



New combinations in Asiatic *Oxybasis* (Amaranthaceae s.l.): evidence from morphological, carpological and molecular data

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Abstract

Two new combinations are proposed in *Oxybasis* (Chenopodioideae, Chenopodiaceae or Amaranthaceae s.l.). *Chenopodium micranthum*, described from Russia in the 1860s and known as *C. urbicum* subsp. *sinicum* in China, is assigned specific rank in *Oxybasis*. It appears to be widespread in China, Mongolia, Kazakhstan and Asiatic Russia. The Siberian-Mongolian *C. gubanovii*, recently described as a new species in *Chenopodium* sect. *Pseudoblitum*, is also assigned to *Oxybasis*. Molecular phylogenetic analysis using maximum likelihood (ML) and maximum parsimony (MP) methods confirmed the placement of *C. micranthum* and *C. gubanovii* in the genus *Oxybasis*. Distribution maps of *O. micrantha* and *O. gubanovii* are provided, the latter species being reported for the first time in the Chinese part of the Altai Mountains. A lectotype for *C. micranthum* (= *O. micrantha*) is designated.

Key words: Chenopodiaceae, *Chenopodium*, China, distribution, Kazakhstan, Mongolia, Russia, taxonomy

Introduction

Recent molecular phylogenetic studies (Kadereit *et al.* 2003, 2010, Fuentes-Bazan *et al.* 2012a) showed that the genus *Chenopodium* Linnaeus (1753: 218) is polyphyletic, and its representatives have been placed in several genera in the tribes Chenopodieae, incl. Atripliceae Duby (1828: 394), Anserineae Dumortier (1827: 20) and Dysphanieae Pax (1889: 92). The taxa earlier included in *Chenopodium* sect. *Pseudoblitum* (Grenier & Godron (1855: 22) Syme (1868: 20) have been reassigned to the genus *Oxybasis* Karelin & Kirilov (1841: 738) [*O. glauca* (Linnaeus (1753: 220) S.Fuentes, Uotila & Borsch, *O. rubra* (Linnaeus (1753: 218) S.Fuentes, Uotila & Borsch, *O. chenopodioides* (Linnaeus (1771: 170) S.Fuentes, Uotila & Borsch, *O. urbica* (L.) S.Fuentes, Uotila & Borsch, and *O. macrospema* (Hooker (1846: 341) S.Fuentes, Uotila & Borsch)]. Mosyakin (2013) divided *Oxybasis* into four sections and added two species. Furthermore, Mosyakin (2013) and Verloove (2013) proposed new combinations for some infraspecific taxa belonging to *O. glauca* and *O. rubra*.

Oxybasis is characterised in having flowers with a hyaline or greenish perianth of 2–4(–5) free or connate segments, a reduced number of stamens (2–4, rarely 5) and usually red seeds with the outer layer (testa) impregnated with tannin-like substances and a diversely oriented seed embryo (see also Fuentes-Bazan *et al.* 2012b, and Sukhorukov & Zhang 2013). However, some members of *Chenopodium* s.l. remain poorly known and their correct placement is still pending. In the present article we transfer two Asiatic taxa, *C. gubanovii*

Sukhorukov (1999: 493) and *C. urbicum* subsp. *sinicum* H.W. Kung & G.L. Chu (Kung *et al.* 1978: 121), from *Chenopodium* s.l. to *Oxybasis*.

Material and methods

Morphological and anatomical studies

Specimens from the herbaria B, BM, E, G, H, K, KAS, LE, MHA, MOSP, MW, PE, PVB, TLT, XJA, XJBI (abbreviations according to Thiers 2008+) and the herbarium of Xinjiang Medicinal Institute (Urumqi) were revised.

Anatomical cross-sections of fruits and seeds were cut by hand. Prior to scanning electron microscopy (SEM), material was dehydrated in aqueous ethyl alcohol solutions of increasing concentration and then in alcohol-acetone solutions and pure acetone. Observations were made using a JSM-6380 (JEOL Ltd., Japan) SEM at 15 kV after critical-point drying and sputter coating with gold-palladium. Non-dehydrated dry fruits were also examined for comparison of pericarp structure. Carpological terms used are according to Werker (1997).

DNA studies

Phylogenetic analysis

The phylogenetic analysis was made using ITS1 sequences from specimens of *O. micrantha* and *O. gubanovii* (present work) coupled with NCBI data. *Polygonum aviculare* Linnaeus (1753: 362) was used as an outgroup. The aligned ITS1 length was 187 bp. DNA was extracted from the leaves of herbarium specimens of *O. micrantha* and *O. gubanovii* and molecular sequences obtained for the nuclear ITS1 region. Voucher specimens and GenBank accession numbers are as follows:

Oxybasis micrantha: China, Burjin, woodland, 25 August 1986, *Xiaoqiang Ma et al.* 86-0694 sub *Chenopodium micranthum* (XJA-00032767); ITS1, 5.8S RNA, ITS2, GenBank accession number KF514654; *Oxybasis gubanovii*: Mongolia, Altay Mountains, valley of the Bulgan river, 35 km from Bulgan vill., 12 August 1982, *I. A. Gubanov* 5577 sub *Chenopodium gubanovii* (MW); ITS 1 GenBank accession number KF514653.

Vouchers for sequences other taxa downloaded from GenBank are as follows: *Polygonum aviculare* EF653684.1; *Chenopodiastrum hybridum* isolate AC380, HE577390.1; *C. hybridum* isolate AC609, HE577388.1; *C. hybridum* isolate AC521, HE577389.1; *Chenopodiastrum murale* isolate AC581, HE577404.1; *C. murale* isolate AC565, HE577402.1; *C. murale* isolate, AC383, HE577400.1; *C. murale* isolate, AC360, HE577398.1; *C. murale* isolate AC397, HE577394.1; *C. murale* isolate AC589, HE577392.1; *C. murale* isolate AC409, HE577391.1; *C. murale* isolate AC415, HE577396.1; *Oxybasis chenopodioides* HE577379.1; *O. urbica* isolate AC576, HE577384.1; *O. urbica* isolate AC536, HE577383.1; *O. rubra* isolate AC564, HE577382.1; *O. rubra* isolate AC411, HE577380.1; *O. rubra* isolate AC653, HE577381.1; *O. rubra* isolate AC385, HE577385.1; *O. glauca* isolate AC652, HE577386.1; *O. glauca* isolate AC417, HE577387.1.

DNA amplification and sequencing

For isolation of genomic DNA we used the modified method of Edwards *et al.* (1991). The ITS1 region was amplified using the combination of the newly designed primers ITS5.1 (5'-TCG AAA CCT GCC TAG CAG AGC-3') and ITS4.1 (5'-CGC AAC TTG CGT TCA AAG ACT-3') based on alignment of nrDNA sequences comprising ITS1, 5.8S RNA and ITS2 from *Oxybasis rubra* [HE577382.1, HE577380.1, HE577381.1, HE577385.1], *O. glauca* [HE577386.1, HE577387.1], *O. urbica* [HE577384.1, HE577383.1], and *O. chenopodioides* [HE577379.1]. The DNA template was added to the reaction mixture at a final concentration of 10 ng/ μ l. The PCR program consisted of an initial denaturation step of 95°C for 5 min, followed by 35 cycles of 95°C for 15 s, 52°C for 20 s and 72°C for 20s, and a final step of 72°C for 5 min. Sequencing was performed using the same primers with an AbiPrism automated DNA sequencer ("Syntol", Moscow).

Alignment and phylogenetic analysis

ITS sequences were aligned using BioEdit 7.1.3.0. To infer phylogenetic relationships the following methods were used: Maximum Likelihood (ML) and Maximum Parsimony (MP). All searches were carried out using MEGA 5.1 (after Tamura *et al.* 2011). Branch support for MP and ML analyses was evaluated by using the nonparametric bootstrap (1000 BS replicates). Bootstrap values < 70% are considered to be weak. The MP tree was obtained using the Subtree-Pruning-Regrafting (SPR) algorithm with search level 1, in which the initial trees were obtained by the random addition of sequences (10 replicates). The Maximum Likelihood analysis was based on the Kimura 2-parameter model (Kimura 1980).

Taxonomy

1. *Oxybasis micrantha* (Trautv.) Sukhor. & Uotila, *comb. nov.*

Bas.: *Chenopodium micranthum* Trautvetter (1868: 464). Type (lectotype, here designated by Sukhorukov & Uotila):—RUSSIA: Gubern. Orenburg, distr. Tscheljabja [Chelyabinsk prov.], 1868, *Lossiewski 4980* (LE!) (Fig. 1). = *Chenopodium urbicum* L. subsp. *sinicum* Kung & G.L.Chu in Kung *et al.* (1978: 121). Type (holotype):—CHINA: Hopei [Hebei] prov., Beijing, Haihuisi, humid place, 9 October 1951, *Li & Xu 0157* (PE-00024040!). —*Chenopodium stipitatum* Aellen, in schedis.

Description:—Plants annual, up to 200 cm tall, glabrous. Stems angled and in part with prominent ridges, yellowish, only sparingly branched in basal parts if at all. Petiole to 15 cm long in the basal leaves, much shorter in the distal ones; blade thin, to 15(–30) cm long, longer than wide, triangular-hastate to trullate, usually with broadly attenuate base and spreading to slightly forward pointing, up to about 1 cm long basal lobe-like teeth; mid-lobe evenly tapering to acute apex, margins entire or with outward to slightly forward pointing teeth, heterogenic in size. Leaves becoming progressively smaller and narrower apically with uppermost bracts long, narrowly lanceolate and entire. Inflorescences mostly ebracteate, dense, spiciform, moderately branched; branches erect, with some entire bracts; secondary branches short and dense; glomerules 2–3 mm in diameter, loose. Flowers stipitate in fruit stage; stipes 0.2–0.5 mm. Perianth segments 5 (sometimes 4), divided almost to the base, adjacent segments not touching, brownish-greenish, margins and apexes broadly membranous, mid-vein prominent and elevated inside; segments spreading and dimorphic at fruit stage: about 0.6 mm long, 0.3–0.4 mm broad in the apical part and 0.2 mm in the basal part, obovate, back without keel, and elongated, to 0.9 x 0.2 mm, lanceolate or oblanceolate, keel prominently swollen at apical part. Stamens 4–5. Stigmas 2, short. Fruit 0.5–0.7(–0.9) x 0.5–0.6 x 0.2–0.3 mm, pericarp scraped off the seed, transparent, one-layered, with mamillae to 30 µm (dry mamillae have crater-like outlines and regain their structure after soaking). Seeds horizontal and sometimes vertical (spatial heterospermy), round in outline, 0.6–0.8 mm in diameter, 0.3 mm thick, slightly convex, flat, red or reddish-black, margin keeled. Outer seed coat layer (testa) lustrous, smooth or undulate, about 12 µm thick and with vertical stalactites, inner layer (tegmen) about 1 µm; no differences were observed in testa thickness between fruits with diverse diameters or spatial heterospermy. Embryo curved.

Distribution and habitat:—*Oxybasis micrantha* is widely distributed from the South Ural Mountains (Chelyabinsk Prov., on the border of Europe) to the temperate Far East and eastern China (Fig. 2). This range includes Kazakhstan, many provinces of Russia, Mongolia and northwestern and eastern China and everywhere extends to a latitude of about 50–55° N. The gap in Central China and Mongolia may reflect both a lack of suitable habitats and lower collecting activity.

The large distribution area is predominantly characterised by steppe and semi-desert, but surprisingly many specimens of *O. micrantha* have been collected from moister habitats, e.g. “humid place” (type of *C. urbicum* subsp. *sinicum*), “marsh”, “along stream”, “near the river” and “among reed” (*C. stipitatum*). There are many finds also from saline localities and some specimens from places clearly strongly influenced by human activity, e.g. “railway station”, “ruderal place” and “wasteland”. A general rarity of moist and saline habitats may be one reason for the rarity of *O. micrantha* everywhere within its vast distribution area.

Taxonomical notes:—*Chenopodium micranthum* was well characterized by Trautvetter (1868), who identified the two most important diagnostic features: the exceptionally small seeds and the spreading perianth segments in the fruit stage. He listed the species 16 years later (Trautvetter 1884), but since then it has been totally forgotten and omitted even from the synonymy of *C. urbicum* and other species (e.g., Iljin & Aellen 1936 and all later Russian floras and checklists). Herbarium specimens from Russia and Central Asia were in general determined as *C. urbicum*, and in some cases *C. rubrum*.

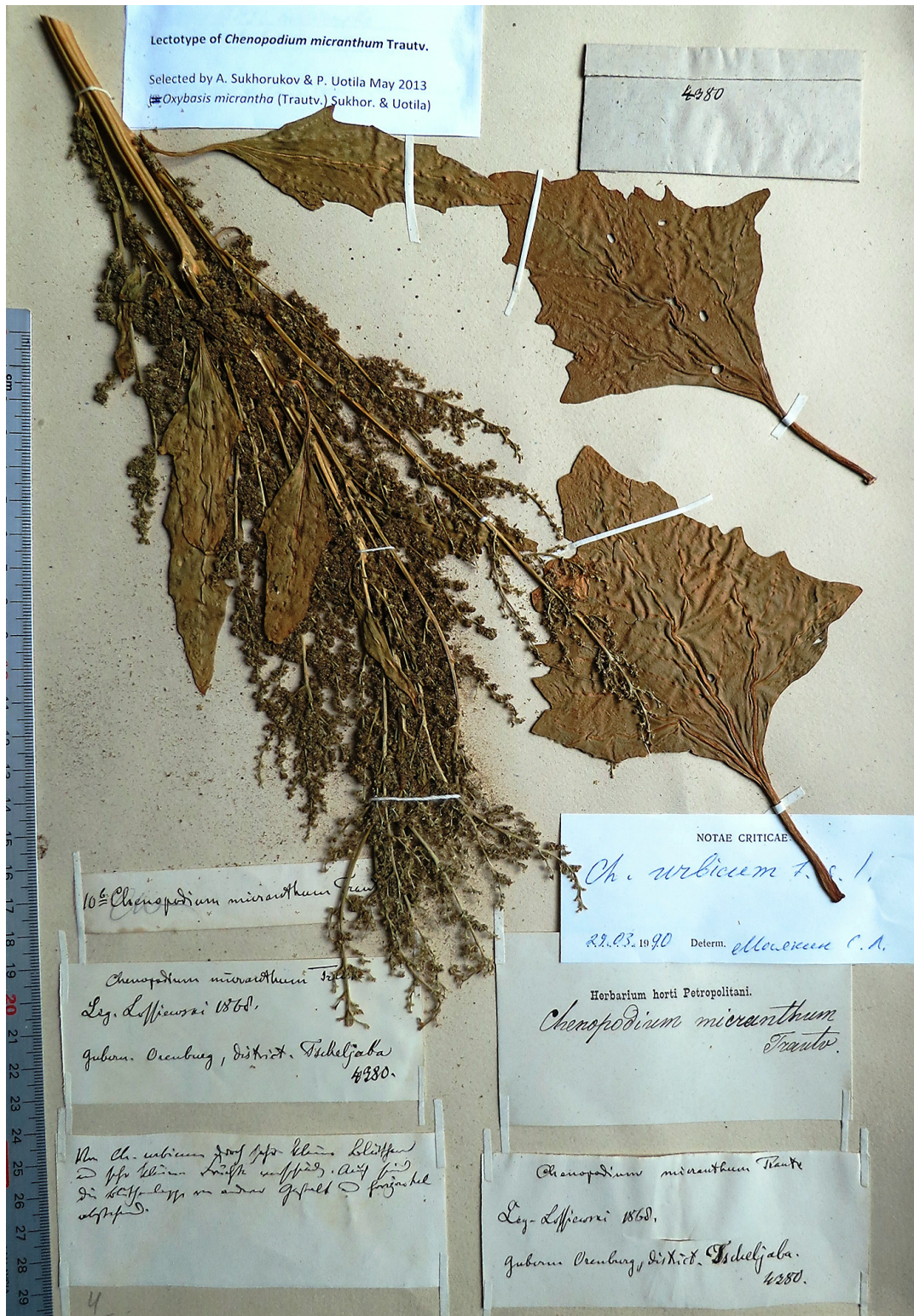


FIGURE 1. Lectotype of *Chenopodium micranthum* Trautv. (LE!).

The second attempt to untangle this enigmatic taxon was made by the late *Chenopodium* specialist Paul Aellen (1896–1973), who came across an unknown Chinese specimen loaned from K. He thought that it could belong to a new species, wrote a preliminary description and added a determination slip “*Chenopodium stipitatum* Aellen sp. n.; Aellen 1967”. He also removed a very small part of an inflorescence and some seeds for his herbarium. In addition to the fragment in an envelope, sketches of the inflorescence and leaves were mounted on sheet no. 24481 of Aellen’s Herbarium (now in G), and a handwritten German description of a new species, *C. stipitatum* Aellen, was added. In 2011 another fragment of this specimen was found in B. For some reason P. Aellen sent part of his fragment to Berlin, to Hildemar Scholz. In 2011 H. Scholz could recall neither the history of this specimen, nor why it was sent to him.

Ten years later the taxon was described from China as a subspecies of *Chenopodium urbicum* (Kung *et al.* 1978). The original description of subsp. *sinicum* and the emended one in the Flora of China (Zhu *et al.* 2003) also well characterize the taxon. However, this subspecies has never been identified outside of China. Before the description of subsp. *sinicum*, the taxon was generally determined as *C. urbicum* in China, and sometimes as *C. hybridum*. Recent Chinese collections have mostly been correctly determined, and it is reported from many northern provinces in Zhu *et al.* (2003).



FIGURE 2. The distribution of *Oxybasis micrantha* (dots) based on the specimens seen, and *O. gubanovii* (triangles) based on Sukhorukov (1999, 2002) as well as additional Chinese specimens seen.

The related *O. urbica* has not been well understood in the area, and in addition to *O. micrantha* many exsiccata of *Chenopodium urbicum* actually belong to *O. rubra* or *O. chenopodioides*. Many specimens have been collected in an early stage of development, and this may be a partial cause of misidentification. *O. urbica* seems to be a rare alien plant in Eastern Siberia and the Russian Far East, and it is not yet reported from the eastern provinces of China (Zhu *et al.* 2003). In the fruiting stage it is easily distinguished from *O. urbica* by its small, stipitate flowers with 5 or 4 spreading, narrow perianth segments and the smaller seeds, which are horizontal and vertical, reddish and keeled (Table 1). Although flowers are at first more or less sessile in both species, in the fruiting stage they are usually distinctly stipitate in *O. micrantha* and \pm sessile in *O. urbica*. In

the vegetative state *O. micrantha* is more difficult to recognize, because its leaf shape is quite variable. The leaves are in general olive (not dark) green, and thinner and larger than those of *O. urbica*. Teeth are usually only few in number and variable in size, sometimes lobe-like and often they have more acute apices and lobes. The bases are broadly attenuate or cuneate to \pm straight, but not over 180° as is common in *O. urbica*.

TABLE 1. Morphological differences between *Oxybasis rubra*, *O. micrantha*, *O. gubanovii* and *O. urbica*.

	<i>O. rubra</i>	<i>O. micrantha</i>	<i>O. gubanovii</i>	<i>O. urbica</i>
Plant height	Up to 150 cm	Up to 200 cm	Up to 70 cm	Up to 100 cm
Lower leaf blade	Fairly thick, to 15 cm long, rhombic	Fairly thin, to 30 cm long, triangular-hastate to trullate	Fairly thin, to 10 cm long, triangular to rhombic-triangular	Fairly thick, to 20 cm long, \pm triangular
Leaf margin	Coarsely serrate–dentate, basal teeth lobe-like, forward-directed; not undulate	Entire to sinuate or with few teeth of varying sizes, basal teeth prominent; often undulate	Entire; often undulate	Dentate with outward-directed teeth, quite similar in size; not undulate
Flowers in fruiting stage	Sessile, glomerules dense	Stipitate, glomerules loose	Stipitate, glomerules loose	\pm sessile, glomerules dense
Perianth lobes / segments at fruiting stage	(4–)5 (apical flowers) or 3 (lateral flowers) lobes, not spreading, unchanged, back not or scarcely keeled, midrib not visible inside	4–5 segments, spreading, unchanged (obovate, back without keel) and elongated (lanceolate or oblanceolate, back with small tubercle), midrib clearly-visible and prominent inside	2–4 segments, not spreading, elongated in fruit, oblanceolate or oblong, back with rounded tubercle, midrib not visible inside	5, seldom 4 deeply divided lobes, in part spreading, unchanged, obovate, back somewhat swollen apically, midrib clearly visible inside
Pericarp	Ruptured irregularly and easily removed; not papillate (Fig. 3A)	Persistent but scraped off; in fresh and soaked fruits with mamillae (Fig. 3B), which are crater-like in dry fruits	Persistent and hardly able to be scraped off; in fresh and soaked fruits with mamillae (Fig. 3C), surface appearing smooth in dry fruits	Persistent but easily scraped off; in fresh and soaked fruits with conical papillae (images in Sukhorukov & Zhang 2013), which are crater-like in dry fruits
Seeds	0.6–0.8(–1.1) mm, red, flattened or slightly concave, margin obtuse or acute, testa with curved cell ornament and fine-pitted ultrasculpture (Fig. 3D)	0.6–0.8 mm, red or reddish black, slightly convex, margin acute or keeled, testa with fine-pitted ultrasculpture (Fig. 3E)	0.5–0.7 mm, red, strongly convex (inflated), margin sharply keeled, testa with fine-pitted ultrasculpture (Fig. 3F,G)	1.0–1.2 mm, black, slightly convex, margin obtuse, testa with curved cell ornament and scattered pits (Fig. 3H)
Embryo position	Horizontal in terminal flowers, vertical in lateral ones	Mostly horizontal, rarely vertical	Almost always vertical	Almost always horizontal

Oxybasis micrantha and *O. gubanovii* share some common features of leaf morphology as well as having stipitate flowers, more or less enlarged perianth segments in the fruiting stage and small seeds. However, *O. gubanovii* is smaller, its leaves have entire margins and the seeds are almost always vertical. Important differences from *O. rubra* include stipitate flowers, almost free perianth segments and more or less similar terminal and lateral flowers in a glomerule.

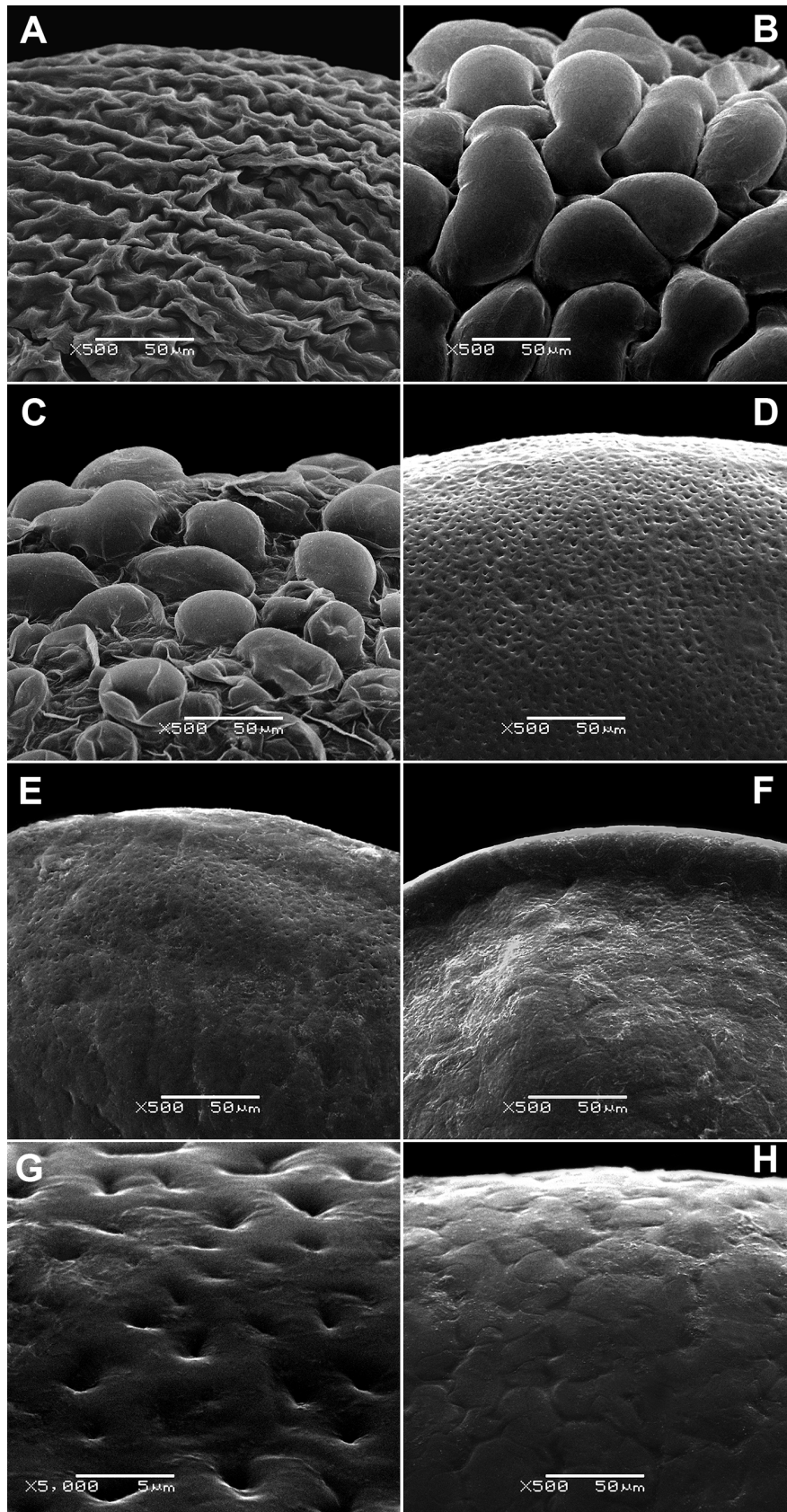


FIGURE 3. A–C: Pericarp surface under SEM after soaking and critical point drying. D–H: Seedcoat ultrasculpture. A: *Oxybasis rubra* (Russia, Tula, no date, *Tsingler & Kozhevnikov 613*; MW); B: *O. micrantha* (China, Peiping, Prince Park, 1934, *Kung 3771*; PE-00540057); C: *O. gubanovii* (Mongolia, Altai, vallis fl. Bulgan, 12 August 1982, *Gubanov 5577*; MW); D: *O. rubra* (Russia, Tula, no date, *Tsingler & Kozhevnikov 613*; MW); E: *O. micrantha* (China, Jinghe, Tuotuo, 31 August 1957, *Guan 4782* (XJBI-00005764)); F–G: *O. gubanovii* (Mongolia, Altay, August 2002, *Ebel & Rudaya*, no voucher); H: *O. urbica* (Russia, Kalmykia, Chernozemelsk distr., October 1996, *Neronov s.n.*; MW).

Additional specimens examined:—CHINA. Xinjiang: Bortala, 21 August 1878, *Regel s.n.* (K, LE); Qitai, grassland, 24 July 1956, *R.C. Ching 655* (PE-00540073); Nanhu, 24 July 1956, *Z.Ch. Chin 650* (LE); Xinyuan, 24 August 1957, *Guan 3774* (PE-00235138); Jinghe, Tuotuo, wasteland, 31 August 1957, *Guan 4782* (PE-00540071 & XJBI-00005764); Yanqi, 13 August 1965, *anonym 651413* (XJBI-00005774); Qapqal, humid place, 29 August 1978, *Xizhi Xinjiang Team 3345* (PE-00235136); Fukang, 7 September 1978, *sine coll s.n.* (herb. Xinjiang Medicinal Institute); Emin, 12 June 1986, *Leng & Fuan s.n.* (herb. Xinjiang Medicinal Institute); Xinhe, 27 June 1986, *Zhiqiang Lian s.n.* (herb. Xinjiang Medicinal Institute); Burjin, woodland, 25 August 1986, *Xiaoqiang Ma et al. 86-0694* (XJA-00032767); Inner Mongol: [Ordos] Uxin, grassland, 8 August 1953, *Fu 7201* (PE-00235139); Shansi [Shanxi] prov.: Inter Yu-tze et Tung-ya, in arenosis salsiliferis humidis, Linfen, ruderal, elev. 800 m, 9 October 1924, *Smith 7934* (PE-00540062); Huozhou, 27 September 1935, *Wang 3873* (PE-00540060); Shensi [Shaanxi]: Near Ch'angan Hsien, Ts'aot'an, 2 July 1933, *Wang 1279* (PE-00540068); Yulin, humid place, 22 July 1953, *Fu 7008* (PE-00540067); Zichang, humid place, 5 September 1953, *Fu 7605* (PE-00540065); Hopei [Hebei]: Peiping [Beijing], 15 September 1905, *Yabe s.n.* (PE-00540049); South of Peking, among reeds, 3 October 1920, *Cowdry 1016* (K); Peiping, Prince Park, 29 September 1930, *Liou 1605* (PE-00540055), 1934, *Kung 3771* (PE-00540057); Leting, 8 June 1950, *Hou 10148* (PE-01218912); Yongnian marshes, 12 August 1972, *Yong 29* (PE-01218917), 15 September 1972, *sine coll. 215* (PE-01218918); Yongqing, along a stream, 30 September 1972, *sine coll. 97* (PE-01218915); Shantung [Shandong]: Zhanhua, 14 August 1955, *Zhou 213* (PE-00540063); Kirin [Jilin]: Zhenlai, sandy and alkali land, 8 August 1959, *Ren 104* (PE-00540048); Heilungkiang [Heilongjiang]: Anda, 16 September 1951, *Skvortsov et al. 843* (PE-00540044); Tsitsikar-Charbin, in salsis, 16 September 1958, *Lavrenko & Czen 62* (LE). KAZAKHSTAN: Turgay: Bolshye Barsuki sand massive, near Chelkar, saline, 14 August 1907, *Androsov s.n.* (LE); Kostanay: Naurzum, Kos-kopa, 29 July 1900, *Kucherovskaya 1692* (LE); Pavlodar: Bayan-Aul prov., near the river, 11 August 1955, *Tzvelev et al. 1690* (LE); Kzyl-Orda: Perovsk, Karauzyak station, 16 August 1912, *Nikolsky s.n.* (LE); Semipalatinsk [Semey]: [Borodulikhinsky distr.] Aul railway station, 16 August 1921, V.I. Vereschagin *s.n.* (LE); Charsk, 15 August 1928, *Ovchinnikov 2239* (LE); Almaty: Heptapotamia, the lower reaches of the Karatal river, floodplain, 1 August 1928, *Smirnov 697* (MW); floodplain of Aksu river, between *Phragmites*, 21 August 1930, *Chernyakowska 523* (LE); Almaty: Talgar distr., southern part of Kapchagay Reservoir, 5 September 1993, *Golub s.n.* (TLT). MONGOLIA. North part, Koin-aul, 1 August 1924, *Kondratyev 519* (LE); Locus ignotus: Altai australis, 1876, *Potanin s.n.* (LE). RUSSIA. Tyumen: Ishim distr., between Gavrina et Udalovo vill., saline soil, 18 August 1912, *Gorodkov s.n.* (LE); Kurgan: Mokrousovsky distr., Poloyskaya vill., weed in the vegetable garden, 28 August 1929, *Inavova & Shikhova 2427* (LE); Tomsk: [Parabelsky distr.] valley of the Kenga river, sands, 21 July 1911, *Kuznetsov 1380* (LE); Novosibirsk: [Toguchinsky distr.], Doronino vill., 17 July 1912, *Kuznetsov 1604* (LE); Barabinsk [without data], *Vagina s.n.* (MW); Altaysky krai: Barnaul distr., Borovye lakes, saline soils, 3 August 1913, *Reverdatto s.n.* (LE); Tyva Republic: confluence of Biy-Khem & Ha-khem rivers, vegetable garden, 16 August 1916, *Miklashevskaya s.n.* (LE); Krasnoyarsk: Minusinsk distr., Syda river, abundant, 24 August 1908, *Volkov 294* (LE); Minusinsk, ruderal, abundant, *sine die*, *Clemens & Pisarev s.n.* (MW); Chita: Dauria Biosphere Reserve, 54 km SSE Nizhny Casuchey, Ulan-Nur Lake on W side of Barun-Torei, 50°02' 22" N, 115°24'45" E", elev. 600 m, inner belt of salt marshes, 11 September 2003, *Freitag 33137* (H, KAS); Primorsky krai: Shkotovo, Ussuri Bay near the Maihe river mouth, mollisols, 17 September 1921, *Shishkin 1401* (MHA).

2. *Oxybasis gubanovii* (Sukhor.) Sukhor. & Uotila, *comb. nov.*

Bas.: *Chenopodium gubanovii* Sukhor. (Sukhorukov 1999: 493). Type:—MONGOLIA. Altai Mongolinense, vallis fl. Bulgan ad meridiem 35 km ad pagum Bulgan in ditio Bajan-Ulegej, elev. ca. 2000 m, 12 August 1982, *Gubanov 5577* (holotype MW!, isotype LE!).

Description:—*Oxybasis gubanovii* resembles *O. urbica* and *O. chenopodioides* especially in the following

features: basally branched stems, entire leaves and habit. However, the flowers are different. They are characterized by 2–4 free perianth segments which become longer and thicker in the fruiting stage in *O. gubanovii*, while in the other species the perianth is more or less lobed and unchanged in fruit. The pericarp is hardly able to be scraped off from the seed coat and the seeds are vertical, with keeled margins (for a more detailed description and illustration, see Sukhorukov 1999). The carpology of this taxon is studied and discussed by Sukhorukov & Zhang (2013).

Distribution:—*Oxybasis gubanovii* is known only from Central Asia (Mongolian and Russian Altai, southern Siberia and Eastern Kazakhstan), with isolated finds from the Kazakh Uplands (Sukhorukov 1999, 2002). Its frequency is uncertain, but it is a fairly common weed in some parts of Mongolia (Alexander Ebel & Natalya Rudaya, pers. comm.). Now we report it also from the Chinese Altai (Fig. 2).

Taxonomic notes:—Sukhorukov (1999) described *C. gubanovii* as a member of *Chenopodium* sect. *Pseudoblitum*, but Fuentes-Bazan *et al.* (2012b) did not transfer it to *Oxybasis* because the perianth lobes deviate slightly from those found in other species of sect. *Pseudoblitum*, and resemble to some extent those of the morphologically very variable genus *Blitum*. Subsequently, the affinity to *Oxybasis* was demonstrated by fruit and seed anatomy: carpological traits, especially seed characters such as red colour and impregnation of tannin-like substances (stalactites) in the outer seed coat (testa) cells correspond well with other species of *Oxybasis* (Sukhorukov & Zhang 2013).

Additional specimens examined:—CHINA. Xinjiang: Altay Beitun, grassland, 30 August 1964, *Chu et al.* 7021 (PE-00540075); Fuyun, 28 August 1980, *sine col. s.n.* (herb. Xinjiang Medicinal Institute). The Chinese specimens were originally determined as *C. urbicum*.

Discussion

The inclusion of *C. urbicum* in the genus *Oxybasis* may seem incongruous due to the presence of black seeds with a horizontal embryo (Sukhorukov & Zhang 2013), but the morphologically most closely related species, *O. micrantha*, combines characters of *O. urbica* with those more typical of members of *Oxybasis* (presence of both vertical and horizontal seeds in a single individual, red seed colour, presence of mamillae on the pericarp). In the MP phylogenetic tree (Fig. 4), *O. urbica* appears in a clade (bootstrap value 79%) with *O. gubanovii* + other related *Oxybasis* species with hyaline perianth segments (*O. chenopodioides*, *O. rubra*, and *O. micrantha*). In the ML phylogenetic tree (Fig. 5), both *O. gubanovii* and *O. micrantha* form a clade with *O. chenopodioides* and *O. rubra* with moderate bootstrap support (76%). In both the MP and ML phylogenetic analyses, *Oxybasis gubanovii* and *O. micrantha* form a clade with other *Oxybasis* species with high bootstrap support (MP 90%, ML 99%). The sectional division of *Oxybasis* proposed by Mosyakin (2013) needs to be clarified using all species of the genus.

The morphological delimitation of the taxa with (almost) free hyaline segments is difficult. The most valuable characters for identifying all the species related to *O. rubra* are seen at the fruiting stage and are connected with the perianth (which may be enlarged or otherwise), and with the fruit and seed characters. The table 1 shows the diagnostic characters useful for identification of the species within the group. However, there is one further Central and Western European taxon of uncertain affinity, *C. intermedium* Mertens & W.D.J. Koch (1826: 297) recently combined as *Oxybasis rubra* var. *intermedia* by Bock & Tison (2012), which requires further investigation.

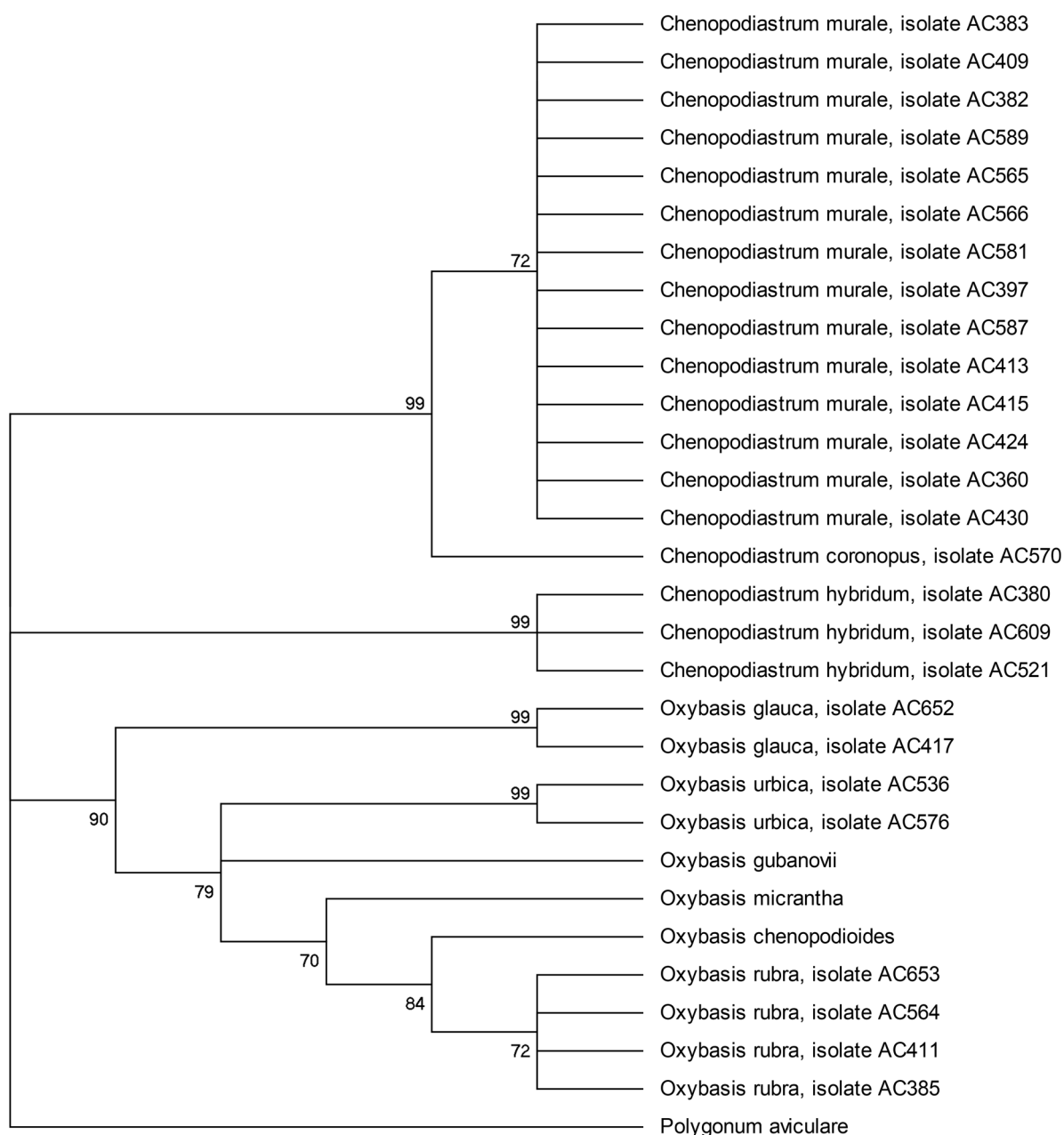


FIGURE 4. Parsimony cladogram inferred from ITS1 nucleotide sequences from *Oxybasis* sp., *Chenopodiastrium murale*, *C. hybridum* and *C. coronopus*. Bootstrap consensus tree built by Maximum Parsimony method. Bootstrap values higher than 70% are shown. The tree was rooted with *Polygonum aviculare*.

Acknowledgements

We are grateful to D. Iamónico, editor of Caryophyllales section of “Phytotaxa”, I. Belyaeva (Royal Botanic Gardens, Kew), M. Christenhusz (Finnish Museum of Natural History), Geoffrey Harper (Royal Botanic Garden Edinburgh) and Maria Kushunina (Moscow State University) for useful discussions, and to the staff of the herbaria visited for help and provision of working facilities and permission to obtain fruits from herbarium specimens. We also thank E. von Raab-Straube (Berlin-Dahlem Botanical Garden and Botanical Museum), who discussed the Berlin specimen with H. Scholz, and N. Bell (Finnish Museum of Natural History) for improving the English and discussing the molecular part of the article. The study was carried out with the support of an RFBR grant (11-04-00123-a) and a grant from the Chinese Academy of Sciences (2012T1Z0020) to A. Sukhorukov.

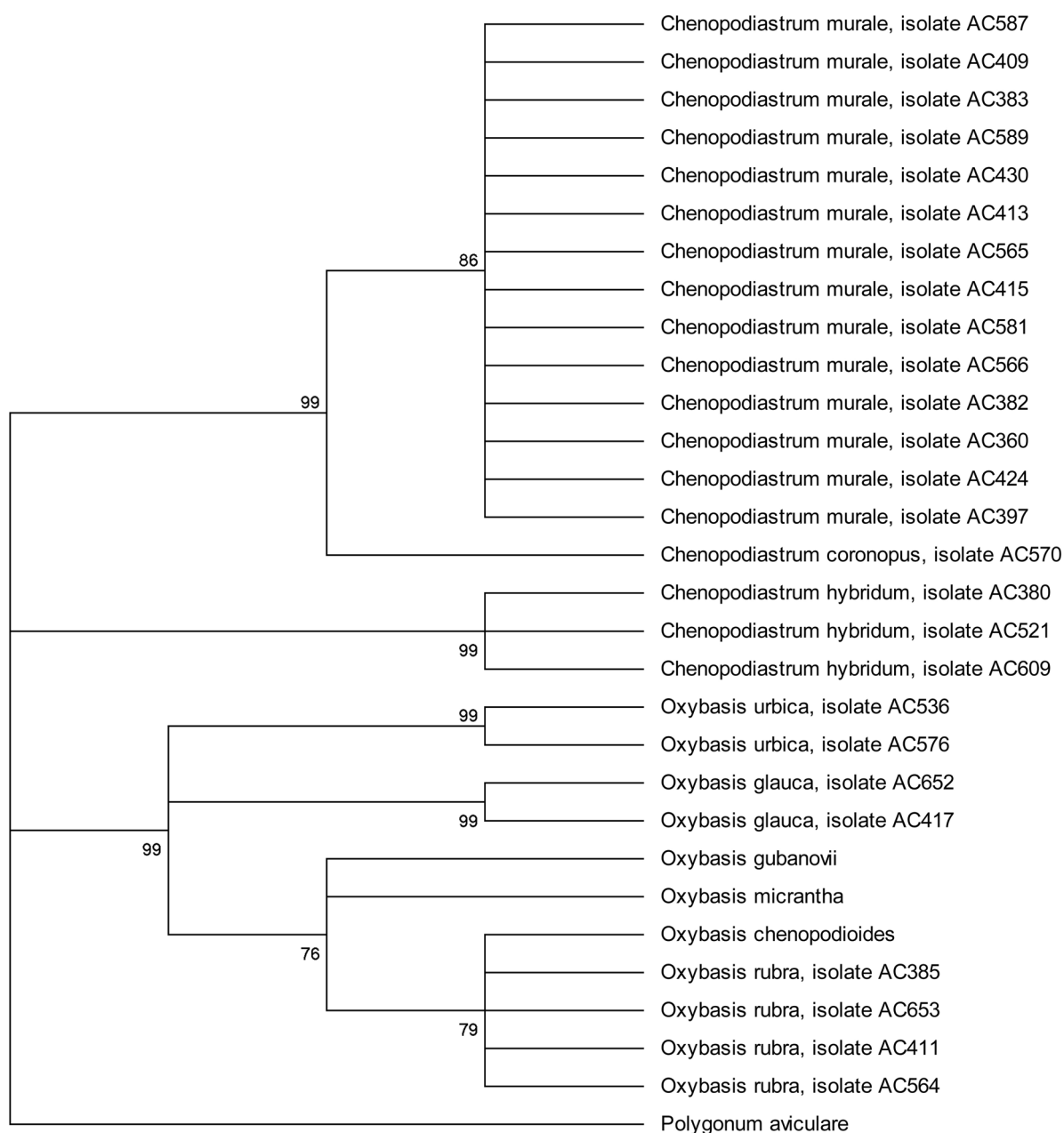


FIGURE 5. ML phylogenetic tree of ITS1 nucleotide sequences from *Oxybasis* sp., *Chenopodium murale*, *C. hybridum* and *C. coronopus*. Bootstrap consensus tree built by Maximum Likelihood method. Bootstrap values higher than 70% are shown.

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