

***Balanites vietnamica* (Zygophyllaceae), A NEW SPECIES FROM VIETNAM**

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ABSTRACT

Balanites vietnamica is described as a new species from Nui Chua National Park in Ninh Thuan province, Vietnam. It is morphologically close to and has been misidentified as *B. roxburghii* but actually differs in many vegetative and reproductive characteristics. The new taxon is found narrowly endemic in the semi-arid Phan Rang region and its distribution area has been much reduced. The new taxon is described, illustrated with field photographs of detailed botanical characteristics and compared to related species. This rare taxon is assessed as CR following the IUCN Redlist Categories.

Keywords: UNESCO Biosphere Reserve, narrowly endemic, Nui Chua National Park, semi-arid.

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INTRODUCTION

Balanites Delile (1813) is widely accepted as a genus of the Zygophyllaceae (APG, 1998; APG II, 2003; APG III, 2009; APG IV, 2016; Boulos, 2000; Cronquist, 1968, 1988; Engler, 1931; Parvati & Narayana, 1978; Sands, 2013; Sheahan, 2007; Sheahan & Chase, 1996; Singh et al., 2002) although it has also been assigned to the monotypic family Balanitaceae (Dahlgren, 1980; Hutchinson, 1973; Sands, 1989, 2001, 2003; Takhtajan, 2009; Takhtajan, 1969, 1997). The genus was first known with the Desert Date under the name Agihalid described by Alpinio (1592) that Linnaeus (1753) named *Ximenia aegyptiaca* and Delile (1813) changed to *B. aegyptiaca*. Although Adanson (1783) transferred *X. aegyptiaca* to *Agialid*, which was adopted as *Agialida* by Kuntze (1891), but the name *Balanites* was conserved (Briquet, 1906; Harms, 1904). In 1906, Tieghem published 22 new species in three genera (*Agialida*, *Agiella* and *Balanites*) which were considered a Series (Aegyptiaceae, Angolenses and Roxburgianae) in Sprague (1913). After that, Mildbraed & Schlechter (1914) described six additional species from Africa and Cufodontis (1958) described *Balanites gillettii* and var. *renifolia* from Ethiopia. In fact, the genus was revised by Engler (1931) and most recently by Sands (2001) who accepted 9 species and 11 infra-specific taxa. According to Parameswaran & Conrad (1982) and Sheahan (2007), *Balanites* is unusual in Zygophyllaceae in having a drupe with a bony endocarp and is further different from other members of the family in having taller, wider rays (up to 35 cells wide) and vested intervacular pits, although vesturing has also been observed in several other members of the family. Based on a thorough examination of many hundreds of specimens, Sands (2001) has determined that *Balanites* taxa vary to have many overlapping morphological traits, and thus too much reliance on detailed floral characteristics may lead to their uncertain

identification. Besides a few key reproductive ones (e.g. floral merosity, hairiness on the ovary, adaxial surface of petals, pedicel length, length, indumentum of the ovary and petals, and sulcation of fruits), several vegetative characteristics are important in recognizing the intrageneric taxa, especially the leaf texture and spine characteristics (position of spines in relation to the subtending leaf axil, spine length, degree of branching, and presence of secondary spines or spinules, presence and position of productive buds on the spines). For example, *B. roxburghii* Planchon (1854) can be distinguished from the other congeners by adaxially hairy petals and spines bearing leaves and flowers.

Balanites has been known to include trees or shrubs highly adapted to dry conditions which are distributed mainly in tropical West Africa to South Asia with *B. trifolia* Tiegh. reaching to Southeast Asia (i.e. Myanmar). However, one taxon has been reported from Phan Rang in central Vietnam. It was first listed as *Balanites* sp. in Simaroubaceae with a very brief description and an illustrating sketch of only part of a branch bearing spines and leaves in Pham-Hoang (1970) who obviously followed the taxonomic system of Cronquist (1968). The taxon was later identified as *B. roxburghii* Planchon (1854) also in the same family (Pham-Hoang, 1992). This piece of information has been inherited in later publications of Vietnam's flora (Le, 1999; Nguyen, 2003; Pham-Hoang, 2003) in which only Nguyen (2003) listed it in Zygophyllaceae. The record of *B. roxburghii* in Vietnam has been ignored in all international literature above cited except Hassler (2022) who synonymized it under *B. aegyptiaca*. Nevertheless, no vouchered specimens of the plant have been known from Vietnam, and this fact was confirmed by our search in all existing Vietnamese herbaria. Therefore, the existence of *Balanites* in Vietnam has remained questionable.

In our recent inventory of the semi-arid flora of Nui Chua National Park of Ninh

Thuan province, which is part of the formerly called Phan Rang area, we luckily found two populations of the taxon. Our continuous observations since 2007 have yielded flowering and fruiting collections that, at first glance, appear to be closest to the description of *B. roxburghii* Sands (2001), which is known to be endemic to India, i.e. occurring only in semi-arid areas of northern and south-central of India (Sands, 2001). Our careful examination of the Vietnamese plant, scanned specimens of *Balanites* obtained from the JSTOR Global Plants database (JSTOR, 2022) and consultation of relevant literature indicates that it is indeed different from all other congeners in key characteristics of taxonomic importance as determined by Sands (2001), and thus we propose it as a new species here.

MATERIALS AND METHODS

The studied material was collected from Nui Chua National Park, Ninh Hai district, Ninh Thuan province, Vietnam. Specimens were sampled and processed using conventional methods guided by the Royal Botanic Gardens, Kew (Bridson & Forman, 1999). Detailed photographs and descriptions of taxonomically important characters of the newly recorded species were taken of fresh materials in the field using a digital camera. Taxonomic identification was done using morphological vegetative and reproductive characters following the aforementioned literature, especially Sands (2001).

RESULTS

Balanites vietnamica Luu, Th.Trung Nguyen & T.Q.T.Nguyen, sp. nov. (Fig. 1)

Balanites vietnamica is morphologically closest to *B. roxburghii* in having a similar lifeform of shrub or small tree, straight or branched spines with orange-brown tip, coriaceous and narrowly elliptic leaflets without petiolules and 5-merous flowers with adaxially hairy petals but different from the later in having an evergreen habit with curved bole, spines without leaves or flowers, no stipule, adaxially sparsely hairy petals,

spherical ovary with yellow hairs and green fruits.

Shrub or small tree with curved bole, evergreen, curved, spiny when immature, up to 5 m high with a trunk up to 25 cm in diameter. Branchlets and immature spines dull green, densely puberulous. Spines to 5 cm long, ascending, borne at an angle less than 90° to the parent stem, 1–3 cm apart, up to 2 cm above the axil, straight, simple or branched, tapering, dull green except the orange-brown tip. Scale leaves occasional on young spines, minute, triangular with round apex. Leaves arising from stem; stipules absent; petiole 0.7–0.8 cm long, puberulous when young; leaflets narrowly elliptic with slightly oblique base and obtuse apex, 3–4 cm long, 1–1.2 cm wide, densely puberulous on both surfaces when young, coriaceous, sessile; foliole minute, puberulous, triangular, 0.5 mm long, 0.5 mm at base. Inflorescence pseudo-terminal or supra-axillary, racymose or compound racymose, 1–7 cm long. Bracts minute, sometimes to 0.5 mm long, broadly ovate. Pedicels 10–12 mm long, 0.6–0.7 mm in diameter, densely tomentellous, to 15 mm long and 3 mm diameter in fruit. Flowers 5-merous, scented. Sepals 4.5–5 mm long, 2.5–2.7 mm wide, ovate, acute, greenish yellow, abaxially tomentellous, adaxially sericeous with glabrous margins. Tepals 6.5–7 mm long, 2–2.5 mm wide, narrowly oblanceolate, sometimes contorted and irregular at apex, basally green, apically yellow, adaxially sparsely villous, abaxially glabrous. Filaments 3–3.5 mm long, filiform. Anthers 1.5 mm long, 0.8 mm wide, ovoid. Disc 2–2.5 mm high, 3.5 mm in diameter. Ovary spherical, densely yellow silky-pilose, 1.5–1.8 mm high, 1.5 mm in diameter; style 1 mm long, rounded and sometimes slightly lobed at the stigmatic part. Fruits a drupe, 4.5–5 cm long, 1.8–3.5 cm in diameter, ovoid-oblong, obtuse at both ends, green, glabrous; mesocarp pulpy hard; endocarp hard, rather fibrous outside, up to 2 mm thick. Seeds 3–5 cm long, 2–2.5 cm in diameter, ovoid.

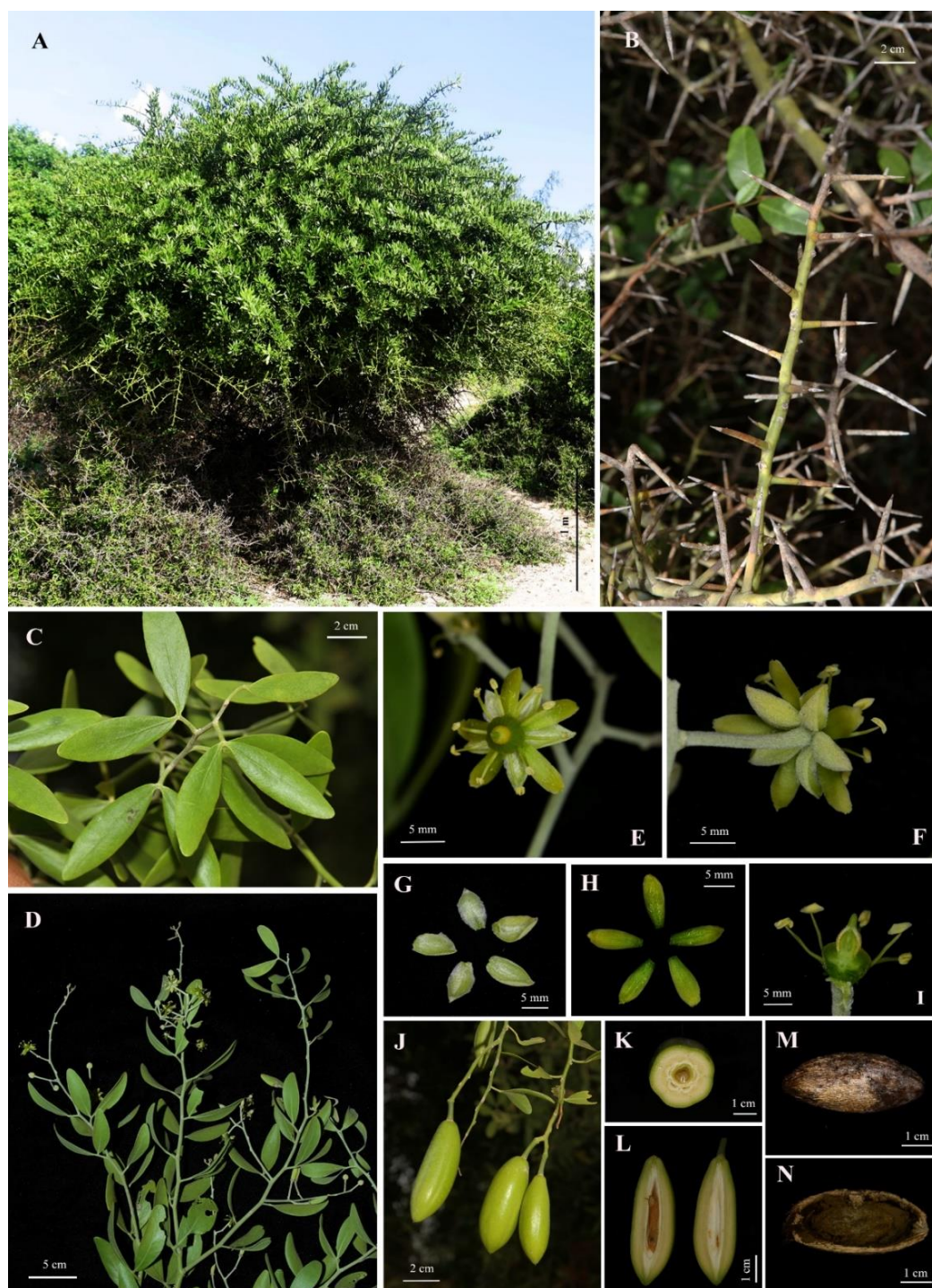


Figure 1. *Balanites vietnamica* Luu, Th.Trung Nguyen & T.Q.T. Nguyen, sp. nov. . A. Habit; B. Spiny branch; C. Leaves; D. Branch with inflorescences; E. Flower, front view; F. Flower, dorsal view; G. Sepals, adaxial; H. Petals, adaxial; I. Stamens and longitudinal section of the ovary; J. Fruits; K. Cross section of fruit; L. Longitudinal section of fruit. M. Endocarp; N. Longitudinal section of the old endocarp

Types

Vietnam, Ninh Thuan province, Ninh Hai district, Nui Chua National Park, 27 May 2021, Nguyen Tran Quoc Trung & Nguyen Thanh Trung NC341 (holotype SGN!, isotypes SGN!, PHH!); 03 July 2020, Nguyen Thanh Trung & Luu Hong Truong Trung 110 (paratypes SGN!).

Ecology

The new species was found growing in open dry coastal savanna on sandy soils with the lowest annual rainfall (< 700 mm) in Southeast Asia and Vietnam's lowest annual humidity (circa 71%). The area is covered with a distinctive flora of many xeric plants which is under a detailed survey by the authors. This semi-arid ecosystem has been much reduced and is presently conserved mainly in Nui Chua National Park, which was recently recognized as an UNESCO Biosphere Reserve (UNESCO, 2022). The plant community is dominated by plants of Euphorbiaceae, Combretaceae, Anacardiaceae, Rutaceae, Salicaceae, Hypericaceae, Rubiaceae, Melastomataceae, Leguminosae, Acanthaceae and Sapindaceae.

Etymology

The species is named after the country where the new taxon is discovered.

Local Vietnamese name

Ca tha as called by local people.

Conservation status

The new species is known only from two very small and distant populations of a total of less than 100 individuals with less than 20 mature individuals. Its distribution has been very much reduced (by circa 90% compared to about forty years ago) due to agricultural expansion. Its total occupancy (and thus its occurrence) is much less than 2 km². Given this situation, we assess this species as CR B1+B2b+c or C+C2a(i)+b (IUCN Standards and Petitions Subcommittee, 2022).

Notes

Balanites vietnamica is morphologically closest to *B. roxburghii* in having a lifeform

of shrub or small tree, simple or branched straight spines with orange-brown tip, coriaceous and narrowly elliptic leaflets, 5-merous flowers with adaxially hairy petals but can be distinguished from the later in a number of characteristics: evergreen (vs. semi-evergreen or deciduous) habit, spines without (vs. with) leaves or flowers, no stipule, sessile (vs. petiolulate) leaflets, larger sepals (5–6 × 2.5–3 mm vs. 3–4.5 × 2–2.5 mm), adaxially sparsely (vs. densely), yellow (vs. green) hairy and oblanceolate (vs. narrowly lanceolate to elliptic-oblong) petals, longer filaments (3–3.5 mm vs. 1.8–2.8 mm), larger anthers (1.5 × 0.8 mm vs. 0.7–0.9 × 0.3–0.5 mm), higher disc (2–2.5 mm vs. 0.5–1 mm), spherical (vs. hemispherical) and larger (1.5–1.8 mm high × ca. 1.5 mm in diameter vs. 0.5–1 mm high × 0.8–1 mm in diameter) ovary with yellow (vs. green) hairs, longer style (1 mm vs. 0.25–0.6 mm) and green (vs. yellowish green or light grey) fruits with round (vs. depressed) ends. In *Balanites*, the adaxially hairy petals are also found in *B. wilsoniana* Dawe & Sprague, *B. maughamii* Sprague from West African countries and *B. triflora* from Myanmar (Sands, 2001). However, they are easily distinguishable from the Vietnamese plant as the African plants have characteristically forked spines and the latter has ovate, broadly elliptic or obovate and petiolulate leaflets with a thin texture and undulate margins. Our new taxon is also different from *B. aegyptiaca*, the type species of the genus, as the latter has a larger size (12–15 m in height), straight bole, semi-evergreen or deciduous leaves, stipules, larger leaflets (0.6–6.8 × 0.3–5 cm), lower disc (1–1.5 mm high), hemispherical ovary, longer style (1.5–3.5 mm) and, especially, adaxially glabrous petals.

Key different characteristics between our new plant and *B. roxburghii* as well as the type species of the genus is presented in Table 1.

Species of *Balanites*, especially *B. aegyptiaca* and *B. roxburghii*, have been known to be used by local people for many purposes, such as food and medicine (Booth

&Wickens, 1988; Burkill, 1985; Dalziel, 1937; Hall & Walker, 1991; Sands, 2001). Because of its wide usefulness, *B. aegyptiaca* has been cultivated for over four thousand years (Delile, 1813; Sands, 2001). Oils, saponins and other substances have been reported from *Balanites*, and thus they are considered a potential resource for producing pharmaceuticals, including steroids and diosgenin. However, fruits of *B. aegyptiaca* are known to have a saponin-glucoside that is very toxic to cold-blooded animals (such as freshwater snails, host to stages of bilharzia (schistosomiasis) and

water fleas) and thus this species has potential for producing pesticides (Sands, 2001; Sheahan, 2007). Likewise, a considerable number of studies had paid attention to explore chemical properties, cultivation and potential uses of the Indian plant, e.g. Jain (1987), Padmashali et al. (2006), Rao et al. (1997), Singh et al. (2009), Talluri et al. (2016), Varshney & Vyas (1982), Yadav & Murthy (2022), Yadav et al. (2022), etc. Such reported uses could encourage further research for sustainable use and conservation of the new species from Vietnam.

Table 1. Key morphological differences among *Balanites vietnamica* and closest congeners

Characteristics	<i>B. roxburghii</i>	<i>B. aegyptiaca</i>	<i>B. vietnamica</i>
Habit	Shrub or small tree with erect bole, to 9 m high, semi-evergreen or deciduous	Shrub or small tree with straight bole, 12 (–15) m high, semi-evergreen or deciduous	Shrub or small tree with curved bole, to 5 m high, evergreen
Spines	Up to 7 cm long, often bearing leaves and flowers	Up to 8 cm long, not bearing leaves and flowers	Up to 5 cm long, existing only in immature plants, not bearing leaves and flowers
Stipule	0.5–0.75 mm long	0.5–1 mm long	Absent
Leaflets	2–4 × 0.6–4 cm, narrowly elliptic, obovate or oblanceolate, with a cuneate base	0.6–6.8 × 0.3–5 cm, variable, narrowly spatulate or elliptic to broadly ovate or obovate, with cuneate or narrowly decurrent base	3–4 × 1–1.2 cm, narrowly elliptic, with a slightly oblique base.
Petiolules	1–2 mm long	1–10 mm long	absent
Inflorescence	Axillary or supra-axillary directly from lateral shoots, or on lateral shoots or on the mature spines, cymose or racymose	At spineless or spiniferous nodes, or closely arranged on shoots of short internodes, cymose	Pseudo-terminal or supra-axillary directly from shoots, never on the spines, racymose
Pedicels	(0.4–) 0.5–0.8 (–1.2) cm long	6–17 mm long	8.5–11.5 mm long
Sepals	(3–) 3.5–4 (–4.5) × 2–2.5 mm	3.5 (–5.5) × 1.5–2 (–2.5) mm	4.5–5 × 2.5–2.7 mm
Petals	4.2–6 (–6.5) × (1.4–) 1.5–2 mm, narrowly lanceolate to elliptic-oblong, adaxially silky–villous	4.5–6.5 (–7) × 1–2 (–2.5) mm, lanceolate or narrowly elliptic to obovate-	6.5–7 × 2–2.5 mm, oblanceolate to elliptic-oblong, glabrous, adaxially

Characteristics	<i>B. roxburghii</i>	<i>B. aegyptiaca</i>	<i>B. vietnamica</i>
		oblong, adaxially glabrous	sparsely villous
Filaments	1.8–2.4 (–2.8) mm long	2–3 (–3.5) mm long	3–3.5 mm long
Anthers	0.7–0.9 × 0.3–0.5 mm, oblong-ovoid	(0.75–) 1–1.5(–1.8) × 0.4–0.7 mm, oblong-ovoid	1.5 × 0.8 mm, ovoid
Disc	0.5–1 mm high	1–1.5 mm high	2–2.5 mm high
Ovary	Hemispherical, 0.5–1 mm high, 0.8–1 mm in diameter, densely green silky-pilose	Hemispherical, 0.75–1 mm high, 1–2 mm diameter, green puberulous or pubescent to tomentose	Spherical, 1.5–1.8 mm high, 1.5 mm in diameter, densely yellow silky-pilose
Style	(0.25–) 0.4–0.5 (–0.6) mm long	style 1.5–3.5 mm long	1 mm long
Fruits	Round or sulcate and depressed at both ends, yellowish-green or light grey	Rounded, truncated or sometimes sulcate at both ends or tapering, conical apex	Obtuse at both ends, green

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REFERENCES

- Adanson M., 1783. Familles des Plantes, Part 2. Paris, Vincent.
- Alpinio P., 1592. De plantis Aegypti liber. Venetiis, Franciscum de Franciscis Senensem.
- APG, 1998. An ordinal classification for the families of flowering plants. *Annals of the Missouri Botanical Garden*, 85(4): 531–553. <https://doi.org/10.2307/2992015>
- APG II, 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Botanical Journal of the Linnean Society*, 141(4): 399–436. <https://doi.org/10.1046/j.1095-8339.2003.t01-1-00158.x>
- APG III, 2009. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG III. *Botanical Journal of the Linnean Society*, 161(2): 105–121. <https://doi.org/10.1111/j.1095-8339.2009.00996.x>
- APG IV, 2016. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society*, 181(1): 1–20. <https://doi.org/10.1111/boj.12385>
- Booth F. E. & Wickens G. E., 1988. Non-timber uses of selected arid zone trees and shrubs in Africa. FAO Conservation Guide 19. Rome, Food & Agriculture Organization.
- Boulos L., 2000. Flora of Egypt, Volume 2: Geraniaceae - Boraginaceae. Cairo, Al Hadara Publishing.
- Bridson D. & Forman L., 1999. Herbarium Handbook - 3rd Edition. Kew, Lubrecht & Cramer Ltd.
- Briquet J., 1906. International rules of botanical nomenclature, adopted by the international botanical congress of Vienna 1905. Jena, Verlag von Gustav Fischer.
- Burkill H. M., 1985. The useful plants of West Tropical Africa, Vol. 1, Families A–D. ed. 2. Kew, Royal Botanic Gardens.

- Cronquist A., 1968. The evolution and classification of flowering plants. London & Edinburgh, Thomas Nelson.
- Cronquist A., 1988. The evolution and classification of flowering plants. Bronx, New York, New York Botanical Garden.
- Cufodontis G., 1958. Systematische Bearbeitung der in Süd-Äthiopien gesammelten Pflanzen. *Senckenbergiana Biologica*, 5–6: 289–314.
- Dahlgren R., 1980. A revised system of classification of the angiosperms. *Botanical Journal of the Linnean Society*, 80(2): 91–124.
- Dalziel J. M., 1937. The useful plants of West Tropical Africa. London, Crown Agents for the colonies.
- Delile A., 1813. Description de l'Égypte. Paris, Histoire naturelle.
- Engler A., 1931. Zygophyllaceae. In: Engler A. & Harms H. Die natürlichen Pflanzenfamilien, 2(19a): 144–184. Leipzig, W. Engelmann.
- Hall J. & Walker D., 1991. *Balanites aegyptiaca*: a monograph. Bangor (United Kingdom), School of Agricultural and Forest Sciences, University of Wales.
- Harms H., 1904. Vorschlag zur Ergänzung der "Lois de la nomenclature botanique de 1867", dem in Wien 1905 tagenden Nomenclatur-Kongreß zur Annahme empfohlen. *Notizblatt des Königl. botanischen Gartens und Museums zu Berlin*, 4(Appendix XIII): 1–37.
- Hassler M., 2022. Synonymic Checklists of the Vascular Plants of the World. Catalogue of Life Checklist 13.2. <https://doi.org/10.48580/dfrq-3dd>
- Hutchinson J., 1973. The families of flowering plants, Vol. 1, Dicotyledons. Oxford, Clarendon Press.
- IUCN Standards & Petitions Subcommittee, 2022. Guidelines for using IUCN Red List Categories and Criteria. Version 15. Prepared by the Standards and Petitions Subcommittee. <https://www.iucnredlist.org/documents/RedListGuidelines.pdf>.
- Jain D. C., 1987. Antifeedant active saponin from *Balanites roxburghii* stem bark. *Phytochemistry*, 26(8): 2223–2225. [https://doi.org/10.1016/S0031-9422\(00\)84687-7](https://doi.org/10.1016/S0031-9422(00)84687-7)
- JSTOR, 2022. JSTOR Global Plants. <https://plants.jstor.org>.
- Kuntze C. E., 1891. Revisio Generum Plantarum 1: 103. London, Dulau & Co.
- Le T. C., 1999. Basic characteristics of the flora of Vietnam. Hanoi, Science and Technics Publishing House (In Vietnamese).
- Linnaeus C. V., 1753. Species Plantarum: 1194. Stockholm, Laurentii Salvii.
- Mildbraed J. & Schlechter R., 1914. Beiträge zur Kenntnis der Gattung *Balanites* Del. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie*, 51: 156–163.
- Nguyen T. B., 2003. Zygophyllaceae R.Br., 1814. In: Nguyen T. B. et al. Checklist of Plant Species of Vietnam. Hanoi, Agriculture Publishing House, Vol. 2: 1039–1040 (In Vietnamese).
- Padmashali B., Vaidya V., Vagdevi H. & Satyanarayana N., 2006. Antifertility efficacy of the plant *Balanites roxburghii* (Balanitaceae) in female rats. *Indian Journal of Pharmaceutical Sciences*, 68(3): 347–351.
- Parameswaran N. & Conrad H. P., 1982. Wood and bark anatomy of *Balanites aegyptiaca* in relation to ecology and taxonomy. *IAWA Bull. n.s.*, 3(2): 75–88.
- Parvati A. & Narayana L., 1978. Systematic position of *Balanites* Delile. *Current Science*, 47(24): 968–970.
- Pham-Hoang H., 1970. An Illustrated Flora of South Vietnam. Sai Gon, Ministry of Culture, Education and Youth (In Vietnamese).
- Pham-Hoang H., 1992. An illustrated flora of Vietnam, Vol. 2(1). Montreal, Canada, Mekong Printing (In Vietnamese).

- Pham-Hoang H., 2003. An illustrated flora of Vietnam, Vol. 2. Ho Chi Minh, Youth Publishing House (In Vietnamese).
- Planchon J. E., 1854. Affinités et synonymie de quelques genres nouveaux ou peu connus. *Annales des Sciences Naturelles, Série 4*, 2: 256–266.
- Rao M., Shah K. & Rajani M., 1997. Contraceptive efficacy of *Balanites roxburghii* pericarp extract in male mice (*Mus musculus*). *Phytotherapy Research*, 11(6): 469–471. [https://doi.org/10.1002/\(SICI\)1099-1573\(199709\)11:6<469::AID-PTR135>3.0.CO;2-5](https://doi.org/10.1002/(SICI)1099-1573(199709)11:6<469::AID-PTR135>3.0.CO;2-5)
- Sands M. J., 1989. Balanitaceae. In: Hedberg I. & Edwards S. Flora of Ethiopia and Eritrea, Vol. 3: 433–436. Addis Ababa University & Uppsala University.
- Sands M. J., 2001. The desert date and its relatives: A revision of the genus *Balanites*. *Kew Bulletin*, 56: 1–128.
- Sands M. J., 2003. Balanitaceae. In: Beentje H. J. & Ghazanfar S. A. Flora of Tropical East Africa. Kew, Royal Botanic Gardens.
- Sands M. J., 2013. Proposal to conserve *Balanites*, nom. cons. (Zygophyllaceae) as being of feminine gender. *Taxon*, 62(2): 410–411. <https://doi.org/10.12705/622.25>
- Sheahan M., 2007. Zygophyllaceae. In: Kubitzki K. The families and genera of vascular plants IX: 488–500. Berlin & Heidelberg, Springer-Verlag.
- Sheahan M. C. & Chase M. W., 1996. A phylogenetic analysis of Zygophyllaceae R. Br. based on morphological, anatomical and *rbcL* DNA sequence data. *Botanical Journal of the Linnean Society*, 122(4): 279–300. <https://doi.org/10.1111/j.1095-8339.1996.tb02077.x>
- Singh B., Kaur I. & Gauchan D., 2002. Floral anatomy and systematic position of the genus *Balanites*. *Acta Botanica Hungarica*, 44(1–2): 137–143. <https://doi.org/10.1556/abot.44.2002.1-2.10>
- Singh V., Patel J., Gaur K., Tyagi L. & Kori M., 2009. In vitro antioxidant activity and phytochemical analysis of stem bark of *Balanites roxburghii* Planch. *Advances in Biological Research*, 3(5–6): 242–246.
- Sprague T. A., 1913. Manduro: a new oil-yielding tree from Portuguese East Africa. *Bulletin of Miscellaneous Information*, 1913(4): 131–141.
- Takhtajan A., 2009. Flowering plants, Springer. <https://doi.org/10.1007/978-1-4020-9609-9>
- Takhtajan A. L., 1969. Flowering plants: origin and dispersal. Translated from the Russian by C. Jeffrey. Edinburgh, Oliver and Boyd.
- Takhtajan A. L., 1997. Diversity and classification of flowering plants. New York, Columbia University Press.
- Talluri M. R., Tadi R. S. & Battu G. R., 2016. Thioacetamide-induced acute liver toxicity in rats treated with *Balanites roxburghii* extracts. *Journal of Acute Disease*, 5(5): 413–418. <https://doi.org/10.1016/j.joad.2016.08.009>
- UNESCO, 2022. Biosphere reserves in Asia and the Pacific. <https://en.unesco.org/biosphere/aspac/>
- Varshney I. & Vyas P., 1982. Saponin and saponin contents of *Balanites roxburghii*. *International Journal of Crude Drug Research*, 20(1): 3–7. <https://doi.org/10.3109/13880208209083275>
- Yadav G. G. & Murthy H. N., 2022. Analysis of phenotypic variation and selection of superior genotypes of *Balanites roxburghii* Planch. from South India. *Genetic Resources and Crop Evolution*, 69(5): 1993–2009. <https://doi.org/10.1007/s10722-022-01366-x>
- Yadav G. G., Murthy H. N. & Dewir Y. H., 2022. Nutritional composition and in vitro antioxidant activities of seed kernel and seed oil of *Balanites roxburghii*: an underutilized species. *Horticulturae*, 8(9): 798. <https://doi.org/10.3390/horticulturae8090798>