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A new species of *Bufonia* L. (Caryophyllaceae) from the Kordestan province (Iran)

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ABSTRACT
During investigation of the genus *Bufonia* L., in various herbaria of Iran, a new species, *B. iranica* Z.Rostami, Assadi & F.Ghahrem., sp. nov., was recognized and thus is described here. This new species is closely related to *B. enervis*, with some morphological differences such as size and shape of the perianth, and the seed shape. A key for the species occurring in Iran, illustrations and a distribution map of the new and related species are provided. The seed morphology was studied using a scanning electron microscope.

KEY WORDS
Alsinoideae,
Flora of Iran,
Sagineae,
seed,
new species.

RÉSUMÉ
Une espèce nouvelle de Bufonia *L. (Caryophyllaceae) de la province iranienne du Kurdistan.*
Au cours de l'examen du genre *Bufonia* L. dans différents herbiers d'Iran, une nouvelle espèce (*B. iranica* Z.Rostami, Assadi & F.Ghahrem., sp. nov.) a été reconnue et est ici décrite. Elle est étroitement apparentée à *B. enervis* Boiss., avec quelques différences dans la taille et la forme du périanthe, ainsi que dans la forme de la graine. Une clé des espèces du genre en Iran, des illustrations et une carte de répartition sont fournies. La morphologie de la graine a été observée au microscope à balayage.

MOTS CLÉS
Alsinoideae,
Flore d'Iran,
Sagineae,
graine,
espèce nouvelle.

INTRODUCTION

Since the publishing of *Flora Iranica*'s treatment for the genus *Bufonia* L., the present work is the first taxonomic study on the Iranian species of *Bufonia*. The genus belongs to the family Caryophyllaceae, subfamily Alsinoideae (Rechinger 1988). The genus *Bufonia* is taxonomically close to the genera *Cerastium* L. and the genus *Sagina* L. In more recent phylogenetic studies *Bufonia*, *Colobanthus* Bartl., *Sagina*, and *Drypis spinosa* L. are placed in a clade that represents tribe Sagineae sensu Harbaugh (Harbaugh *et al*. 2010; Greenberg & Donoghue 2011).

Diagnostic morphological characteristics of this genus are having flowers with four sepals, four tepals and a bivalve compressed lenticular capsule. The genus is morphologically such a complex taxon that finding the proper characters for accurately separating species is difficult. During our work on this genus in several Iranian herbaria, it appears that many specimens, especially from W Iran, were mistakenly determined at the species level. *Bufonia* includes nearly 35 species in the world (lçim & Behçet 2013), it is widely distributed from Macaronesia through Turkey, and Iran to Afghanistan; the northern boundaries of the distribution range are in the western Iberian Peninsula, central France and southern Switzerland and east Mediterranean region. It continues from Serbia to Macedonia, Romania to the southern Ukraine. In Africa, it occupies lands of Maghreb, in Libya but it is not present in the African part of Egypt. Southern limits of the Asian range are Sinai Peninsula, Jordan, Syria, mountainous parts of Iraq to Iran. At the eastern edge, it grows in southern Pakistan, reaching Turkmenistan and Transcaucasian republics of Armenia and Azerbaijan in the north. The highest species richness is found in Iran and NW Africa. In Europe, the genus is represented by a few species only, often of rare occurrence (Italy, Greece). Its complete absence in some Mediterranean islands is striking (e.g. Sardinia, Sicily, Cyprus). Most species grow on dry stony slopes up to alpine area (e.g. Morocco and Iran above 3000 m) (Chrtek & Křísa 1999a). The number of species decreases to the east.

According to *Flora Iranica*, *Bufonia* includes 14 species in Iranian plateau of which 13 grow in Iran, 10 of them are endemics for Iran (Rechinger 1988). Based on newer studies, *B. koelzii* Rech.f., an endemic species for Iran, was transferred to genus *Arenaria* as *A. polycnemifolia* Boiss. because of having pentamerous perianth and six-part splitting capsule (Chrtek & Křísa 1999b). According to molecular and anatomical evidences, *B. koelzii* is a synonym of *Eremogone polycnemifolia* Boiss. (Sadeghian *et al*. 2015; Mousavi *et al*. 2019). Additionally, *B. kotschyana* Boiss. was

A new identification key for *Bufonia* L. species in Iran

1. Annual 2
— Perennial, woody at base 3

2. Inflorescences are often limited to the upper part of the stem, stamens 3-4 ..... *B. parviflora* Grisb.
— The flowers are all along the stem, stamens 8 ..... *B. oliveriana* Ser.

3. Inflorescence not congested, pedicels usually longer than sepals, up to 30 mm long 4
— Inflorescence congested, pedicels shorter up to 10 mm long 6

4. Pedicel filiform 5
— Pedicel not filiform ..... *B. capsularis* Boiss. & Hausskn.

5. Sepals 2-3 mm long, ovate-orbiculate, apiculate, ovule 4 ..... *B. macrocarpa* Ser.
— Sepals 2.5-4 mm long, ovate-lanceolate, acute, ovule 4-8 ..... *B. sintenisii* Freyn.

6. Sepals puberulent or velutinous 7
— Sepals glabrous 9

7. Pedicel glabrous, sepals up to 6 mm long ..... *B. iranica* Z.Rostami, Assadi & F.Ghahrem., sp. nov.
— Pedicel pubescent, sepals up to 4 mm long 8

8. Stems branched, sepals velutinous ..... *B. hebecalyx* Boiss.
— Stems usually not branched, sepals glabrous or puberulent ..... *B. enervis* Boiss.

9. Inflorescential parts with 5-12 flowers ..... *B. capitata* Bornm.
— Inflorescential parts with up to 5 flowers 10

10. Sepals 2-3 mm long ..... *B. micrantha* Boiss. & Hausskn.
— Sepals longer 11

11. Sepals ± 6 mm long ..... *B. calycina* Boiss. & Hausskn.
— Sepals 3- 5.5 mm long 12

12. Ovules 2 ..... *B. stapfii* Bornm.
— Ovules 4 ..... *B. kotschyana* Boiss.

FIG. 1. — *Bufonia iranica* Z.Rostami, Assadi & F.Ghahrem., sp. nov. From holotype: *Mozaffarian 70066* (TARI).

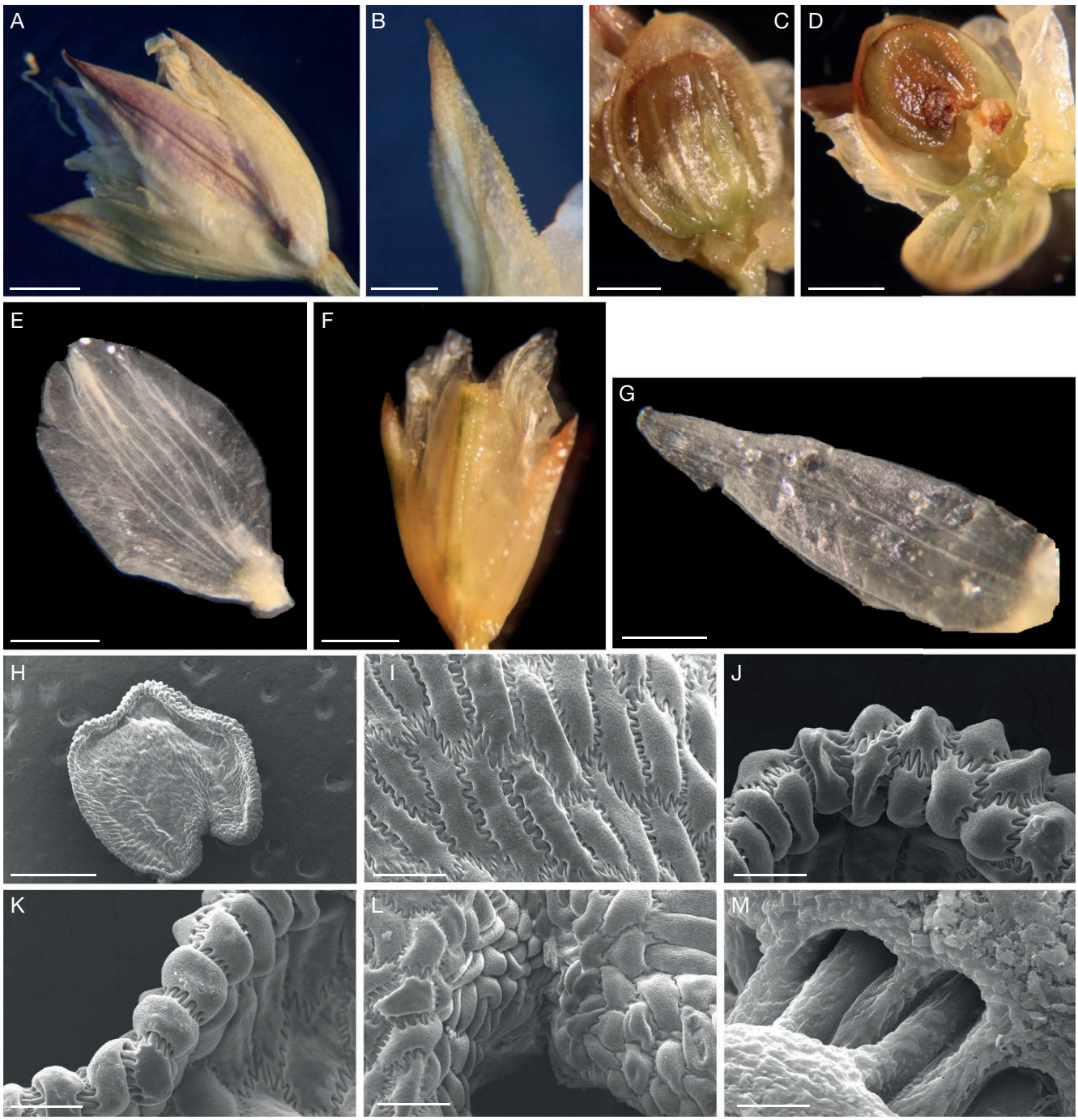

Fig. 2. — **A**-**E**, Details of morphological characters of *Bufonia iranica* Z.Rostami, Assadi & F.Ghahrem., sp. nov. (*Mozaffarian 70066*): **A**, calyx; **B**, upper part of sepal; **C**, mature ovary; **D**, mature open ovary; **E**, petal; **F**, **G**, *Bufonia enervis* Boiss. (*Iranshahr & Termeh 12159-E*): **F**, calyx; **G**, petal; **H**-**M**, *B. iranica* Z.Rostami, Assadi & F.Ghahrem, sp. nov.: **H**, seed; **I**, close view of the seed surface from median part of the seed at the position between hilum and abfunicular side; **J**, **K**, close views of the seed surface at the abfunicular side; **L**, close view of the seed surface from median part of the seed at the hilum; **M**, close view of anticlinal border between testa cells. Scale bars: A, D, E, 1.2 mm; B, 0.38 mm; C, 0.97 mm; F, 0.87 mm; G, 0. 82 mm; H, 1 mm; I-L, 100 µm; M, 10 µm.

recorded from Syria (Post 1932), but was not yet mentioned in *Flora Iranica*. Most of the nine endemic species for Iran are narrow endemic taxa. The most species of *Bufonia* are distributed in the west and north west of Iran. However, some species are also distributed in the mountainous areas of the northeast and center of Iran. The distribution of this genus in Iran is often limited to over 1500 meters in the Irano-Touranian region.

List of Iranian species of *Bufonia*

B. macrocarpa Ser.; distribution: Iran. Endemic.
B. sintenisii Freyn.; dist.: Iran, Afghanistan, Turkmenistan.
B. capsularis Boiss. & Hausskn; dist.: Iran. Endemic.
B. capitata Bornm.; dist.: Iran. Endemic.
B. hebecalyx Boiss.; dist.: Iran. Endemic.
B. iranica Z.Rostami, Assadi & F.Ghahrem., sp. nov.; dist.: Iran. Endemic.

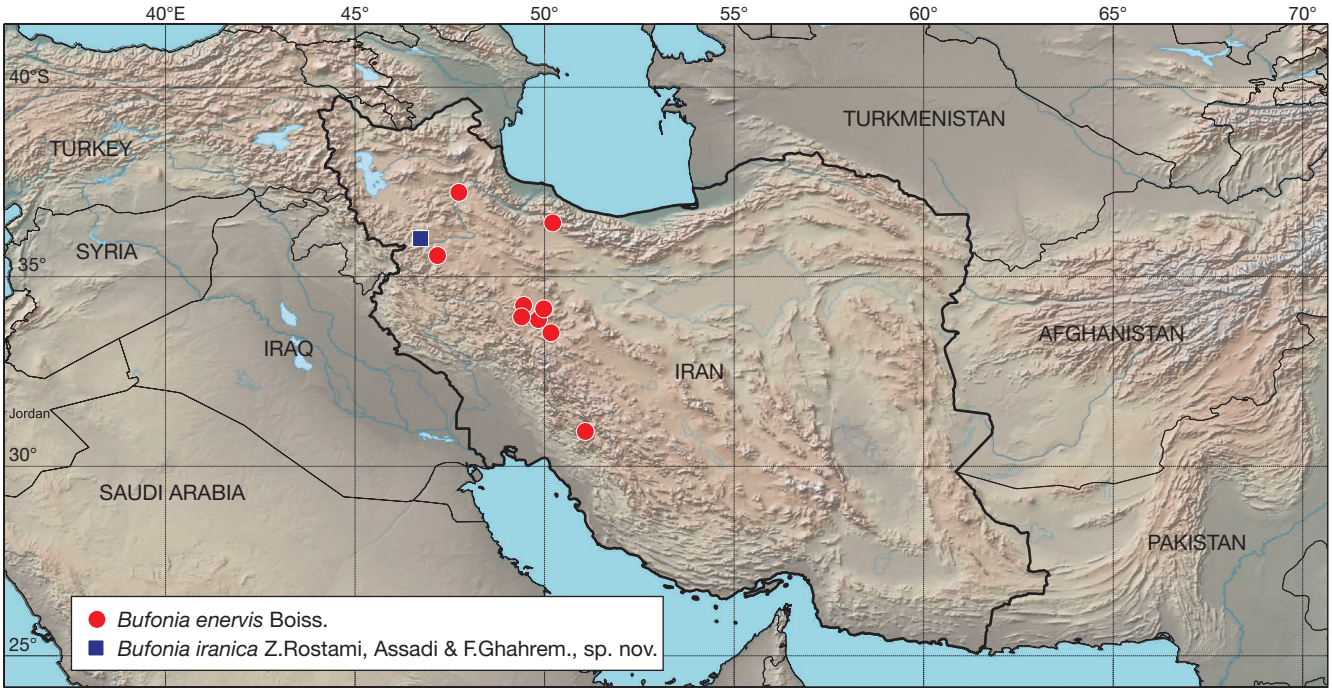

FIG. 3. — Distribution of *Bufonia iranica* Z.Rostami, Assadi & F.Ghahrem., sp. nov. (■) and *Bufonia enervis* Boiss. (●).

B. enervis Boiss.; dist.: Iran. Endemic.
B. stapfii Bornm.; dist.: Iran. Endemic.
B. kotschyana Boiss.; dist.: Iran, Syria.
B. calycina Boiss. & Hausskn.; dist.: Iran. Endemic.
B. micrantha Boiss. & Hausskn.; dist.: Iran. Endemic.
B. parviflora Grisb.; dist.: Anatolia, Syria, Lebanon, Jordan, Iran, Armenia, Azerbaijan, Europe Macedonia, Greece, Bulgaria, Ukraine, Serbia.
B. oliveriana Ser.; dist.: Iraq, Iran, Turkmenistan, Afghanistan.

MATERIAL AND METHODS

For this study, we used several important references for determination of the genus, like *Flora Orientalis* (Boissier 1867), *Flora of Turkey* (Cullen 1967), *Flora Europaea* (Halliday 1966), *Flora of the U.S.S.R.* (Schischkin 1936), *Flora Iranica* (Rechinger 1988), etc. Also several type specimens photos have been studied from BM, G, JE, P, S, W and WU herbaria. All the specimens of *Bufonia,* nearly 230, preserved in five Iranian herbaria, i.e. FAR, FUMH, IRAN, T and TARI, have been determined.

The authors did a comparison between diagnostic characters of the new species and its most closely related species (Table 1). Most differences were related to reproductive structures (length and shape of outer and inner sepals, their margin width, length and shape of petal, its apex shape and seed size). Most similarities were related to plant inflorescence and growth form. Seed samples were scanned with a KYKY SEM, EM3200 model. Vouchers were scanned with Olympus SZH stereomicroscope equipped with Canon EoS 700 D camera.

SYSTEMATICS

Bufonia iranica
Z.Rostami, Assadi & F.Ghahrem., sp. nov.
(Figs 1; 2)

Species nova affinis Bufoniae enervis *Boiss. sed differt a pedicellis glabris (nec puberulis), sepalis late ovatis ad margines 0.5-1 mm late membranaceis (nec ovato-lanceolatis et minus quam 0.5 mm late membranaceis), 4-6 mm longis (nec 3-4 mm longis), petalis late ovatis, acutis, 5-5.5 mm longis (nec ovato-lanceolatis, obtusis, 2.5-3.5 mm longis), seminibus orbicularibus, 2 × 2 mm (nec late ellipticis, 2.5 × 1.5 mm).*

TYPUS. — **Iran**. Kordestan province: Saghghez, between Sonnate and Divandarre, Kuh-e Ghaleh, between Bashmagh and Jafarabad, 2300 m, 14.VII.1991, *V. Mozaffarian 70066* (holo-, TARI!).

SEED MORPHOLOGY. — The seeds of *B. iranica* Z.Rostami, Assadi & F.Ghahrem., sp. nov. are brown, orbicular with lateral hilum, and about 2 mm diameter. The surface has elongated testa cells on the wing and hilum of the seed (Fig. 2H-M). The periclinal wall of the testa cells is slightly convex. The anticlinal walls are Zip-shaped.

DISTRIBUTION. — This endemic species was collected from west of Iran, Kordestan province (Fig. 3). The locality of type specimen in label was erroneously mentioned as Azarbaiejan province, the other notes are accurate. It grows on dry rocky slopes of a mountainous area.

ETYMOLOGY. — The specific epithet refers to the country of the type specimen, Iran.

DESCRIPTION

Perennial, woody at base. Stems numerous, 12-25 cm high, erect, rigid, glabrous puberulent, simple or with short branches parallel to the stem; internodes 35-40 mm long. Basal leaves connate and sheathing, lower leaves 8-10 mm

TABLE 1. — Comparison of the new species with its close species.

Characters	***B. iranica* Z.Rostami, Assadi & F.Ghahrem, sp. nov.**	***B. enervis***
Pedicel	Glabrous	Puberulent
Length sepals	4-6 mm	3-4 mm
Shape sepals	Broadly ovate	Ovate-lanceolate
Length petals	5-5.5 mm	2.5-3.5 mm
Shape petals	Ovate	Obovate
Seed shape	Orbicular	Elliptical

long, upper leaves shorter, subulate, rigid, adhesive to stem, ciliolate on the margin. Bracts 3 mm long, ovate-oblong, acute, ciliolate on the margin. Inflorescence compact. Flowers crowded in few flowered (2-5 flowers) terminal or lateral cymes, subsessile or very shortly pedicellate. Pedicels very short, rigid, glabrous. The outer pair sepals 4-5 mm long, broadly ovate, acute, 5-nerved, with white 0.5-0.7 mm wide scarious margin, straw yellow or black red. The inner pair sepals 5-6 mm long, broadly ovate, acute, 5-nerved, middle nerve excurrent, with 1 mm broad white scarious margin, straw color, pale purple or pallid purpurine or reddish, glabrous. Petals 5-5.5 mm long, broadly ovate, acute. Stamens 8, 3.5 mm long. Ovary with 4 ovules. Capsule compressed, 3.5 mm long, semi-elliptic. Seeds brown, 2 × 2 mm, orbicular, laterally compressed, with few tubercles. In terms of exomorphology, the surface of the seed is constructed of regularly arranged elongate cells with zip-shaped margins.

REMARKS

The new species is close to *Bufonia enervis* but it differs with having glabrous pedicels; longer sepals (4-6 not 3-4 mm long), and wider sepals (>0.5 not 0.5 mm wide) broadly ovate in shape (not ovate-lanceolate); longer petals (5-5.5 not 2.5-3.5 mm long), broadly ovate in shape (not obovate), and acute at the top (not obtuse); and different seeds (2 × 2 not 2.5 × 1.5 mm; orbicular not broadly elliptical). The type specimen was determined as *Arenaria* cf. *szowitsii* Boiss., but with having four sepals, four petals and bivalve compressed lenticular capsule, it definitely belongs to *Bufonia*.

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