

A NEW RECORD OF FICUS (MORACEAE) FOR THE FLORA OF IRAN

F. Bordbar & M. Mirtadzadini

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This study records *Ficus salicifolia* belonging to *Ficus* sect. *Urostigma* subsect. *Urostigma* (Moraceae), a species not previously known from Iran, using morphological and molecular (based on nuclear nrDNA) evidences. The species is described based on the specimen collected from south of Iran, southeast of Jiroft Dosari spring. Detailed description of the species with photographs is provided.

Firouzeh Bordbar (Correspondence <bordbar@uk.ac.ir>) & Mansour Mirtadzadini, Department of Biology, Faculty of Sciences, Shahid Bahonar University of Kerman, Kerman, Iran.

Key words: *Ficus salicifolia*; sect. *Urostigma*, Moraceae; new record; Molecular data, ITS; Iran

یک گزارش نو از جنس *Ficus* (Moraceae) برای فلور ایران

فیروزه بردبار: استادیار گروه زیست‌شناسی دانشگاه شهید باهنر کرمان

منصور میرتاج‌الدینی: استادیار گروه زیست‌شناسی دانشگاه شهید باهنر کرمان

این مطالعه، گونه *Ficus salicifolia* متعلق به *sect. Urostigma subsect. Urostigma* از تیره توت، گونه‌ای که قبلاً برای فلور ایران گزارش نشده است را با استفاده از مشاهدات ریخت‌شناسی و مولکولی (بر پایه DNA ریبوزومی هسته‌ای) گزارش می‌دهد. این گونه براساس نمونه جمع‌آوری شده از جنوب ایران، جنوب شرقی جیرفت، چشمه دوساری شرح داده می‌شود. شرح کامل ویژگی‌های این گونه همراه با تصاویر آن فراهم شده است.

INTRODUCTION

Ficus L. is among the largest genera of angiosperms with approximately 750 species of trees, epiphytes and shrubs. The species of the genus have a worldwide distribution in Asian-Australasian (Asia, Malesia, Pacific islands and Australia), Neotropical (Central and South America) and Afrotropical (south of the Sahara and Madagascar) regions (Berg & Corner 2005). Figs are important food source for hundreds of frugivores which provide an effective seed dispersal service (Shanahan & al. 2001). Therefore, they cause the diversity and widespread distribution of figs. They are also known for their relation with their pollinating wasps and important role in plant-insect coevolution especially in tropical ecosystems (Rønsted & al. 2005). The genus is divided into 6 subgenera, 19 sections and 27 subsections (Berg & Corner 2005; Rønsted & al. 2008).

During the botanical explorations in southern Iran,

southeast of Jiroft, the authors recognized an interesting species of *Ficus* growing in a rock crevice. It is found to be rare and quite distinct from the other Iranian species of *Ficus*. After precise morphological surveys and the phylogenetic reconstruction based on nrDNA ITS, the species was identified as *F. salicifolia* Vahl.

MATERIALS AND METHODS

Morphological studies

The specimen of *F. salicifolia* was collected from southern Iran, SE of Jiroft, Dosari spring and deposited in MIR herbarium (herbarium acronyms here and below following Thiers 2018).

The specimen was identified using the identification keys in Flora of Iran (Azizian 2001), Flora of the Kingdom of Saudi Arabia (Chaudhary 2001) and Flora of Oman (Ghazanfar 2003). In addition, the collected sample was compared with the photo of the type specimen of *F. salicifolia* preserved

in C herbarium.

Molecular phylogenetic studies

Total genomic DNA was extracted from dried leaf tissue of the herbarium specimen according to Gawel & Jarret (1991). PCR amplification of the nrDNA ITS region (ITS1 and ITS2 spacers plus the 5.8S gene) was performed according to Blattner (1999) using primers ITS-A and ITS-B. Additional sequences of *Ficus* sect. *Urostigma* subsect. *Urostigma* and the outgroups (Chantarasuwan & al. 2015) were obtained from GenBank and included in the analyses. All the Nucleotide sequences were aligned using the program BioEdit sequence alignment editor v.7.2.5 (Hall 1999). Sequences belonging to *F. salicifolia* were submitted to GenBank (accession number MN170559). The best-fitted model of sequence evolution was estimated to be HKY+G+I with the Akaike information criterion (AIC) in jModelTest 2.0 (Darriba & al. 2012). Bayesian analysis (BI) was carried out with MrBayes 3.1 (Ronquist & Huelsenbeck 2003) for the data set, running two analyses for 3×10^6 generations, sampling a tree every 1000 generations. The initial 25% of the trees were discarded as burn-in, and posterior probabilities were calculated on the basis of the remaining trees. Tree visualization was performed on FigTree v.1.3.1 (Rambaut 2006-2009).

RESULTS AND DISCUSSION

Morphological data

Based on the morphological characters, the specimen is identified as *F. salicifolia*. This species belongs to *Ficus* subg. *Urostigma*, sect. *Urostigma*, subsect. *Urostigma*. *Ficus* subsect. *Urostigma* includes about 27 species of which seven species are from Africa, Madagascar, and the Arabian Peninsula and 20 species from Asia, Australia, and the Pacific Islands (Chantarasuwan & al. 2013, 2015). *Ficus salicifolia* was regarded as *F. cordata* subsp. *salicifolia* (Vahl) C. C. Berg, but in a morphological revision of *Ficus* subsect. *Urostigma*, Chantarasuwan & al. (2013) reinstated the taxon as a separate species because of the differences with *F. cordata* Thunb. and *F. lecardii* Warb. In some literatures, these three species were considered as the subspecies of *F. cordata*. However, Chantarasuwan & al. (2013) believed that they can be separated by the absence of internal hairs in *F. cordata* (present in the other two species) and the narrow leaves (with the leaf length 2.5-5 times longer than the leaf width) of *F. salicifolia* (with the leaf length 1.25-2.5 times longer than the leaf width in the other two species). The specimens belonging to *F. salicifolia* are

trees or shrubs (fig. 1A) which are distributed in Africa as well as Arabian Peninsula (Chaudhary 2001; Ghazanfar 2003; Chantarasuwan & al. 2013) and Iran (according to the results of this study). The leaf blades are diverse in shape i.e., subovate, oblong, lanceolate (fig. 1B) or elliptic. Stipules are 0.3-1.7 cm long, glabrous or white puberulous, persistent at the shoot apex and forming a terminal bud (fig. 1C) or sometimes caduceus. Figs are axillary below the leaves, solitary (fig. 1C), in pairs, or up to 4 (-6) on spurs. *Ficus salicifolia* is the only species in subsect. *Urostigma* that shows persistent and caduceus basal figs bracts. The internal hairs are persistent, minute and sparse in this species (fig. 1D). The staminate flowers are near the ostiole. Wasps enter the figs via the ostiole and pollinate pistillate flowers by carrying the pollen grains (fig. 1E). This is a mutualistic relationship between the wasps and *Ficus* species for over 60 million years which help them for a better pollination (Rønsted & al. 2005). Other *Ficus* species reported for the flora of Iran belong to subgenus *Ficus*, section *Ficus*, subsect. *Ficus* with more or less palmate leaves including *F. carica* L., *F. johannis* Boiss. and *F. rupestris* (Hauskn. ex Boiss.) Azizian. They are distributed over the country mostly in moderate mountainous regions (Azizian 2001).

Ficus salicifolia Vahl (fig. 1)

Type: Yemen, Wasab and Wadi Zabid, 29.III.1763, Forsskål 780 (types: C and B).

Tree or shrub up to 2.5 m tall. Stems pale brown, young branches with short erect hairs. Leaves glabrous, leaf blades lanceolate, coriaceous, 2-8×1-2 cm, apex acute or acuminate, base cuneate to rounded, margin entire, glabrous; petiole 0.5-2.5 cm long, with short hairs; stipules 3-6 mm long, persistent, conical, with short sparse hairs. Figs axillary, solitary, ± globose, pale green to yellowish, 7-9 mm in diam. when dry; peduncle up to 2-3 mm long; figs and peduncle with short sparse coarse hairs; basal bracts 5, 1-2 mm long; ostiole circular, 1-2 mm in diam., ostiolar bracts 5, 0.5-1 mm long, wide triangular, ciliate, acuminate; internal hairs present, minute and sparse. Staminate flowers near ostiole, sessile; tepals 3, lanceolate, free, brown; Pistillate flower sessile or pedicellate; tepals 3, ovate or lanceolate or oblong, free, brown.

Flowering time: August – October

Specimen examined: Iran, south, SE of Jiroft, Dosari spring, N28° 25' 59.20", E57° 57' 31.31", 677 m, 01.XII.2018, Mirtadzadini, Bordbar and Doostmohammadi 3116 (MIR!).

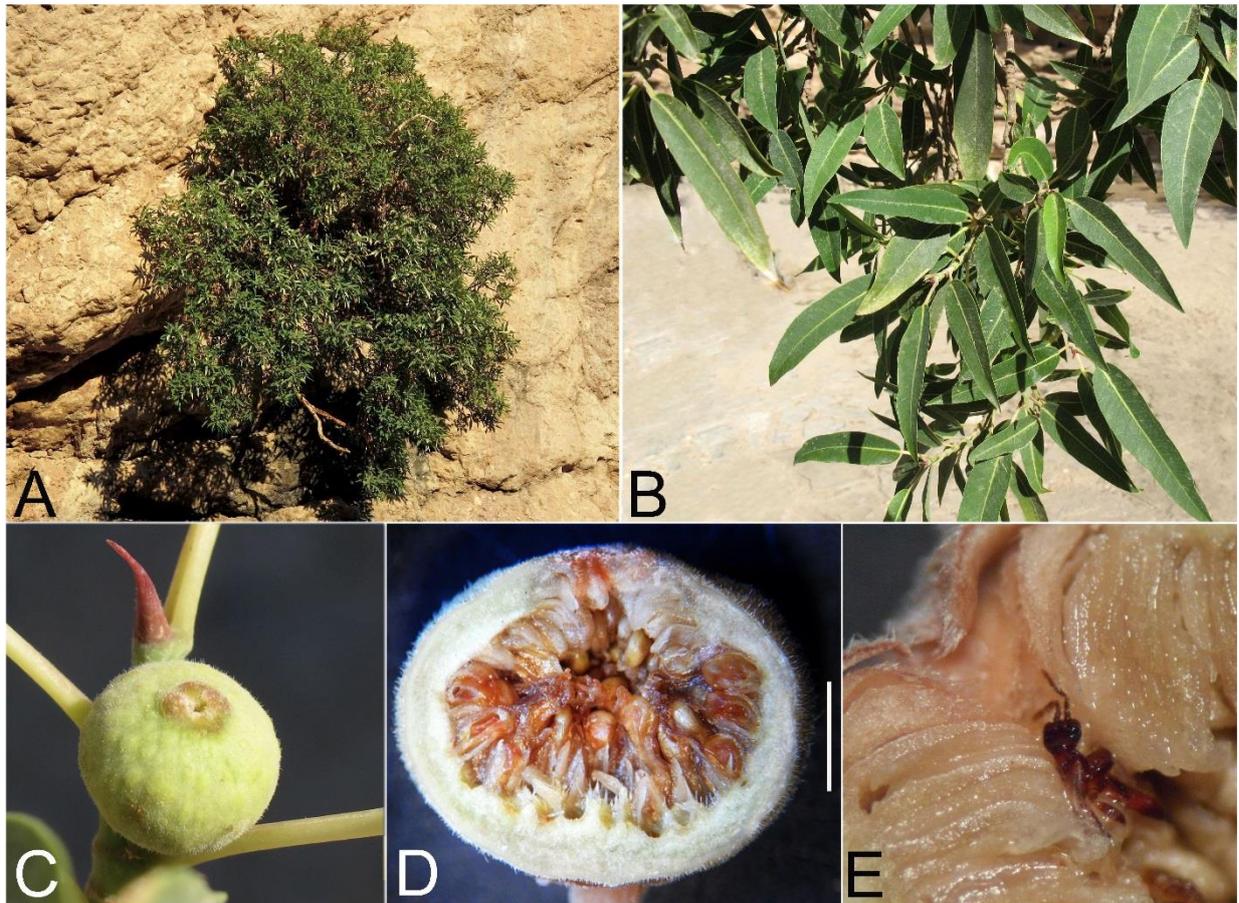


Fig. 1. *Ficus salicifolia*. A, habit; B, Leaves; C, Stipule; D, Transection of fruit; E, Symbiotic wasp . Scale bar=2 mm.

Other specimens studied: Yemen. Wasab and Wadi Zabid, 29.III.1763, Forsskål 780 (type: C, photo!). Oman. N. Wadi Beni Habib, Jabal Saiq, N23° 04', E57° 36', 1000 m, 22.III.1994, I.Mc Leish 3953 (ON, photo!); Nibbah, Khor Habilayn, N26° 05', E56° 25', 22.III.1985, R.E.Ash 299 (ON, photo!); S. Dhofar, Leger waterhole (Sadh), N17° 06', E55° 05', 0-250 m, 16.IX.1993, I.Mc Leish 2478 (ON, photo!).

Molecular data

Phylogenetic analyses of nrDNA ITS sequence data strongly supported the placement of our specimen in a clade with an accessions of *F. salicifolia* (KJ845977, KJ845976, AY063586) as well as *F. verruculosa* Warb (fig. 2). Moreover, an accession of *F. salicifolia* (KF850595) retrieved from the GenBank was placed in a different clade with *F. lecardii* and two accessions of *F. salicifolia* (AY730060 and KJ845975) united with *F. densifolia* Miq in another clade. This tree topology suggests that there is either a species circumscription problem or an identification problem (or both) in this

species. A properly circumscribed species should exhibit a unique clustering of the individuals that comprise it. Reviewing the taxonomic history of the species reveals that the circumscription of species and infraspecific taxa has been problematic. Therefore it is necessary to revise the species taxonomic position by conducting a precise study of morphology and phylogeny.

Ecology and conservation status

The area of the distribution of this specimen is a part of Saharo-Arabian region (Zohary 1973) which displays hot and moist climate with low annual precipitation. In this region, wadis and moist valleys including the area of the distribution of this species, create especial ecosystem for the growing of the tropical and subtropical plants such as *Ficus* species. The report of *Ficus salicifolia* in this area is based on only one tree growing on crevice of the vertical limestone cliff and around 15 m above the ground. Therefore the access to this plant is not possible without equipment. At the base of this wall, there is a permanent

spring indicating that there is sufficient moisture in the clefts of this rocky wall and favorable condition for the growth of this plant. It is unclear whether there were more trees of this species in the region in the past, and all but one was lost, or most probably it was the only tree that had been brought to the area by frugivorous from the adjacent areas like Oman and Saudi Arabia in the past. The existence of only one plant of this species indicates the necessity of its protection. This species is

accompanied by *F. johannis*, *Prosopis cineraria* (L.) Druce, *Ziziphus nummularia* (Burm. f.) Wight & Arn., *Rhazya stricta* Decne., *Lycium shawii* Roem. & Schult., *Calotropis procera* (Aiton) Dryand., *Capparis mucronifolia* Boiss., *Pycnocycla aucheriana* Boiss., *Forsskaolea tenacissima* L., *Andrachne* sp., *Pteris vittata* L. and the cultivated plants such as *Phoenix dactylifera* L. and *Citrus* species.

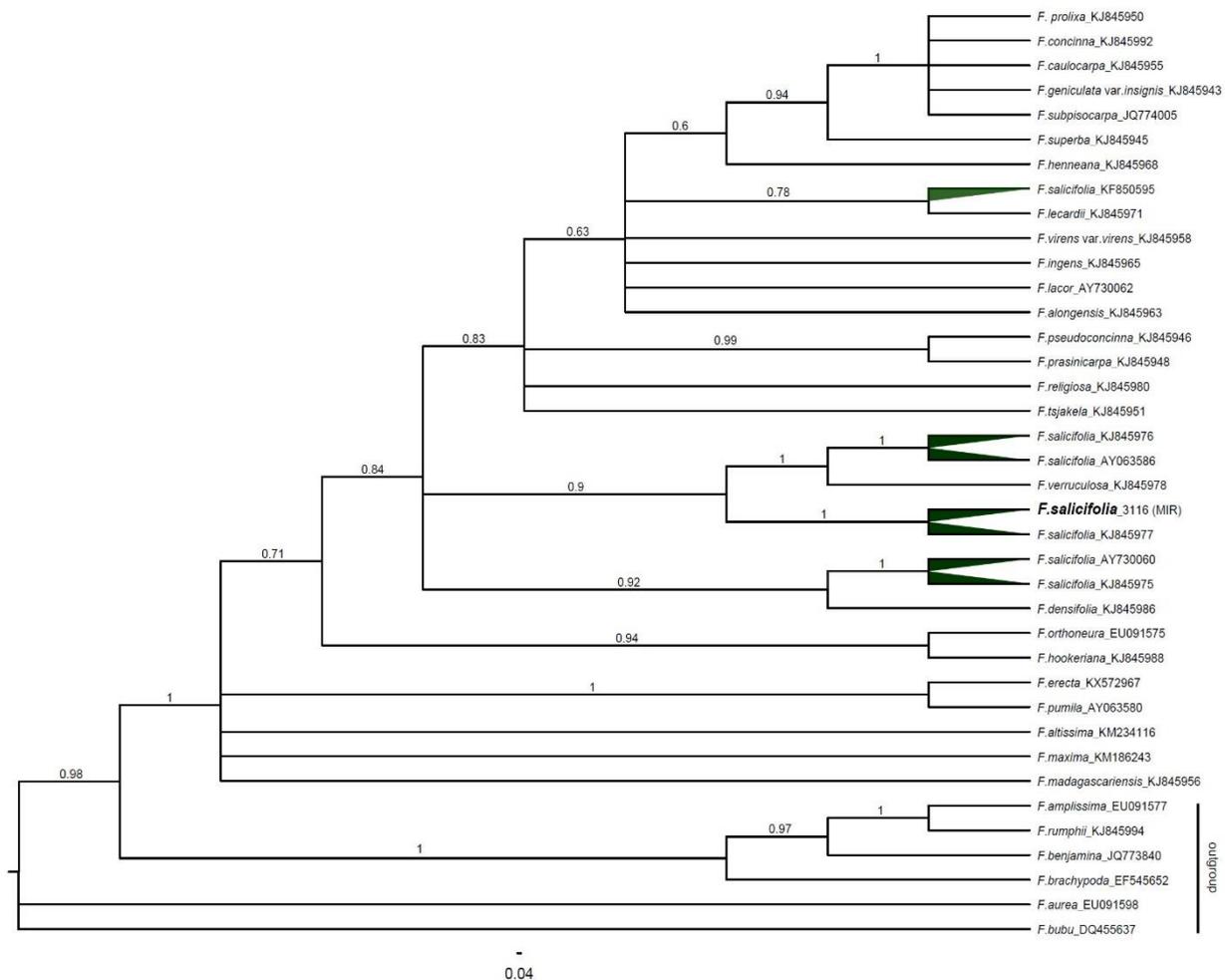


Fig. 2. Bayesian consensus tree from the nuclear ribosomal DNA internal transcribed spacers (nrDNA ITS) of *Ficus* subject. *Urostigma*. Data above branches are the value from Bayesian inference (BI). Green triangulars represent *F. salicifolia* accessions. *F. salicifolia* from flora of Iran are shown with bold letters.

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