw.) Christenh, *Pentodon pentandrus* (Schum. & Thonn.) Vatke. var. *pentandrus*, and *Zornia glochidiata* Rchb. Ex DC. (Al Khulaidi et al. 2024). Studies and discoveries are still recording many wild plants and adding them to the Saudi flora, so that the inventory of plants included in Saudi Arabia is constantly increasing. There is no doubt that enriching the Saudi flora with new taxa has a positive impact on the economy of the Kingdom, especially if they are plants of economic importance. This in addition to report the biodiversity of the region, which is a natural heritage that must be preserved (Al Khulaidi et al. 2024).

Faifa Mountains (Jazan region, SW of Saudi Arabia) is one of the most diversified areas regarding plant species and very important hot spot due to its unique nature (AlFarhan et al. 2005). The heavy annual rainfall, high elevation (up to 2500 m asl), wide area and rocky rugged topography are some of the distinctive features of Faifa region. These conditions in addition to the lack of paved roads along the mountainous escarpments make it difficult for surveying this rich flora set (Abbas et al. 2020). This clarifies the scarcity of floristic studies and checklists on this region (Abbas et al. 2020, Safhi et al. 2022, Al-Khulaidi et al. 2024) so, we still need more work to fill the gaps in our knowledge of the flora of Faifa Mountains. The present study records a new species of genus *Ziziphus* from Faifa highlands, SW Saudi Arabia, for the first time not only in the Saudi Arabia, but also in the whole Arabian Peninsula.

MATERIALS AND METHODS

Complete fresh specimens of mature *Ziziphus rivularis* plant were collected from natural habitats of Faifa highlands, SW Saudi Arabia (17° 14' 11 N 43° 4' 45.9 E and 17° 15' 16.2 N 43° 5' 59.5 E) during different seasons. Many field trips were conducted to different locations of Faifa region SW Saudi Arabia (Figure 1) through 2024 for data collection regarding plant

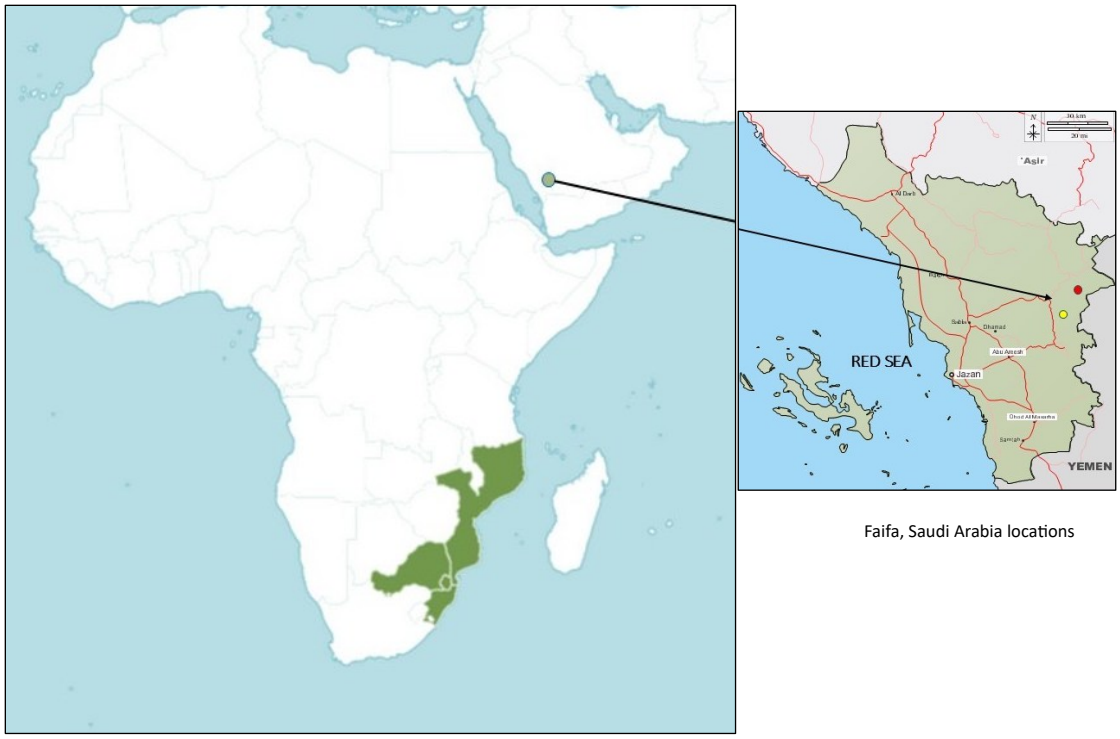


Figure 1. Map showing the original distribution of *Z. rivularis* in green, and the locations in Faifa Mountains, where it is newly discovered.

diversity, habitat, altitude and other related environmental conditions. The intensive search in literature and herbaria revealed that this species was not reported or collected previously from Arabian Peninsula. Plant identification was done by the aid of available reference (Dyer et al. 1958) and formal botanical websites (Royal Botanic gardens Kew, Plants of the World Online: POWO; SANBI, Plantz Africa: PZA; The World Flora Online: WFO; iNaturelist, Flora of Africa) and confirmed by comparison with the specimens kept in Kew Herbarium with numbers K000036296 and K000036297 as illustrated in the Global Biodiversity Information Facility website (httpp://www.gbif.org). The Herbarium specimens of the plant were deposited and kept in Jazan University Herbarium (JAZUH) with numbers JAZUH1398-JAZUH1401 and replicates were sent to be kept in Cairo University Herbarium (CAI) The morphological description of both vegetative and reproductive parts of the plant were recorded carefully through the examination and measurements of at least 10 fresh specimens collected each trip. Some photos and diagrams of the plant from its nature habitats are included for illustrating different criteria of the plant.

RESULTS

Rhamnaceae Juss is phylogentically divided into 3 clades: ziziphoids (up to 600 species), rhamnoids (up to 300 species) and ampeloziziphoids (c. 15 species) (Richardson et al. 2000a, 2000b; Islam & Simmons 2006; Onstein et al., 2015; Hauenschild et al., 2016; Wang et al. 2021; He & Lamont 2022). Genus *Ziziphus* Mill, belongs to ziziphoids group, is subdivided into section *Ziziphus* with glabrous plant body and section *Perdurans* with pilose plant organs. *Z. rivularis* Codd is included in sec. *Ziziphus* (Liu and Cheng, 1995).

Environment and habitat

As reported in Dyer et al. (1958), *Ziziphus rivularis* has been collected from stream banks or nearby water courses, mostly among rocky habitats. These conditions which this plant species prefers were the reason of its name derivation “rivularis”. For the first time in Arabia, several *Z. rivularis* individual trees were observed exactly at western frontage of Faifa highlands, Jazan Province, SW Saudi Arabia. The locations are about 1300 meters above sea level near water stream, characterized by rocky habitat with loamy soils of deep valleys. The associated vegetation with the plant and surrounded area represented by several shrubs like: *Ecbolium gymnostachyum* (Nees) Milne-Redh, *Grewia tenax* (Forssk.) Fiori, *Withania somnifera* (L.) Dunal, *Achyranthes aspera* L., *Abutilon fruticosum* Guill. & Perr. and *Cocculus pendulus* Guill. & Perr. Faifa region lies in the subtropical dry zone, with hot summers and warm winters (Walter et al.,

1975). The climatic data obtained from the nearest Meteorological Station of Jazan City during the years 2000-2020 revealed that the annual perception was 1560 mm (the maximum was in July and August), the average temperatures were varying between 34.9 ± 0.93 °C and 26.9 ± 0.88 °C (the maximum were in November-June; the minimum were in July-January).

Distribution

Z. rivularis Codd is a native species from Southern Mozambigue to Southern Africa, (Sievers, 2006), the first worldwide record has been published in 1958 in Bothalia (Dyer et al., 1958). The current research is the second record for that species, but this time in another continent, exactly in Faifa mountains (17°14'10.3"N 43°04'45.9"E) southwestern province of Saudi Arabia. The plant has several common names such as: sidr, nabq, nabaq (Arab) (Chaudhary, 2001; Boulos, 2009) false buffalo-thorn, river buffalo thorn, river jujube (Eng.); rivierblinkblaar, vals-wag-'n-bietjie (Afr.); mukhalu-vhufa, mulalantsa (Tshivenda). It has been a valuable plant in the South Africa and harvested for many purposes (Constant and Tshisikhawe, 2018).

Economic and traditional uses

Almost all plant parts of *Ziziphus* ssp. are used by local people of Faifa region to meet their daily requirements. For example, Fruits: for food and animal fodder; wood: for fuel, home and fence constructions; leaves: for camel feeding, cosmetic purposes and traditional thereby; flowers: for honey producing bees. Taxonomically, native and traditional people in Faifa cannot distinguish different species of *Ziziphus*, however, by their culture they called the species with edible fruits including *Z. rivularis* as "Shidn".

Conservation status

The plant is not threatened as reported in the Plant Red List (IUCN, 2024). Globally, it is a rare species due to its limited distribution. Locally it is very rare that only two individuals were recorded from Faifa. The upcoming field work is recommended for studying its distribution carefully in Arabia particularly its density and frequency to report its conservation status accurately.

Morphological Description

STEM: The plant is an unarmed tree of about 7-10 meters tall with dense stout branches and branchlets give the tree's crown its shape. The trunk is covered by rough dark grey bark (Figure 1a). Young twigs have a white grey to light brownish appearance (Figure 1b,c).

LEAF : Leaves are petiolate, alternatively arranged on the branches (Figure 1b). The leaf petiole is cylindrical, pubscent, about 5-15 mm long with minute non-spiny stipules at leaf base (Figure 1g). Blade is a simple narrow lanceolate to wide elliptic-ovate, with average measurements: 3.4-6.2 x 1.3-3.2 cm., often oblique, with an acute apex, serrate margin with black dots in marginal indents. (Figure 1e,f) and conspicuous symmetrical rounded base (Figure 1d). The venation is reticulate trinervous run from the base to the apex of the lamina (Figure 1g,h). Leaves are shiny, glabrous, dark green at the upper surface, while lower surface is slightly pubescent at the base of lamina along the nerves and margins and become glabrous by ageing. (Figure 1b).

FLOWER: Inflorescence is an axillary sessile cyme comprising 3-6 flowers. Flowers are green, yellow in color, with short pedicel (1.5 - 2 mm), become longer in fruit (3 - 5.5 mm). Sepals are five coriaceous, white, triangular segments with stiff keeled apex (1 - 1.5 mm long and 1.5 - 2 mm wide), sheathing stamens in floral bud (Figure 1b). Petals are five ovate segments with truncate apex curved backward upon maturity. Sepals and petals are alternatively attached, five stamens are attached opposite to petals, others are 2-lobed, medifixed attached to short filament (1.2 mm long). The center of the flower is occupied by a fleshy nectarous 5-lobed, notched disc, white in color, turns yellow then brown upon maturity. Ovary superior, embedded in the disc, chambers 3 in floral bud, reduced to a couple upon maturity and in some cases to only a single chamber with full maturity at fruiting stage, ovules solitary, erect. Style thick, free, short (0.5 mm long) rising above the disc splits outwards from its middle into 2 or 3 short segments, each is ending by poorly- differentiated stigma. (Figure 2a-e).

FRUIT & SEED: Fruit is a drupe, usually solitary, a couple in some cases, axillary, pedicelled, smoth, globose in shape, start green in color, become yellow upon maturity, enclosed relatively thin, semi-woody endocarp and septum with 1-3 compressed seeds inside (Figure 2f-h). It is important to mention that *Z. rivularis* spent more than two months in its fruiting stage, this phenomenon is unusual regarding other *Ziziphus* ssp. that grow in the same area.

DISCUSSION

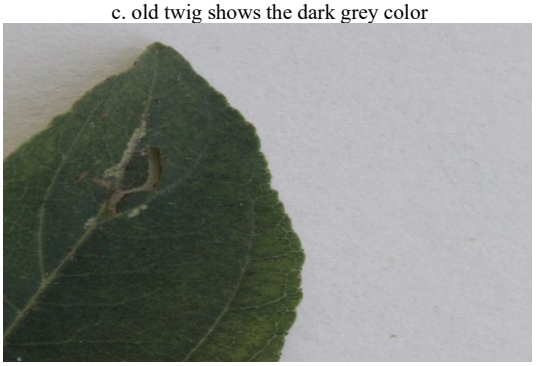
Genus *Ziziphus* represented in the flora of Saudi Arabia by 5 species i.e, *Z. nummularia, Z. mauritiana,*

a. star refers to the trunk of *Z. rivularis*

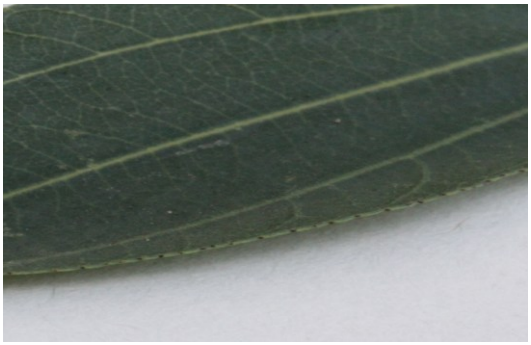
b. young whitish twig shows leaves, flowers and fruits in its natural habitat

c. old twig shows the dark grey color

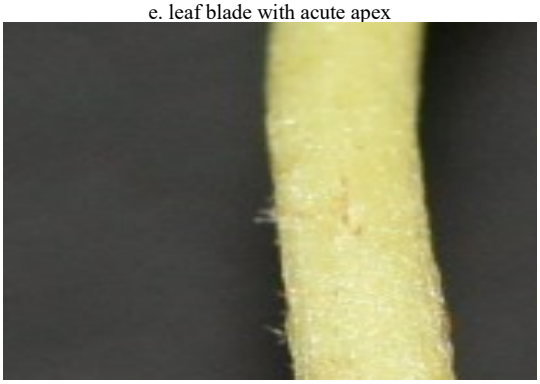
d. leaves, show upper and lower surface



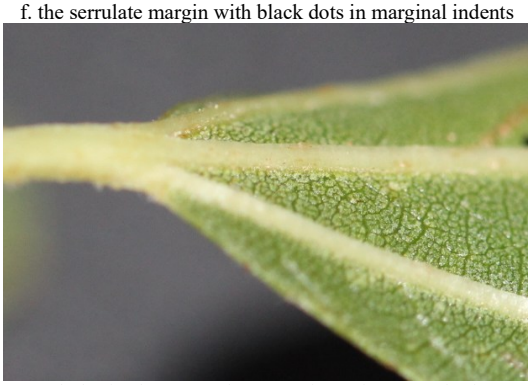
e. leaf blade with acute apex



f. the serrulate margin with black dots in marginal indents



g. pubescent leaf petiole



h. leaf pubescence, lower surface of a young leaf

Figure 1. The vegetative parts of *Z. rivularis*

a. the early flowering stage of *Z. rivularis*

b. flower in its late flowering stage

c. sessile cyme of *Z. rivularis*

d. short style with two stigmas

e. sepals of mature flowers with curved backward apex

f. fruits of *Z. rivularis* in early fruiting stage

g. nearly mature fruits of *Z. rivularis*

h. mature fruit shows the number of chambers/seeds

Figure 2. Shows the flowering and fruiting parts of *Z. rivularis*.

Z. macronata, Z. spina-chrisri and Z. glabrata (Chaudhary, 2001). Morphological features of the newly recorded *Z. rivularis* from Faifa highly matched what has been reported by Dyer et al. (1958) and other formal taxonomic websites. It wasn't mentioned before in research works that branches of this species are almost straight without the usual zigzag pattern. For example, *Z. spina-christi* has been observed with different branch shapes. Almalki and Alzahrani (2018) reported that some *Ziziphus* species have clear zigzagged branches while other species are not. Here, the species *Z. rivularis* has no tends of zigzag growth behavior. Thus, we can add this feature to this species. The color of the branches takes a clear gradual coloring pattern from dark grey to very light grey. *Z. rivularis* is almost spineless, and its leaves have hairs when they are young which makes the classification of the species confused. *Z. rivularis* somewhat resembles *Z. pubescens* recorded in Mozambique (PZA, 2024; Islam and Simmons, 2006), which is spineless shrub (POWO). Both are spineless with pubescent leaves, while *Z. rivularis* leaves is characterized by shiny and hairless upper surface upon maturity (PZA, 2024). Recently, some references argued that each of *Z. rivularis* and *Z. pubescens* should be excluded from *Ziziphus* group (Islam and Simmons, 2006; Rickenback et al., 2024). Rhamnaceae is divided into three groups: rhamnoid, ziziphoid, and ampelozizyphoid in which *Z. pubescens* has been added to *Ziziphus* group (Onstein et al., 2015; Hauenschild et al., 2016). However, additional genetic studies should be conducted concerning *Z. pubescens* (Hauenschild et al., 2016), and the same way could be suggested for *Z. rivularis*.

Through the published literature, the morphological studies of *Ziziphus* spp. Focused on the characters of both vegetative and fruits. There are no considerations on the floral features. *Ziziphus* genus includes many species, and they are different in the morphology of stems, branches, leaves and fruits (Grygorieva et al., 2014; Norouzi et al., 2017; Riaz et al., 2021). Cyme of *Ziziphus* usually carries a package of more than ten flowers (POWO, 2024). The cyme of *Z. spina-christi* is usually carried on an apparent long peduncle. However, *Z. rivularis* flower are different, (Fig.2, e). The flowers appear solitary not inflorescence. In addition, flowers are usually 3-4 in number. Fruits of this species are axillary and solitary per each leaf axil, (Fig.2, f). Some other species of *Ziziphus* bear multiple fruits per a leaf axil, as *Z. mucronata* which having numerous fruits per each axil (PZA, 2024).

Ziziphus ssp. grow in different environments including tropical rainforest, savanna, desert across Asia and Africa, the Arabian Peninsula and Australia (Rickenback et al. 2022). It grows in the southwestern Saudi Arabia, Faifa Mountain is up to 2000 meter above sea level, where the weather is generally temperate (Sayed and Masrahi, 2023). In this study, the plant was collected from an environment that is flourished with different *Ziziphus* taxa such as *Z. spina-christi, Z. mucronata* and *Z. glabrata*. Based on the relationship between the diversity of *Ziziphus* species and the climate, the probability for *Z. rivularis* to be native to the region is high.

The plant is native to the subtropical of eastern Africa, from South Mozambique to South Africa (POWO, 2024) and reported in current discover in Saudi Arabia which is classified as a subtropical region. According to Lashkari and Mohamadi (2015) and Hasanean and Almazroui (2015) *Z. rivularis* can grow and thrive in southwestern province of Saudi Arabia. According to PlantZ Africa, the plant is drought- resistant; therefore, Saudi Arabia's severe conditions would not be a barrier to this species from being existed, and yet native to the land.

Regarding the distribution and phytogeography of *Z. rivularis*, Dyer et al. (1958) reported that, Southern Mozambigue to Southern African the region which the species exists is classified as Sudano-Zambezian region of endemism. Additionally, Wickens (1977) recognized that the Sudano-Zambezian region of endemism has an extension to include territories of Southwestern part of Saudi Arabia, Yemen bordering and coasts of Red Sea and Gulf of Aden. On the other hand, Southwestern region of Saudi Arabia is considered a meeting point of the flora of Africa and Asia representing a link between both continents. This evidence ensured that the new *Z. rivularis* collected from Faifa lies in its natural range of endemics, but didn't discover previously.

CONCLUSION

The morphological description of the plant parts discovered in Faifa agrees with the morphological description reported and posted on *Ziziphus rivularis* in different literature. There are some debates about including or excluding this species from *Ziziphus* group for some aspects; however, we go in this work with the accepted classification revealed that *Z. rivularis* is a member of *Ziziphus* group. The environmental conditions which make the plant native to Africa is like those of SW Saudi Arabia; therefore, the plant can grow well in Saudi Arabia, and

there is no reluctant to decide after these similarities that the plant is native to Saudi Arabia and the Arabia Peninsula. Intensive field work is recommended for discovering its distribution particularly in Saudi Arabia.

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REFERENCES

Abbas, A. M., Al-Kahtani, M. A., Alfaifi, M. Y., Elbehairi, S. E. I., & Badry, M. O. (2020). Floristic diversity and phytogeography of Jabal Fayfa: A subtropical dry zone, south-west Saudi Arabia. *Diversity*, *12*(9), 345.

Alansi, S., Tarroum, M., Al-Qurainy, F., Khan, S., & Nadeem, M. (2016). Use of ISSR markers to assess the genetic diversity in wild medicinal *Ziziphus* spina-christi (L.) Willd. collected from different regions of Saudi Arabia. Biotechnology & Biotechnological Equipment, 30(5), 942-947.

Alfarhan, A.H.; Al-Turki, T.A.; Basahy, A.Y. Flora of Jizan region. Final Rep. Supported King Abdulaziz City Sci. Technol. 2005, 1, 545.

Al-Hawshabi, O. S. S., & El-Naggar, S. M. (2015). Vegetation patterns and floristic composition of Yemen. Current life sciences, 1(3), 103-111.

Al-Khulaidi, A. W., Alzahrani, A. M., Al-Namazi, A., Al-Faify, E. A., Alfaifi, M. M., Al-Sagheer, N. A., & Al-Gifri, A. N. (2024). New plant records for the flora of Saudi Arabia. *Journal of Threatened Taxa*, *16*(3), 24899-24909.

Almalki, R. A., & Alzahrani, D. A. (2018). Morphological investigation of genus *Ziziphus* mill.(Rhamnaceae) in saudi arabia. *American Journal of Plant Sciences*, *9*(13), 2644-2658.

Boulos, L. 2009. Flora of Egypt Checklist, Revised Annotated Edition. Al Hadara Publishing, Egypt.

Boulos, L. & Al Dosari, M. (1994) Checklist of the Flora of *Kuwait. Journal of the UniPersity of Kuwait (Science)* 21: 203-217.

Chaudhary S.A. Flora of the Kingdom of Saudi Arabia. 1999;Vol. 1

Chaudhary S.A. Flora of the Kingdom of Saudi Arabia. 2000;Vol. 2

Chaudhary S.A. Flora of the Kingdom of Saudi Arabia. 2001;Vol. 3

Collenette S.I. National Commission for Wildlife Conservation; Riyadh: 1999. Wildflowers of Saudi Arabia; p. 799.

Collenette, S. A Checklist of Botanical Species in Saudi Arabia; International Asclepiad Society: West Susscx, UK, 1998; pp. 1–80.

Comes, M.D. & Comes, C.D. (1989) *The Wild Flowering Plants of Bahrain.* IMMEL Publishing, London.

Constant, N. L., & Tshisikhawe, M. P. (2018). Hierarchies of knowledge: ethnobotanical knowledge, practices and beliefs of the Vhavenda in South Africa for biodiversity conservation. *Journal of ethnobiology and ethnomedicine*, *14*, 1-28.

Dyer, R. A., Henderson, M., Killick, D. J. B., Meeuse, A. D. J., Verdcourt, B., & Codd, L. E. (1958). New and Interesting Records of African Flowering Plants. *Bothalia*, *7*(1), 21-39.

El-Shaboury, G. A., Haroun, S. A., Al-Wadi, H. M., & Badr, A. (2018). Three new records of Solanum species for the flora of Saudi Arabia. *Feddes Repertorium*, *129*(2), 69-74.

Flora of Africa: https://www.inaturalist.org/observations?taxon_id=596434

Gabali, S. A., & Al-Gifri, A. N. (1990). Flora of South Yemen—Angiospermae A provisional checklist. Feddes Repertorium, 101(7-8), 373-383.

Ghazanfar, S.A (1992) *An Annotated Catalogue of the Flora of Oman.* Scripta Botanica Belgica. National Botanic Garden of Belgium, Meise, Belgium.

Global Biodiversity Information Facility: https://www.gbif.org/occurrence/912102368#occurrenceNcePage_media

Grygorieva, O., Abrahamová, V., Karnatovská, M., Bleha, R., & Brindza, J. (2014). Morphological characteristics of fruits, drupes and seeds in genotypes of *Ziziphus* jujuba Mill. *Potravinarstvo*, *8*(1).

Hasanean, H., & Almazroui, M. (2015). Rainfall: features and variations over Saudi Arabia, a review. *Climate*, *3*(3), 578-626.

Hauenschild, F., Matuszak, S., Muellner-Riehl, A. N., & Favre, A. (2016). Phylogenetic relationships within the cosmopolitan buckthorn family (Rhamnaceae) support the resurrection of Sarcomphalus and the description of Pseudo*Ziziphus* gen. nov. *Taxon*, *65*(1), 47-64.

He, T. & Lamont, B. B. (2022). Ancient Rhamnaceae flowers impute an origin for flowering plants exceeding 250-million-years ago. *iScience* 25(7): 104642.

Islam, M. B., & Simmons, M. P. (2006). A thorny dilemma: testing alternative intrageneric classifications within *Ziziphus* (Rhamnaceae). *Systematic Botany*, *31*(4), 826-842.

IUCN: https://www.iucnredlist.org/ 2024

Lashkari, H., & Mohamadi, Z. (2015). The role of Saudi Arabian sub-tropical high pressure on the rainfall systems on south and southwest Iran. *Physical Geography Research*, *47*(1), 73-90.

Liu, M. J., & Cheng, C. Y. (1995). A taxonomic study on the genus *Ziziphus*. In *Internat. Symposium on Medicinal and Aromatic Plants 390* (pp. 161-166).

Mandaville, J.P. (1977) Plants. Pp. 229-267 in *The Scientific Results of the Dman Flora and Fauna Survey* 1975. *The Journal of Oman Studies Special Report No.1.* D.L. Harrison, ed. Ministry of Information and Culture, Muscat, Oman.

Mandaville, J.P. (1985) A botanical reconnaissance in the Musandam region of Oman. *The Journal of Dman Studies* 7: 9-28.

Mandaville, J.P. (1990). Flora of Eastern Saudi Arabia. Kegan Paul Internatonal, London & N.Y. jointly with the Natonal Commission for Wildlife Conservaton and Development, Riyadh, 482 pp.

Migahid A.M. Riyadh University; Riyadh: 1989. Flora of Saudi Arabia

Migahid A.M. Riyadh University; Riyadh: 1990. Flora of Saudi Arabia

Migahid, C.A.M. Flora of Saudi Arabia, 3rd ed.; University Libraries, King Saud University: Riyadh, Saudi Arabia, 1988; p. 683.

Norouzi, E., Erfani-Moghadam, J., Fazeli, A., & Khadivi, A. (2017). Morphological variability within and among three species of *Ziziphus* genus using multivariate analysis. *Scientia Horticulturae*, *222*, 180-186.

Onstein, R. E., Carter, R. J., Xing, Y., Richardson, J. E., & Linder, H. P. (2015). Do Mediterranean-type ecosystems have a common history?—Insights from the Buckthorn family (Rhamnaceae). *Evolution*, *69*(3), 756-771.

Plant of the World Online: https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:719230-1

Plant of the World Online: https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:719398-1/general-information

PlantZAfrica: https://pza.sanbi.org/*Ziziphus*-mucronata

PlantZAfrica: https://pza.sanbi.org/*Ziziphus*-rivularis

Remesh, M., Masrahi, Y. S., & Sayed, O. H. (2019). Phragmites australis (Poaceae): New addition to flora of southwestern Saudi Arabia. *Saudi Journal of Biological Sciences*, *26*(7), 1563-1566.

Riaz, M. U., Raza, M. A., Saeed, A., Ahmed, M., & Hussain, T. (2021). Variations in morphological characters and antioxidant potential of different plant parts of four *Ziziphus* Mill. species from the Cholistan. *Plants*, *10*(12), 2734.

Richardson, J. E., Fay, M. F., Cronk, Q. C. B. & Chase, M. W. (2000b). A revision of the tribal classification of Rhamnaceae. *Kew Bulletin* 55(2): 311 – 340.

Richardson, J. E., Fay, M. F., Cronk, Q. C. B., Bowman, D. & Chase, M. W. (2000a). A phylogenetic analysis of Rhamnaceae using *rbcL* and *trnL-F* plastid DNA sequences. *American Journal of Botany* 87(9): 1309 – 1324.

Rickenback, J., Lehmann, C., Hauenschild, F., Hughes, M. J., Pezzini, F. F., & Pennington, T. (2024). Geography and ecology structure diversification in *Ziziphus* Mill.(Rhamnaceae): Running Title: Geography and ecology structure diversification. *Frontiers of Biogeography*, *17*, e133817.

Rickenback, J., Pennington, R. T., & Lehmann, C. E. (2022). Diversity in habit expands the environmental niche of *Ziziphus* (Rhamnaceae). *Biotropica*, *54*(5), 1285-1299.

Royal Botanic Gardens, Kew (2024). Royal Botanic Gardens, Kew - Herbarium Specimens. Occurrence dataset https://doi.org/10.15468/ly60bx accessed via GBIF.org on 2024-12-15. https://www.gbif.org/occurrence/912102368

Safhi, F. A., Alshamrani, S. M., Fiteha, Y. G., & Abd El-Moneim, D. (2022). DNA barcoding of endangered and rarely occurring plants in Faifa mountains (Jazan, Saudi Arabia). *Agriculture*, *12*(11), 1931.

Sayed, O. H., & Masrahi, Y. S. (2023). Climatology and phytogeography of Saudi Arabia. A review. *Arid Land Research and Management*, *37*(3), 311-368.

Shuaib, L. (1995) *Wildflowers of Kuwait*. Stacey International, UK.

Sievers, C. (2006). Seeds from the middle stone age layers at Sibudu Cave. *Southern African Humanities*, *18*(1), 203-222.

Walter, H.; Harnickell, E.; Mueller-Dombois, D. Climate Diagram Maps of the Individual Countries and the Ecological Climatic Regions of the Earth; Springer: Berlin, Germany, 1975; p. 36.

Wang, G. T., Shu, J. P., Jiang, G. B., Chen, Y. Q. & Wang, R. J. (2021). Morphology and molecules support the new monotypic genus *Fenghwaia* (Rhamnaceae) from south China. *PhytoKeys* 171: 25 – 35.

Wickens, G.E. Some of the phytogeographical problems associated with Egypt. Publ. Cairo Univ. Herb. 1977, 7–8, 223–230.

World Flora Online: https://www.worldfloraonline.org/taxon/wfo-0001130995.